Environmental and Socio-Economic Aspects of HURRI

A Traditional Agroforestry System in Sindh Pakistan

A Research Study

RDF

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Authored by:	Dr. G.R Keerio
Supported by:	Trocaire
Reviewed by:	Ms. Abida Begum (Program Manager Livelihood, Trocaire, Country Office Islamabad)
Supervision:	Ashfaque Soomro, (Head of Programs, RDF)
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Preface

RDF is proud of printing this book on Hurry plantation, which is a traditional agroforestry practice in Sindh. The study highlights its economic and environmental aspects to promote what benefits this traditional system offers for the improvement of soils, habitat for wildlife, wood production and environment conservation through increasing ability of capturing atmospheric green house gases. This study includes published work on Hurry by various forestry experts and three international studies conducted on the soil fertility improvements, increase in crop productivity and economic and environmental aspects of Hurry. This study also well explains the technical aspects of Hurry, which we hope would be very useful to forest professionals also in understanding and promoting this practice appropriately.

RDF since couple of years is trying to promote this practice in various parts of Dadu, Jamshoro, Mirpurkhas and Sanghar districts for the improvement of soils of degraded lands and mitigate potential impacts of climate change, availability of fodder to animals as well as improve household income of the vulnerable poor.

This book is an effort by RDF to recommend this traditional system as an environment friendly and socially acceptable strategy for the improvement of problematic lands, climate change mitigation, environment conservation and meeting the requirements of wood-based industries. We are thankful to the Trocaire for its support in the development and printing of this book. We are also thankful to Dr. G.R Keerio who has compiled and well organized this study. We hope that this study would be useful for you in planning and promoting this traditional agroforestry system.

Research and Development Foundation (RDF)
January 2015, Hyderabad

Message From Trocaire

I feel great honour to write a message for the book on 'Hurri Plantation' prepared and printed by Research and Development Foundation (RDF) under Trocaire's funded livelihood program in district Dadu. The project besides improving and strengthening livelihood opportunities, also contributes to the environmental conservation. Hurri plantation is one of the major activities of the RDF project. The multiple benefits of the hurry system, as expertly documented by Dr. G. R. Keerio in this study, strongly resonate with Trócaire's efforts to secure sustainable livelihoods and environmental justice. Trócaire is committed to supporting diversified and sustainable approaches to increasing agricultural production, which enhance the natural environment and increase resilience to hazards including climate change. The promotion of the Hurri plantation is not only a traditional source of livelihood, but significantly improves the improvement of soils of degraded farmlands and wastelands also.

I would like to thank the Research and Development Foundation, particularly Masood Ahmed Mahesar and Ashfaque A. Soomro, for their energy and resolve in commissioning this important study. This study would help the reader in understanding important environmental and socio-economic aspects of the Hurri plantation.

John O' Brien
Country Director Trócaire
Country office Pakistan

Trócaire

Summary

Acacia nilotica locally known as Babul or Kikar is indigenous species of southern Pakistan. It is known as the "golden tree" of Sindh province of Pakistan as it is extensively grown in the forests and farmlands. Babul is also the main species of riverine forests and irrigated plantations of Sindh. It is also a main component of agroforestry in Sindh on private farmlands lands by the farmers grown as woodlots, tree lines and scattered trees. It is a multiple use species as it performs wide variety of uses such as fuelwood, constructional timber, farm implements, furniture and pit props in coal mining industries. It is a fast growing species with a rotation of 20 years if managed for large timber and 6-8 years if managed for industrial uses.

Among a wide range of agroforestry practices in Sindh an indigenous agroforestry system locally known as Hurry is commonly used system mostly on farmlands in Hyderabad, Matiari, Sanghar, Mirpurkhas, Shaheed Benazirabad (Nawabshah) districts and in forests all over province for soil improvement and wood production. Hurry is defined as "Growing of Acacia nilotica at close spacing (less than 1 meter between plants) for short rotation (6 to 8 years) over time followed by agriculture crops". Hurry is only block plantation of Acacia nilotica species but the block plantation of other tree species is not called as Hurry.

The main objectives of the Hurry cultivation are improvement of soils of degraded farmlands and wastelands and production of wood required for meeting the requirements of wood based industries especially coal mines and for several domestic purposes. Babul being a nitrogen-fixing tree species has proved ability to capture atmospheric Green House Gases (GHG's), fixes nitrogen gas and transfers to the soils and ultimately improves the soil fertility.

This system is in vogue since 1858 when Sir Bartley Frere, the Commissioner of Sindh allocated an area of 4 ha of state land free of charge coupled with other incentives to farming families for raising tree crops for meeting their local wood requirements and improvements of marginal lands. Although this system has an age-old history and acceptance by the forestry professionals and farmers but no scientific-based research studies were formally laid out so as to quantify the benefits of the system. The only previously produced documents were written by some forestry experts primarily as information papers on various aspects of Hurry targeted to farmers in social forestry programs.

This document titled "Hurry a traditional Agroforestry system in Sindh – highlights on socio-economic and environmental aspects" includes published works on Hurry by various forestry experts and three international studies conducted on the soil fertility improvements, increase in crop productivity and economic and environmental aspects of Hurry.
Three studies were conducted in low fertility soils of Sindh under semi-arid conditions having following aspects:

i) Quantify the effects of Hurry on selected soil physical and chemical properties
ii) Monitor soil fertility dynamics after harvesting Hurry crop and agriculture crop

performances after its harvest

iii) Conduct financial analysis of Hurry to quantify economic and financial benetits

This document is specially directed to assess and highlight role of Hurry on environmental and socio=economic aspects. This effort is an attempt to recommend future strategies for improving Babul tree cover in Sindh for improvement of problematic lands, meeting the requirements of wood-based and coal mining industries. Prior to this, such type of work has not been assessed and documented hence this document will provide a guideline for forestry managers, policy makers, planners and the end users i.e farmers.

Though the demand for variety of uses of this species is increasing day by day, but the productivity is decreasing due to many factors which have created fuelwood and timber shortages on the one hand and overall ecosystem degradation on the other. The factors influencing the growth and development of Babul are climatic, social, economic, edaphic, biotic and political.

The document also describes the roles played by Hurry in different policies and programs at global, national and local perspectives. Its contribution in the economy of country and people are also given. In addition, the prominent uses of Hurry wood and their financial contribution and the marketing system are also described.

At global level the contribution of Babul tree used in Hurry and its part played in meeting the global agenda, although small but significant is discussed. The report also describes in detail the contribution of Hurry in various environmental aspects. Climate change adaptation aspects, environmental ecosystem services and emissions and role of Hurry in climate change aspects is also described briefly.

At national perspective meets the requirement of wood for industries, poverty alleviation, land reclamation, halt water logging and salinity and improve farm income as an effective tool for overall economic development.

At local perspective meets wood requirements, provides feed and fodder for grazing of goats, local needs of people through production of several kinds of roles, associated benefits, productivity enhancement and contribution to socio-economic aspects of people and society at large.

The study concludes with some important conclusions and recommendations for the farmers, foresters, environmentalists, students, industrialists, and other scientific community groups.

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Structure of Report
The report is structured in four sections and one appendix as follows.

Section 1:	Presents to introduction and background of Hurry Agroforestry System, its technical details and previous studies undertaken.
Section 2:	Detailed highlights on socio-economic aspects of Hurry.
Section 3:	Highlights on the environmental aspects of Hurry
Section 4:	Conclusions - Issues, opportunities and recommendations
Appendix I:	Monograph on Acacia nilotica (L) Willd. Ex. Del on Production, Management and Utilization

Section 1

Introduction and Background

1.1 Introduction and Background

The Lower Indus Basin comprising of Sindh province is situated in southern part of the Pakistan. Since time immemorial this plain has been built by the flow of the river Indus out of sediments brought by its colossal waters collected from its vast catchment of different mineral formations. The economy of the area is dependent on the water provided by Indus river system. For the graces it bestows on the otherwise dry desert Sindh, the river is locally known as Mehran – the one that brings favors and kindness.

Sindh is predominantly an agricultural area irrigated through one of the world's largest contiguous irrigation networks. Total land area of the province is 14.09 million ha which accommodates over 30 million people. Climatically it is semi-arid with average 125 mm rainfall during monsoon season and the temperatures during summer and winter reach 45o and 7o C, respectively.

Only 5% of Sindh's area is under forestry, of which the productive forests occupy only 2.3% of the total land area. Forest resources in Sindh are rapidly dwindling, resulting in the shortage of the essential wood products needed for domestic and industrial purposes. Due to increasing population and limited sources of energy, the demand for fuelwood over time is increasing while the supply is continually decreasing. The state forests meet only 10% of the wood demands whereas 90% is contributed by private farmlands. Thus, it is considered necessary to incorporate tree planting in the agricultural systems in order to ensure a sustainable supply of wood. Due to scarce state controlled forest resources and limited wood production the demand for fuelwood is primarily met from the private farmlands where trees are grown in different forms and configurations.

After agriculture and forestry, the 3rd form of land use system in Sindh is agroforestry. Farmers grow trees in different combinations such as wood lots or block plantations, linear plantations along farm boundaries, paths, water channels, tree lines in inter cropping and scattered trees within the farm plots. The predominant tree species grown in all the above agroforestry configurations is Acacia nilotica locally known as Babul or Kikar. This tree is designated as Golden Tree of Sindh due to its multi-ferrous economical and environmental benefits.

Fig. 1: Physiographic Features of Sindh
Source: Report on Status of rangelands in Sindh by Dr. G. R. Keerio 2014

Rural farmers of Sindh practice agroforestry with different tree components for accomplishing a variety of objectives. Acacia nilotica is a predominant tree component in agroforestry practices in the province for

multi-purposes. Hurry is a traditional agroforestry system that has been used by the farmers of Sindh for over a century. This system was started by Sir Bartley Frere, Commissioner of Sindh, in 1958 to meet the fuelwood requirements of the local people and ensure conservation of agricultural lands.

Among a wide range of agroforestry practices an indigenous agroforestry system locally called as Hurry is commonly used system mostly in Hyderabad, Matiari, Sanghar, Mirpurkhas, and Shaheed Benazirabad (Nawabshah) districts for soil improvement and wood production. Hurry is defined as "Growing of Acacia nilotica at close spacing (less than 1 meter between plants) for short rotation (6 to 8 years) over time followed by agriculture crops". The name Hurry is locally used for block plantation of Acacia nilotica (Babul) species but the block plantation of other tree species is not called as Hurry.

The main objectives of the Hurry cultivation are improvement of soils of degraded farmlands and wastelands and production of wood required for meeting the requirements of wood based industries especially coal mines and for several other domestic purposes. Babul being a nitrogen-fixing tree species has proved ability to capture atmospheric nitrogen and transfers to the soils through its root system and ultimately improves the soil fertility.

This study titled, "Hurry – A Traditional Agroforestry System in Sindh and its social, economic and environmental impacts" has been documented by reviewing secondary information published and primary un-published information, field visits and meetings and interviews with the stakeholders, farmers, industrialists, wood producers, wood users, experts engaged in growing and marketing of this agroforestry system and the experts who have been engaged in research and environmental aspects.
Much of the information has also been obtained from the Hurry growing farmers, sellers, users, foresters, researchers and publishers. A thorough search of available literature has also been conducted and used in this document.

1.2 Historical Perspective of Hurry

In 1858, Sir Bartley Frere, the then Commissioner of Sindh province, issued a directive (Circular No. 481 dated 6 March, 1858. He ordered his collectors to allocate up to ten acres (4 ha) of state land, free of charge to farming families to raise trees of Acacia nilotica (Babul) as block plantations. These plantations were locally known as "Hurry Plantations". The notified order issued by the Commissioner is popularly known as Hurry Grant. The objectives of this order were to meet the wood requirements of local people and to ensure conservation of agricultural lands. Other incentives provided at the time of land allotments were remission of land revenue and water rates.

The land allotted to for raising Hurry plantations has since then become the property of the farmers. Hence, this system has a traditional and age old historical background. The ownership of this set aside land, has evolved into an agroforestry system for improvement of marginal lands while providing for local fuelwood and timber needs.

Although these concessions are no longer available, the farmers are still raising Hurry on their lands. The decision to put the land under Hurry is exclusively the farmer's own choice and judgment. The fact that the farmers are still growing Hurry suggests that it is certainly an economic proposition.

The cultivation of Hurry has evolved into an agroforestry system for improvement of marginal lands providing income from the sale of timber and fuelwood and meeting the needs of fuelwood. This trend clearly indicates that cultivation of Hurry is certainly an economic proposition otherwise the farmers would have abandoned this practice long ago.

The incentives for establishing Hurry are:

- the lower water requirement of Acacia nilotica, thus enabling the farmers to divert more water to other agriculture crops,
- the improvement in soil productivity due to the nitrogen fixing capability of Acacia nilotica,
- as a hedge against emergencies to supplement the meager income from farms,
- no landlord-tenant conflicts.
- provide a ready cash for times of economic distress

1.3 Major uses of wood from Hurry

The major uses of the wood produced from Hurry plantations are industrial wood i.e coal mining industry of Sindh and Baluchistan, timber for construction and use of various articles in houses and local markets and industries, fuel wood for cooking and heating in houses and village hotels, implements for farming, household articles and, hedges for protection of farmlands.
Due to strength and hardness of Hurry wood it is a preferred wood in coal mines in the form of pit props of different lengths/sizes locally called as Gatoos and Thaps which are converted into sawn timber. The ultimate objective of these forms of Hurry wood is to provide security from collapse of mines and save the lives of workers working in mines.

1.4 Technical Aspects of Hurry

1.4.1 Hurry cultivation methods

Hurry is grown both on private farmlands and government-owned forest lands. 0n farmlands it is grown on cultivated lands and on problem lands. The objective on cultivated lands is traditional agroforestry for wood production and on forest lands Hurry is grown in riverine forests during flooding in Indus where the objective is only wood production and in irrigated plantations the objectives are wood production from fertile lands and land reclamation of degraded lands.

1.4.2 0n farmlands

Hurry is raised like agricultural crops. 0n farmlands after land leveling and making of irrigation system, and preparing 100*100' plots Babul seed is broadcasted and irrigation water is applied. The water in the first 6 months is frequently applied (3-4 times a month), but later on as the age

of trees increases its frequency is reduced because Babul roots gets established and can utilize the soil moisture.

Some farmers also grow Hurry with cotton crop. Babul seed is broadcasted after germination of cotton and first irrigation is applied. Later on usual irrigations required for cotton crop are applied. After cotton picking the cotton sticks are cut but the Babul seedlings are not cut but protected while cutting of cotton sticks. Afterwards no any agricultural crop is grown but the area is irrigated when required.

1. 4.3 0n forestlands

Hurry is cultivated in Riverine forests and irrigated plantations of Sindh. In Riverine areas the primary objective is establishing of forests. The soil of these areas is sandy loam and fertile. Babul seed is broadcasted during flooding time during pre-abkalani, mid-abkalani and post-abkalani sowings. During mid-abkalani when the flood water starts receding Babul seed is broadcasted. Where the water is deep boats are usually used for broadcasting of Babul but where the water is about knee deep the seed broadcasting is done manually. No subsequent irrigations are applied as there remains sufficient moisture in the soil for quite a longer time and the seedlings attain required growth and required height and root system.

In irrigated forest plantations the objectives of Hurry are to i) increase the tree cover on blank lands through forestation and ii) improve the quality of marginal lands by growing Babul – the nitrogen fixing tree and improve the productivity of these lands. After land preparation and development of irrigation system the plots are prepared and Babul seed is either broadcasted manually or is drilled at appropriate distance. Irrigation is immediately applied and afterwards the area is irrigated when required.

1.5 Hurry rotation and estimates of wood production

1.5.1 Hurry Rotation

The rotation of Hurry depends upon the objective of growing it and the will of the owner. The original rotational length of Hurry was 8-10 years. When the objective is wood production for industrial purposes Hurry is harvested at year 6 to 7. In case the objective is soil improvement the rotation is enhanced for few more years. But due to its benefits and demand in the market the rotation has now-a-days been reduced to 5-6 years. The preferable rotation of Hurry for improvement of marginal lands is still 6-8 years.

1.5.2 Hurry wood production

The yield curve constructed from the data is obtained from 8 - years old hurry shows that a total quantity of 122 cubic meters (m^3) of wood material is produced, of which about 2/3 quantity (82 m^3) is mining timber (wood used in coal mines) and the remaining (41 m^3) fuelwood. Hurry yield depends upon the quality of land and availability of water.

1.5.3 Hurry Production Areas on Farmlands

Hurry plantations are concentrated in the order of priority in districts of Hyderabad, Matiari,

Sanghar, and Mirpurkhas of Sindh province which are considered the main production centers. Initially the farmers of Hyderabad district adopted this system for fuelwood production and later on with the development of coal mining industries in Sindh and Baluchistan and emergence of land degradation problems due to waterlogging and salinity in the cultivated lands, the Hurry was raised for mining timber and soil improvement, respectively. District wise areas under Hurry reported earlier in 1996 are mainly Hyderabad, Matiari, Sanghar, lower part of the then Nawabshah where as it is also scattered on farmlands in Mirpurkhas, Badin and Thatta districts. Soaring populations, more demand for fuel and industrial wood, degradation of fertile lands and the need of immediate financial returns are the main factors for raising more hurry plantations on farmlands.

1.5.5 Hurry seed production and marketing

Production: The sources of Hurry seed are the existing Hurry plantations grown on farmlands. Seed is also collected from the block plantations and scattered Babul trees in the Riverine and irrigated forests. The seed producing areas are identified before the seed is about to ripe. Seed is collected in two ways i) directly from the trees at the time of ripening of pods, dried and separated by sticks ii) from the established goat pounds within the Hurry. The goat owners are allowed to feed their goats while the seed is still in pods and pass through the intestine and collected from droppings. The seed collected through this process is considered as the best quality seed as it passes through stomach of goats and the seed coat becomes soft. The Hurry owner gets the quality seed while the goat owner gets free feed.

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Fig. 3: Hurry seed collection area through goat pounds

Marketing: Marketing of Hurry seed is generally through the direct sell from the seed production areas or from the shops or markets in nearby towns and villages from the shops. The main centers where there are markets of Babul seed are Khaiber, Hala, Saeedabad, Matiari, Tando Adam and other places. The shopkeepers purchase the Babul seed either from forest lands or from the Hurry owners and store in the shops/houses. The preferred seed is from Hurry plantations and collected from goat pounds. There are 1200-1500 maunds of Babul seed at each place which is usually purchased at Rs. 1200 per maund (40 kg) and sold at Rs. 1500 per maund (40 kg).

Fig. 4: Babul pods containing seed

Fig. 5: Hurry seed

1.5.6 Hurry in Social Forestry Programmers

After construction of three barrages on Indus in Sindh during middle of 20th century the biological degradation of arable lands in the form of waterlogging and salinity has emerged due to inadequate drainage and over cultivation for economic gains. This has resulted in decreasing the productive capacity of farmlands ultimately resulting in shortages of goods and services. Apart from expensive engineering solutions of such problems the biological drainage through growing of trees thereby improving soils has proven scientific evidence.

Under such circumstances, Hurry having Babul – a nitrogen-fixing tree, as tree component has proved as a viable system for improving marginal farmlands and wood production. In addition, the main outputs from Hurry are:

i) Industrial timber for coal mining industries in Sindh and Baluchistan
ii) fuelwood for domestic consumption
iii) seed production area for Babul seed
iv) fodder for grazing of goats

1.5.7 Maturity consideration in Hurry

The definition of maturity in trees is as broad as it is in humans. Trees are certainly not considered mature until they are old enough to reproduce and bear seed, but many will continue to grow taller and wider after point is reached. Different species do mature at different ages, dwarf fruit trees bear fruit at 4-5 years but oaks and evergreens may take 10-15 years.

1.5.7.1 Biological Maturity

Biological maturity refers to age when a tree begins in vigor and health and become increasingly susceptible to diseases harmful environmental impacts.

1.5.7.2 Financial Maturity

A tree is financially mature when its rate of value increase falls below a desired level. Maximize financial returns received from trees.

In Hurry the Babul is the only tree species and the objectives are both the economic returns and land reclamation which also ultimately leads to economic returns. Hurry is the short rotation crop of Babul which is usually harvested in 6-8 years but when it is grown in riverine forest then its rotation period is generally 15-20 years. Hence, in Hurry cultivation the financial maturity is considered and practiced than the biological maturity.

Fig. 6 and 7: Mature Hurry plantation

Fig. 6 and 7: Mature Hurry plantation

1.5.8 Incentives for Hurry

Growing trees is a long term investment. Voluntary participation in tree growing is a critical factor. Generally farmers lack the capital to tide them over temporary drops in income. Hence, the extent of participation depends directly on the incentives. The people will grow trees if they convinced that they will profit in terms of time, effort and resources. Important in this decision is the individual's perception of the relative risks involved. Risk aversion is high among poor rural

people.

The incentives which motivate farmers to plant trees may be cost sharing, subsidized credit, exemption of taxes, fixing government support price and providing efficient extension service.

1.5.9 Hurry as Source of Energy

Sindh is the energy deficient province of Pakistan due to its 60% area under wastelands where the climate is arid and the opportunities for tree cover are minimal. 0f all the bioenergy sources wood is the most important fuel for the domestic sector accounting for 45%of the total domestic energy consumption. Its availability is short of its requirement due to low production output both from forests and farmlands.

Woodfuel is the oldest source of energy. Wood is also a ligno-cellolusic material and can be burnt directly for various energy uses or converted to charcoal and modern forms of energy such as, fuel gases, liquid fuels, and the generation of electricity. Wood has an advantage of being not so readily inflammable as other fuels and not so dangerous as electricity. Fuel wood is a cheap source of energy in comparison to other sources.

Fig. 8: Hurry wood depot after harvesting

Forests and farmlands are valuable sources of wood energy and non-wood products. They meet almost entire needs of industrial and fuelwood of the province. The major sources of wood energy in Sindh are the government-owned riverine forests growing all along the banks of river Indus, irrigated plantations, woodlots known as Hurry plantations, canal/roadside linear tree strips, wastelands and private farmlands irrigated from the Indus river canal network. All these energy sources play a significant role in meeting the wood energy for the people, construction

requirements of households and wood based industries also play an important role in physical, biological and social environments of the area.

Woodfuel production is carried out on particular types of land. Basically these are high lands, waste lands, and marginal lands and all of these are usually less productive for agricultural crops. Agro forestry involves the use of trees and shrubs in combination with food, fodder and fiber crops grown simultaneously on the same piece of land.

1.6 Assessment of importance of Hurry through Scientific Studies

Some published documents by various forestry experts have been published in the form of brochures for the benefit of farmers. These studies highlighted the importance of Hurry plantations as a tool for expansion and popularization of this system for social/community programs and as requirements of graduate and post graduate degrees.

The documents published by various experienced foresters/authors are as under:

1.6.1 Previous studies on Hurry

2. The first study on Hurry was conducted and published in 1986 by Mr. M. I. Sheikh, a senior forestry specialist and researcher at Pakistan Forest Institute at Peshawar. This was a pioneering study on Hurry and provided a basis for further research work on different aspects.

3. In 1987, Mr. Manzoor Ali Sangi, forestry professional of Sindh province, as partial fulfulment of requirements of the Master of Science degree at Pakistan Forest Institute, Peshawar conducted survey of Hurry plantings in Hyderabad district of Sindh. He designed a survey questionnaire with the objective to gather reliable information on Hurry in and around Hyderabad district as to why farmers plant Hurry, how farmers plant Hurry and what is the productivity of Hurry.

4. In 1989, Food and Agriculture Organization (FAO) of United Nations under Regional Wood Energy Development Programme in Asia GCP/RAS/111/NET produced a Field Document No. 20 authored by Mr. M. I. Sheikh titled "ACACIA NILOTICA (L.) WILLD. EX DEL. its production, management and Utilization, Pakistan". The study contained description and habitat, silvicultural characteristics, cultivation methods, wood properties and utilization and research aspects.

5. In 1991, Mr. Ghulam Rasool Keerio, an officer of Forest Department, Government of Sindh wrote a Professional Paper on "Analysis of Ecological and Socio-economic factors Influencing Growth and Establishment of Acacia nilotica in Lower Indus Basin of Pakistan". This paper was a partial fulfillment of the requirements for the degree of Master of Science in the College of Graduate Studies at University of Idaho, USA. This research work was divided in three parts; part I gave a general description about Acacia nilotica in Sindh forming the basis of part II analyzed and discussed the climatic, edaphic, economic,, biotic and technical factors influencing the growth and establishment of Babul in Sindh. Part III of paper ended with conclusions and

recommendations synthesized in the light of the analysis of the factors presented in Part I and II.

6. After creation of social forestry wing in Sindh Forest Department the forest extension work in Sindh conducted by Mr. Lala Fazal Ahmed Belai, an energetic and hard working forestry professional in Sindh Forest Department, provided boost in growing of Acacia nilotica Hurry plantations on farmlands. His efforts and dedication in social forestry wing of Forest Department provided a significant head way for incorporating trees as a component in agricultural system by the farming community in Sindh.

1.6.2 Research Studies on Hurry at International Level

Although this system has an age-old history and acceptance by the forestry professionals and farmers but no scientific studies were formally laid out so as to quantify the benefits of the system. It was in early nineties (1991-93) that Dr. G. R. Keerio – a forestry expert of Sindh-conducted studies for his Ph.D program on the soil fertility and economic aspects of Hurry at University of Idaho, USA.

Three research studies were designed and conducted in low fertility soils of Sindh under semi-arid conditions having following aspects:

iv) Quantify the effects of Hurry on selected soil physical and chemical properties
v) Monitor soil fertility dynamics after harvesting Hurry crop and agriculture crop performances after harvest
vi) Conduct financial and economic analysis of Hurry.

The three studies are discussed as follows:

1.6.2.1 Hurry Agroforestry System: Effect on some physical and chemical soil properties

Study objectives

A study was conducted in low fertility soils of Sindh, Pakistan under semi-arid conditions to quantify the effects of an age-old traditional agroforestry system called "Hurry" on selected soil physical and chemical properties. A comparison of results obtained from control (no Hurry) and treatment (age of system) and rotation is presented.

Study Results

Physical Properties of soil: Compared to the control, tree growth within the Hurry system increased soil clay content and water holding capacity and decreased pore space, particularly in the older plantations.

Chemical Properties of soil: Soil pH decreased dramatically from 8.5 to 7.2 over an 8 year period of time. Hurry resulted in increased soil organic matter (0M), total Kjeldahl nitrogen (TKN), available phosphorus (P) and exchangeable cations calcium, magnesium and potassium (Ca, Mg, K). Exchangeable sodium (Na), electrical conductivity and soluble cations (Ca, Mg, K) significantly

decreased with Hurry. Accumulation of beneficial nutrients in the surface soil layer (0 to 15 cm) was greater than in the subsurface (15 to 30 and 30 to 45 cm). The higher levels of OM and TKN observed in the Hurry plantation treatments were probably responsible for improved soil physical properties.

Conclusions of the study
Based on the data of wood production collected from an 8- year Hurry at the time of harvest a yield curve has been prepared which shows that Hurry produces 122 cubic meters of wood material of which 2/3 is the mining timber and the remainder is the firewood.

This study shows that the Hurry agroforestry system is an excellent example of forestry being used on farmlands to reclaim marginal lands. These lands can then be put to multiple uses by the farmers in this region of Pakistan. Based on these results, further research is needed to optimize both economic and biologic factors that make this system the most sustainable.

1.6.2.2 Soil fertility dynamics and crop performance after harvesting Hurry agroforestry system without any artificial fertilization

Objectives of study
The main objective of the study was to monitor soil fertility dynamics after harvesting Hurry and subsequently six consecutive wheat crop rotations.

Results of study
The results presented in this paper describe:

(i) The changes in soil chemical properties 6 years after harvesting a- year old Hurry and
(ii) The yield performance of an irrigated wheat crop without fertilizer amendment for six consecutive years.

The results indicate highly significant differences in changes in soil properties six years after harvesting the Hurry crop.

- Gradual but significant increases were observed in soil pH, electrical conductivity, soluble salts (Ca, Mg and K) and exchangeable sodium (Na) levels after harvesting Hurry and wheat rotations.
- A drastic decrease in soil organic matter, total nitrogen, available phosphorus (P) and exchangeable cations leading to deficiencies of these soil variables was observed over a period of 6 years.
- Compared to the control, wheat grain yield increased significantly up to the fourth year after harvesting Hurry; yield then leveled off in the fifth year and decreased in the sixth year.

Conclusions of study
Following conclusions were drawn from this study:

- The study found that the soil fertility stored by one rotation of the Hurry system lasts up to 5 years after the system's removal, and as a result higher wheat grain yields could be produced without fertilization.
- The study also found sufficient evidence that after 5 years of Hurry removal and continuous cropping the soils require replenishment of N, P and K either by another Hurry rotation, by fertilization or by other reclamation practice.
- Hence, the Hurry rotation for soil improvement should be carried out for 5-6 years in the low fertility soils of Sindh.

1.6.2.3 Financial and Economic Analysis of Agroforestry Hurry system

A study was undertaken to conduct financial analysis of Hurry. Based on method of growing Hurry and associated production alternatives such as wood production, cash crops and nutrient yield incomes, and other supplementary and complimentary benefits two models were examined.

i) The estimates for wood, fodder, seed/pods and miscellaneous products of Hurry and cotton crop were estimated after field investigations.
ii) The estimates of Nutrient Yield were computed from annual increases in Total N during 8- year Hurry in upper 15 cms of soil which was further converted in Total N in kg/ha by assuming weight per ha furrow slice of 2,000,000 kg.

Average mineralization rate of 3% was used for determining the mineralized quantity of N. The mineralized N per ha was valued in financial terms at the rate of $ 0.40 (Rs. 24) per kg as of 1993. Net Present value (NPV), Cost Benefit Ratio (CBR) and Realizable Rate of Return (RRR) at 10% discount rate were used as financial analysis criteria. NPV of model 1 (Hurry grown with cotton and associated benefits from wood production, cash crops and nutrient yield) and model 2 (Hurry grown without cotton and benefits from wood production, cash crops and nutrient yield) works out to be Rs. 42,000 and Rs. 34,000, respectively.

CBR and RRR of above models works out to 1:1.93 and 1:1.87 and 12.33% and 9.64%, respectively.
The results of financial analysis suggested that Hurry is a financially beneficial agroforestry system.

1.6.2.4 Conclusions derived from all above described studies

Following conclusions were drawn from above three studies:

- Studies confirmed the observation and experience-based statements by the farmers/foresters and hypothesis of this research that the Hurry significantly contributes to the problem soils by ameliorating the soil physical and chemical properties.
- Improvement in the soil organic matter is the key factor responsible for changes in the soil properties.
- Hurry help balance nutrient supply, protect leaching and act as buffer against acidity and sodicity/salinity due to beneficial changes in soil pH.
- An important effect of Hurry is creation of nutrient pool in the degraded soils and assured availability for crops followed by Hurry.
- Due to improved NPK levels of soils under Hurry, future inputs such as fertilizer for growing agriculture crops will be reduced for a certain period of time.
- Significant positive changes in the soil physical and chemical properties especially in the root zone of agriculture crops and the soil fertility stored by this system at its harvest could be maintained up to five years even by growing two continuous crops (Wheat and Cotton) without adding any fertilizers.
- Compared to fields without Hurry average per ha increase up to 15% in wheat and cotton crop yields could be obtained without artificial fertilization during the above period.
- Financially, Hurry gives 13% Realizable Rate of Return (RRR), positive NPV and BC.
- Hurry is a sustainable land use and practical management option for solving farmers socio-economic and environmental problems.

Section 2

Highlights of Socio-Economic Aspects of Hurry

2.0 Highlights of Socio-Economic Aspects of Hurry

This section of document highlights the socio-economic benefits of Babul Hurry apart from its other traditional uses. The roles played by Hurry in different policies and programs at global, national and local perspectives are also described. Its contribution in the economy of country and people are also given. In addition, the prominent uses of Hurry wood and their financial contribution and the marketing system are also described.

2.1 Role of Acacia nilotica Hurry in Traditional Forestry Development in Sindh

Acacia nilotica (Babul or Kikar) is indigenous species of southern Pakistan. It is known as the "golden tree" of Sindh province of Pakistan as it is extensively grown in riverine tract of Indus River in Sindh and on private lands in Sindh and Punjab provinces. It is a multiple use species as it performs wide variety of uses such as fuelwood, constructional timber, farm implements furniture and pit props in coal mining industries. It is a fast growing species with a rotation of 20 years if managed for large timber and 8 years if managed for industrial uses.

Babul is the main species of riverine forests of Sindh. It is also grown on private lands by the farmers as woodlots (Hurries), tree lines and scattered trees. Though the demand for variety of uses of this species is increasing day by day, but the productivity is decreasing due to many factors which have created fuelwood and timber shortages on the one hand and overall ecosystem degradation on the other. The factors influencing the growth and development of Babul are climatic, social, economic, edaphic, biotic and political. The professional paper will describe and analyze these factors and attempt to recommend future strategies for improving Babul tree cover in southern Pakistan. Prior to this, such type of work has not been conducted hence this document will be a guideline for forestry managers, policy makers, planners and the end users i.e farmers.

Fig. 9: View of Hurry on farmland

2.2 Role of Acacia nilotica Hurry in Agroforestry System

The third form of land use system in the Indus Basin is agro-forestry. People of the area grow trees along with agricultural crops in different combinations such as woodlots, linear plantations along boundaries, paths, water courses, lines in between the plots, and individual trees. Apart from agro-silviculture systems agro-silvo-pastoral and horti-silviculture systems are also very common in Sindh.

Babul is an important tree component in agro-forestry systems being practiced in Sindh (Keerio, 1989). Among all tree species planted in agro-forestry systems, Babul gets priority by the farmers due to its multiple use and soil improving qualities. For example, in agro-silviculture systems it is grown as 1) individual tree and 2) line and block plantations. In silvo-pastoral and agro-silvo-pastoral systems, Babul, as a good fodder tree, gets priority by the farmers as a tree component.

The private landowners have been practicing agroforestry on marginal lands. The most of which are the traditional practice of using Babul block plantations to reclaim salt affected and degraded lands.

Fig. 10: Babul as component in Agroforestry

2.3 Role of Hurry in Productivity Enhancement of Agricultural crops

Although, these concessions are no longer available the farmers are still raising Hurry plantations. The decisions to put the land under tree crops are exclusively the farmer's own choice and judgment. The fact that farmers are still growing Hurry plantations suggests that it is certainly an economic proposition (Sheikh, 1989). The incentives for raising Hurries are 1) the lower water requirement of Babul, thus enabling the farmers to divert more water to agricultural crops, 2) the improvement in soil productivity due to the nitrogen-fixing ability of Babul, and 3)

as a hedge against emergencies to supplement the meager income from farms. The rotation length of Babul Hurry is 8 years. The predominant uses of the wood are mining timber and fuelwood. It is estimated that the area under Hurry ranges between 30,000 to 40,000 acres in Sindh which indicates that the role this system is very significant.

2.4 Role of Hurry in Promotion of Social Forestry

The term "Social Forestry" was used for the first time by J. L. Westbey, a forest scientist in 9th Commonwealth Forestry Congress in 1968 in New Delhi. Social Forestry refers to a broad range of trees or forest-related activities that rural land owners and community groups undertake to provide products for their own use and to generate local income. Furthermore the term social forestry is used interchangeably with "farm and community forestry" and "forestry for local community development". Social Forestry overlaps with the conventional forestry sector, the agriculture sector, and in many countries with energy sector. In social forestry, the primary focus is on people, on community involvement, and on the trees that offer direct and indirect benefits. In conventional forestry the focus is on the wood and trees.

2.5 Social forestry a tool for rural development

The social forestry is actually an instrument for rural development. The principle underlying the social forestry is not only to utilize every piece of vacant land for growing trees but also to let the people participate and feel at home on their land. Thus social forestry assumes a different dimension as compared to conventional forestry. Conventional forestry meets the demands of society where as the plantations under social forestry program meets the immediate requirement of society.

Social forestry is closely related to the landless and small farming communities in rural areas. They are indirectly dependent on tree growth for green manure, subsoil water, reducing wind velocity, providing a favorable micro-climate and ecological stability.

The social forestry is meant to ameliorate the degraded environment and to meet the day-to-day requirements of villages which include firewood, leaves, fodder, grass, small timber and a variety of produce for cottage industries. Social forestry gives rise to significant on farm and off-farm employment opportunities for farm families and the landless population.

2.6 Social Forestry in Sindh and Hurry Cultivation as its component

It was in 1991 that an Asian Development Bank funded project titled, "Sindh Forestry Development Project" for forestation in riverine and irrigated plantations in Sindh a social forestry was included as a component. Under this project apart from establishment of nurseries for farmland plantations growing Hurry was included as a sub-component. Under this project an area of 1,000 ha was envisaged to be planted under Hurry plantations on farmlands throughout Sindh province. The farmers were given subsidy at the rate of 2500 per ha under the project. Apart from this, all the required expertise was provided to the farmers free of charge.

Since then Hurry has been included as a component in almost farm forestry and social forestry

Fig. 11: Hurry wood in depot being loaded in trucks for sell in wood market

development schemes in Sindh

2.7 Social Forestry programs in Sindh and contribution of Hurry

Various social forestry programs have been initiated in the past which are funded by the international funding agencies namely Asian Development Bank, The World Bank and USAID. The programs have also been funded through the Government of Sindh funded projects. In all the above projects the component of Hurry was a component. Under this component Hurry plantations were established both on the farmlands and forest lands. The farmers were provided all technical and financial support of Hurry.

2.8 Role of Hurry in Poverty Alleviation/Reduction

There is strong nexus between environment and poverty. The rural areas are witnessing rapid deforestation, biodiversity and habitat loss, crop failure desertification and land degradation. Many of these issues are compounded by climate change. Hurry is cultivated both on the government and private lands in the form of forest development in riverine and irrigated plantations and social forestry, community forestry and farm forestry on the private lands. All these forms of Hurry ultimately improves the financial position of people, society and rural economy by developing forests, farm forestry, crop yields improvements and environment at large.

2.9 Bioenergy and Poverty

Employment and income generation obtained from bioenergy cushions impact of dryer poverty. In many parts of the Sindh province where poverty is a way of life, unemployment is a stark reality it is not just the search for food, the most basic of all human needs, that is hard to come by, but also the fuel for cooking the food must be made available. Where there is unemployment the opportunity cost of labor is zero in as much as in many areas there is a market for wood fuels

and other biomass resources, the potential for jobs and income derived from bioenergy is high.

Fig. 12: View of Hurry fuelwood collected and stored in depot

and other biomass resources, the potential for jobs and income derived from bioenergy is high.

2.10 Role of Hurry in rural poverty

There is strong nexus between Hurry cultivation and poverty. Hurry, improves soil and land productivity which ultimately improves the poverty status of not only the people and their families but also of the society at large. The main functions of Hurry are:

- Production of wood and crops
- Increase in organic material and fodder
- Retain water as mini reservoir and reduce runoff
- Lower plants and insects production that helps in decomposition
- Manure and green manure production

In the rural areas of Sindh the poverty and unemployment are the way of life. Woodfuel and other forms of biomass energy sources having potential and being easily available in rural areas provide employment and income generation opportunities. Thus, bioenergy plays a significant role in reducing the poverty of the rural communities.

2.11 Role of Hurry in rural economy

Fig. 13: Mining timber of Hurry used for coal mines

Majority of the people in arid and semi-arid areas support livelihood through agro-pastoral activities in Sindh. The land area is affected by aridity which ultimately affects the people especially in rural areas. Land degradation is mainly due to four major causes namely water erosion, wind erosion, salinity/sodicity and water-logging. All these factors ultimately affect the rural economy through land degradation and ultimately low crop yields. Babul being nitrogen fixing tree improves the quality of land by improving soil fertility and ultimately improved crop yields.

In addition, the Hurry apart from land and soil improvement mentioned above create employment opportunities for people engagement in cultivation and such as land development, sowing, silvicultural operations including cleaning, tending, spacing, watering, protection, harvesting, transportation, sawing, marketing etc.

Through land and soil improvement, cultivation operations, employment generation the sale value of Hurry in the form of wood including mining timber for coal mines, local domestic uses and firewood for cooking and heating etc. and ultimately crop productivity enhancement after harvesting Hurry, the overall impact on local and national economy is substantial.

2.12 Role of Hurry in Maintenance/Increase value of lands

Hurry is an agroforestry system which could also be grown in marginal lands. Babul is the nitrogen fixing tree and has recorded ability to improve poor soils. After harvesting the Hurry crop due to soil improvement the value of degraded/marginal lands increases to a remarkable degree not only for a smaller period but also to a longer periods. The Hurry owners harvest bumper agricultural crops without addition of fertilizers for at least 4-5 years. Hence, the Hurry

is a system of enhancing and maintaining the land value.

2.13 Role of Hurry in Economic Perspective at National and Global levels

From economic perspective the Hurry plays a significant role especially for the farming communities who plant it for wood production and improvement of fertility of degraded farmlands. Hurry wood is also preferred to be used as pit props due to its strength wood and other wood qualities. Due its role in production of mining wood for coal mines, the coal industries are dependent on Hurry wood which ultimately improves the local as well as national economy as the coal produced from mines is used for several other products/industries.

The Hurry is also used for improving the quality of degraded lands. After harvesting of Hurry the degraded lands are improved in soil fertility and the agricultural crops grown on those lands produce not only bumper crops but the chemical and farmyard fertilizer inputs are not given to the crops for 3-4 years after harvesting Hurry crop. The role of Hurry has been determined through research studies and also the experiences narrated by the farming communities during the study.

The above aspects of Hurry prove that it has both financial and economic benefits for the communities and industries which ultimately improve the economy of the country.

2.14 Role of Hurry in Economic SWAP

Swap is defined as the exchange of one type of asset, cash flow, investment, liability, or payment for another nature. Following are the common types of SWAP in the world:

Currency SWAP: It is mechanism of simultaneous selling or buying of a currency to current debt principal from lender's currency to debtor's currency.
Debt SWAP: Exchange of a loan (usually to a third world country) between banks
Debt to equity SWAP: Exchange of a foreign debt (usually in a third world country) for a stake in the debtor country's national enterprises such as power or water utilities
Debt to debt SWAP: Exchange of an existing liability into a new loan, usually with an extended payback period
Interest rate SWAP: Exchange of periodic interest payments between two parties – called counter parties

2.15 Hurry wood distribution system

Hurry is generally sold on per ha basis. Number of trees/ha, age of Hurry and the proximity to market are the factors considered while estimating per ha value of Hurry. After reaching the settlement of sale value, the Hurry wood is harvested and converted by the purchaser according to specifications of the coal mining industry. The wood is then transported to bulk depot where grading and sorting is carried out. These mining pit props are locally known as gatoos, are sold to the coal mine owners directly or through agent by the purchaser.

Fig. 14: Hurry Gatoos ready for sale for coal mines

2.16 Hurry wood marketing system

Hurry fuelwood trade is dominated by the retailers. The growers, middlemen, retailers, industrialist and local households are beneficiaries of hurry wood. The roadside retailers in towns and cities conduct the fuelwood market business. The market of hurry has an special peculiarity due to its good quality wood and demand in small and big markets. Babul fuelwood due to its high calorific value (4870 kcals/kg) is preferred in the market and fetches more price than other species.

Fig. 15 and 16: Hurry wood used as firewood being transported for sale in local market

Fig. 17: Hurry wood being loaded in trucks for sale

2.17 Utilization of Hurry Wood

The tree grown in Hurry cultivation is Acacia nilotica. This is considered as a golden tree whose every vegetative underground parts, from root to shoot, is useful for some product. The main products of Hurry are and their uses are as under:

- The twigs and leaves are used as fodder for animals especially goats
- The small wood/branches are used as fuel in households and brick kilns
- The roots, un-wanted and de-shaped wood are used as charcoal
- The straight and sawn stems and branches are used for agricultural implements, house construction material and wood for furniture and other uses
- Wood of Hurry is used for construction of houses and hutments
- The pit props of Hurry wood are used in coal mining industries due to its hardness and other qualities
- The Hurry trees produce gum, lac, and honey and are used by the local people and also sold in local markets and industries.
- Gum is used in medicines and as an adhesive material for binding.
- Branches of Hurry are the best material for fencing materials around houses and agricultural fields
- The bark of Babul is used for tannin for coloring
- Medicinal uses for diarrhea and dysentery disease
- Land stabilization is an important aspect of Hurry
- Nitrogen fixing from the atmosphere and soil adds fertility to the soils especially to the degraded and un-productive lands

2.18 Current market values of Hurry products

Generally the benefits of Hurry revolve around economic, financial and environmental uses as all parts from root are used significantly.

The rates at which Hurry wood is sold as per survey of markets are as under:

Babul Firewood	Rs. 220 / unit
Babul Gutka	Rs. 200 / unit
Babul Gatoo 11 feet size	Rs. 240 / unit
Babul Gatoo 9 feet long	Rs. 225 / unit
Babul Gatoo 7 feet long	Rs. 135 / unit
Babul Munna	Rs. 240 / unit
Babul Planks 4 x 3 x 1	Rs. 19 / unit
Babul Planks 3 x 3 x 1	Rs. 16 / unit
Hurry seed	Rs. 1,500 per 40 kg

Source: Market Survey, 2014

Section 3

Highlights on Environmental Aspects of Hurry

3.0 Highlights on Environmental Aspects of Hurry

In recent years there has been awakening for tree growing for environmental purposes and for meeting the rural needs for fuel, fodder, and timber. Acacia nilotica is one of the species which grows naturally and planted by the farmers since many decades in the semi arid tracts of Pakistan and India. This species is adaptable to the harsh bio-physical and climatic conditions and is quite resistant to pests and diseases. The wood is ideally suited to a variety of purposes such as fuel, fodder, timber, gum etc. The nitrogen fixing ability is an added advantage, which makes it one of the most preferable species for small farmers.
This section of document highlights the environmental benefits of Babul Hurry apart from its traditional uses.

3.1 Description of Environment

The environment constitute the land, water, trees in forests, farmlands and wastelands, climate, air, all forms of biodiversity, climate change, energy and other associated areas on the globe.
The initiatives to assess the contribution of any natural resource and development activity towards environmental aspects is considered a step forward towards meeting the International and National Agendas on which Pakistan is signatory. The trees not only bring the prosperity to the area, increase the productivity of barren lands, improve various ecosystems but also meet the requirements of national and international agenda on environment.

Pakistan recognizes the importance of incorporating environmental concerns as a cross cutting theme in its sustainable development strategy. Due to various social, climatic and biological problems/pressures the overall environment is being affected resulting in several negative impacts on all types of life. The government has initiated the National Environment Action Plan (NEAP) in 2001 as an umbrella programme to address environmental concerns in a holistic manner. The development agenda of NEAP is environmental sustainability and poverty reduction in context of economic growth.

At international level Pakistan is not only a signatory to numerous Multilateral Environmental Agreements (MEAs).but has also shown its commitment to non-legally binding instruments such as Agenda-21Rio principles and Johansburg Plan of Implementation aiming for sustainable development of natural resources. Pakistan is also signatory to CBD, CITES, UNFCCD, UNFCCC, CMS, Ramsar Convention on Wetlands and others. The Government has committed itself to achieving Millennium Development Goals (MDGs) as adopted by UN member states in the year 2000.

3.2 The World Bank in its Report titled, "Agriculture and Rural Development" have reported following quick facts – Why trees in the forest ecosystems are important?

- A single tree can absorb 10 pounds of air pollutants per year
- The average healthy, mature tree produces roughly 260 pounds of oxygen annually. The average person consumes 366 pounds of oxygen per year. Two tree provide enough oxygen for one person per year
- Forests cover 25-30 percent of the earth's land surface and contain about 80 percent of the world's remaining terrestrial biodiversity

- Forests help to maintain the fertility of soil, protect watersheds, and reduce the risk of natural disasters, including floods and landslides
- Forests absorb about 15 percent of the planet's green house gas emissions. At the same time deforestation and forest degradation contribute significantly to those same emissions. (17.4 percent according to the PCC)
- About 13 million hectares of forests – an area of size of Costa Rica – are lost world wide each year

3.3 Role of trees on Environment

There are several environmental and socio-economic issues in Sindh resulting in degradation of physical, biological, social and economical environments of area. It is an established fact that the trees are the answer to above issues by improving the environment and socio-economic aspects for the society. But the trees belonging to family Leguminoceae having nitrogen fixing ability are of paramount importance. The tree like Acacia nilotica is one of them. This is the tree being used in establishing Hurry.

3.4 Role of Trees in Climate Change

A protocol to the United Nations Framework Convention on Climate Change (UNFCC) was adopted in Kyoto (Japan) in 1997 which was later on ratified by Pakistan.
Changing climate is generally deemed mankind's greatest threat in modern times and is likely to have profound consequences for socio-economic sectors like health, food production and security, energy consumption, water resources etc. Global warming is already manifesting themselves in the form of extreme weather events like storms, rising temperatures, tornadoes, floods, and droughts. Babul as nitrogen fixing tree improves the fertility of soils, carbon sequestration, GHG emissions.

Some impacts of Hurry are as under:

- Production of oxygen and absorption of carbon dioxide
- Balance of nature due to its care and maintenance by tree
- Hurry as climate change adaptation strategy

Adaptation is a strategy for minimizing the effects of expected changes in the climate of the area through adaptation activities. The environmental mitigation could best be carried out through investments in forestry initiatives. The Hurry cultivation is an agro-forestry system. In order to mitigate the potential impacts of climate change the contribution would be in the form of afforestation and reforestation, sustainable management practices, carbon sequestration in standing biomass through conservation, substitution of fossil fuels through bio-fuels and carbon sequestration in forest products.

3.5 Environmental Mitigation Priorities

Mitigation measures are those that tackle the causes of climate change as opposed to cushioning against their impact. Mitigation is essentially about reducing green house gas emissions. Pakistan's contribution to the global emissions inventory might be less than 1% at the

moment it will not grow in the future.

The main factors contributing GHG emissions are from local transport and deforestation. The emissions from transport are 13,025,000 tons and deforestation rates account for more than 20% of human GHG emissions. These estimates will go on escalating as our transport sector expands at the annual rate of 7.6% and existing meager (4%) forest resource is dwindling fast adding to the increase of globing warming in the region.

Some of the mitigation measures that should be concentrated on at the moment are as under:
Investing in renewable technologies, including natural gas, hydro, solar and wind

- Shifting towards a less carbon intensive economy
- Creating carbon sinks with forestation programs
- Promoting energy conservation programs and campaigns
- Reducing electricity distribution losses
- Establishing mass public transit systems
- Promoting waste-to-energy programs

3.6 Role of Hurry in betterment of environment

From environment point of view the Hurry performs several functions. Some of them are as follows:

- Absorption of dust pollution
- Detoxification of air and biological monitoring
- Deodorization of air
- Free protective function from against wind and water erosion
- Hurry in carbon storage
- Environmental valuation
- Hurry as carbon sink
- Trees and wetland sinks
- Hurry for earning of carbon credits

3.7 Role of Hurry in environment and economic perspective

There is nexus between environment and poverty. Hurry, improves soil and land productivity which ultimately improves the poverty status of not only the people and their families but also of the society at large. The main functions of Hurry are:

- Production of wood and crops
- Increase in organic material and fodder
- Retain water as mini reservoir and reduce runoff
- Lower plants and insects production that helps in decomposition
- Manure and green manure production

3.8 Opportunities of Hurry in earning carbon credits

There are several opportunities for land owners to benefit from the potential market for carbon credits. The three Hurry-specific opportunities for the landowners of Sindh to benefit from

earning carbon credits as under:

- Renting of land for Hurry cultivation
- Growing of Hurry for carbon credits
- Establishing Hurry for other uses

3.9 Rationale on Carbon Credits

A protocol to the United Nations Framework Convention on Climate Change (UNFCC) was adopted in Kyoto in 1997. This protocol establishes legally binding greenhouse gases (GHG) emission targets for developing countries.

The protocol includes flexibility mechanisms to help countries meet their emission reduction targets. These flexibility mechanisms include the use of carbon sinks and emissions trading. Emissions trading will allow countries and individual companies to buy and sell carbon credits created by activities that reduce the level of GHG emissions.

3.10 Opportunities for Hurry in environmental benefits

Hurry is a carbon sink and could be used as a source of earning credits in light of Kyoto Protocol under UNFCC. The only carbon credits that can be traded to meet emission reduction requirements are those credits arising from carbon sequestration. This means that carbon sequestered are available for sale as carbon credits from Hurry plantations. This aspect of Hurry is significant but is not much understandable both at the government and farmers levels. But this is an established fact Hurry is a remarkable source of trading and earning of carbon credits. The table given below provides a guideline for this environmental aspect including services/products, annual production, values of products from Hurry, annual benefits from standing trees and total value of trees.

3.11 Environmental benefits of mature standing trees

Some benefits of a mature tree based on empirical research and applicable to Hurry are as under:

Products and Services	Annual production	Value of product/ Service or replacement Cost (US $)	Annual benefits that a standing Tree gives (US $)	Total value of trees in ha assuming 100 trees) (US $)
Production of oxygen and adsorption of carbon Dioxide	4.6 tons oxygen 6.3 tons of CO2	120 per year	120	2000
Organic material and fodder	55 kg	150 per year	150	15,000
Retain water as mini reservoir and reduce runoff	30,000 litres	Building such mini reservoir cost 106/year	106	10,600
Lower plants and insects production that helps in decomposition humus and green manure production	Bacteria 40 kg, Fungi 40 kg, earthworms 16 kg, others 3 kg	Synthesis of these products will cost 177, 133 and 118/year	177 133 118	17,700 13,300 11,800

Products and Services	Annual production	Value of product/ Service or replacement Cost (US $)	Annual benefits that a standing Tree gives (US $)	Total value of trees in ha assuming 100 trees) (US $)
Balance of nature due to its care and maintenance by tree	Saving of cost keeping natural balance & limitation of of pests	Artificially such material balance may cost 2130/ha	213	213
Absorption of dust pollution,	Dust	Annual values of these	150	15,000
detoxification of air and biological monitoring	absorption=700 kg, Air detoxification, biological monitoring	services are estimated at 150, 14, and 150/year	14 150	1,400 15,000
Deodorization of air	Deodorants cost per day and per annum	Maintenance of such product may cost 1/day	365	36,500
Supply of water for irrigation and drinking Prevention of runoff	Retention of ground water table for irrigation and drinking Prevention of rainwater runoff	Supply of per ha irrigation and drinking water may cost 3500 and preventive steps for such runoff cost 1000/year	3.50 1.00	350 100
Tree protective function against wind and water erosion	Wind and water erosion control measure Replacement cost of landslides and avalanches Embankments and lakes stabilization	Mechanical measures to protect wind and water erosion may cost 2/year, concrete retaining wall & embankments may cost 145 and 1/year	2.0 145 1.0	200 14,500 100
Maintenance of land value	Land value stabilization	Mechanical land stabilization cost may be 71/year	71.0	7,100
Total			1708.63	170,863.0

Source: ENF0, Bangkok, 1997 and circulation to the Ministry of Environment, Government of Pakistan
Value of carbon credits is a key aspect and most important issue. Estimates have been ranged from $ 2 per ton (C02 equivalent) up to $ 60 per ton.

3.12 Valuation of Environmental aspects of Hurry

No any work on assessment of Hurry for environmental aspects have been done so far but there is dire to work on this aspect of this agroforestry system of Sindh. The research wing of Sindh Forest Department should initiate on this important aspect.

Section 4

Conclusions, Opportunities and Recommendations

4.1 Conclusions

The study reveals that the Hurry Agroforestry system is the best option for soil fertility improvement, income generation for the farming communities and a mitigation measures for the improvement of degraded environment of the farmlands and overall environment of the Sindh province. Thus, the role of Hurry on social, economic and environmental aspects presented in sections 2 and 3 of this document is significantly positive. The study also reveals that there are some issues/ problems in Hurry production, distributions and marketing in Sindh which are required to be resolved through management and technical steps.

4.2 Issues and problems in Hurry

The problems encountered in cultivating, distribution and marketing of Hurry fuelwood are similar to other fuelwood production systems. Some Hurry-specific problems are as under:

- Hurry has not been very common in the province due to large land holdings.
- Involvement of 2-3 middlemen limits the profit of Hurry growers.
- Taxation structure at local council level also reduces the profit to the growers.
- Land owners are the sole beneficiaries of Hurry the tenants are deprived of the benefits.
- Smaller targets of Hurry planting have been kept in the social forestry component of the development projects.
- Little work on valuation aspect of Hurry has been carried out.
- Hurry has not been popularized in most of the districts of Sindh and other suitable areas of Pakistan
- The research on various aspects of Hurry especially on environmental aspects has been limited to only few studies
- There is dearth of literature on Babul and Hurry cultivation at farmers level

4.3 Opportunities for Hurry Cultivation

In Sindh the land degradation problems are increasing day by day due to various climatic and environmental problems. Babul, the indigenous species of Sindh has nitrogen fixing ability thereby improving the fertility of degraded soils. Furthermore, this tree as a component in the Agroforestry system in the form of Hurry is a proved tool for the environmental improvement and meeting the socio-economic needs of the people of the area especially the farming community.

The land degradation, environmental deterioration and associated social problems are increasing resulting in decrease in soil quality, food security, wood production, farm income and overall environment and other associated problems. The opportunities to combat these problems could further be effectively utilized through promotion of Hurry cultivation for soil improvement, poverty alleviation, food production and over all environmental improvement. In this context a social/community forestry program in Sindh with strong awareness and extension components is recommended.

The study revealed that there are following opportunities for Hurry in environmental benefits at local, national and international levels.

- Opportunities for Hurry in environmental benefits
- Opportunities for Hurry in socio-economic benefits
- Opportunities for Hurry in earning carbon credits

Thus, the growing of Babul in the form of Hurry is the answer to such problems and opportunities for improvement of environment, socio-economic and earning of carbon credits internationally.

4.4 Suggestions/Recommendations

Following recommendations/suggestions are made:

- It is to be explored why the Hurry plantations have not been common even after a century.
- The involvement of middlemen in hurry fuelwood trade should be minimized.
- Social forestry programs should give priority to Hurry raising on farmlands..
- Incentives of subsidies, payments in cash, and exemption from land revenue shall be be provided to Hurry growers.
- Fuelwood trade should be tax free.
- Land and tree tenure should be changed, so that the tenants may also be benefitted from Hurry production.
- An effective awareness campaign to further popularize the Hurry Agroforestry System for improvement of degraded lands is the need of time..
- Research is needed to explore the possibilities of carbon credits through sequestration process.

Appendix I

Memograph of Acacia nilotica Tree

Botanical Name	**Acacia nilotica (Linn.) Delile**
Family	Leguminoceae
Sub family	Mimosoideae
Common Name	Kikar or Babul

Description

The tree is an evergreen, thorny, moderate-size tree and 20 meters tall. Diameters up to 1 meter have been recorded. Leaves are compound, 2.5 to 7.5 cm long. The crown form varies from conical to spreading.

The flowers are fragrant, yellow to bright yellow growing in bunches and mature year around depending on sub-species and geographic location. The pods are available 4 to 22 cm long, and also mature year around depending on sib-species and geographic location.

Fig. 18: Acacia nilotica (Babul orKikar) tree grown in the field

Distribution and Habitat

Acacia nilotica most commonly used as Babul or Kikar is one of the most important tree species not only in India and Pakistan but also in the continent of Africa and some middle eastern countries. It is indigenous to Sindh, Utter Pardesh, Gujrat and the northern Deccan.

This is essentially the tree of plains, growing on flat or gently undulating areas.This tree is extensively planted along roads, highways, canal and river embankments, tertiary irrigation systems (water distributaries and water courses. In the riverine forests and irrigated plantations and the farm lands this is the pre-dominant tree species in Sindh.

Cultivation
Babul grows and regenerates well in good conditions but it can also survive but not grow well in drought and under intense competition from weeds or grazing. In order to have good Babul stands the artificial planting has to be undertaken.

Due to importance of this multipurpose tree it is planted in the form of man-made forests under several environmental conditions using different methods of establishment such as irrigated plantations, riverine areas, waterlogged sites, water conservation and drought prone sites, and saline sites.

Silvicultural Characteristics
Habitat and Ecology
Babul is an intolerant, drought resistant tree that grows on a variety of sites. It will tolerate saline, sodic sites if adequate soil moisture is available. It requires precipitation of 125 to 1300 mm/yr. It prefers a semi-arid, sub-tropical climate within a temperature range of 1 to 45o C. It exhibits distinct differences between subspecies as to frost hardiness and drought resistance. At present there are minor problems with seed insects.

Reproduction
Babul is easily reproduced from seed. Pre-treatment of seed with boiling water increases germination. Keeping in cow dung for a week also helps.

Productivity
Babul is relatively fast growing, and will yield 4 to 15 m^3/ha/yr in 20 years. Average height and diameter for 20 years old trees is 10 m and 15.7 cm, respectively.

Management Implications
Babul is a valuable tree and is adapted to a variety of arid sites. It is aggressive and is easily established. It is important in the central and southern regions of Pakistan and its wood is valued for fuel and charcoal. Young trees need protection from grazing. It has great potential as a farm forestry tree. It is useful for controlling erosion in gullied areas and also can be grown on saline, sodic sites for soil reclamation and biomass production.

Wood Properties

Grain	Close grained.
Color	Sapwood is white, heartwood is pinkish white turning to reddish brown.
Density	Specific gravity of 0.75 and a calorific value of 4900 kcal/kg.
Strength	Wood is durable, heavy, hard and very strong.

Distribution of Acacia nilotica in Lower Indus Basin
Babul tree is native to Pakistan and is found in the Sindh, Punjab, Baluchistan and KPK Provinces. It is wild as well as extensively cultivated throughout the world, usually below 600 m in elevation. Babul is widely grown in the Lower Indus Basin in forests, agricultural fields,

wastelands, grazing grounds, near villages, along roads and canals, and in agroforestry systems.

Importance of Babul in Ecological Regions of Sindh

Sindh Province of Pakistan is a land of distinct agro-ecological contrasts having vast agricultural tract irrigated by canal network of Indus, sandy Thar desert, hilly mountainous tract of Khirthar hills and coastal area. Food, fodder and wood needs are primarily met from these areas. Sindh is an energy deficient province of Pakistan due to very limited wood land resources. In the rural areas of Sindh woodfuel is the oldest and primary source of energy for domestic cooking and heating. These major renewable and extremely dependable resources are depleting at a very alarming rate due to overwhelming energy demand of households and other needs coupled with a growing population.

Babul due to its adaptability in all the ecological regions of Sindh finds its place in all the ecological regions and ecosystems.

Following is the importance of Babul in different ecological region of Sindh.

In Government Forests

Forests in Sindh are managed by the government. Both the riverine forests and irrigated plantations contain Babul as the predominant species.

Riverine Forests

Among all the species grown in riverine forests, Babul is the main species and is well distributed throughout these forests. It is estimated that in Riverine forests 75 percent of the constitutes Babul trees, with the remaining 25 percent containing other species (NCA, 1988). Although Babul is well distributed throughout Sindh, the climatic conditions of Lower Sindh are more suitable to Babul. For example young Babul is adversely affected by the occurrence of frost in upper Sindh which ultimately affects the growth and distribution (Keerio, 1976).

Irrigated Plantations

Soils of irrigated tracts of Sindh, where plantations of different species are grown, are suitable for Babul. Out of 0.150 million acres planted in irrigated zones, it is estimated that 85 percent of the areas contain Babul species. This is because it can be successfully grown in marginal lands that have water logging and salinity problems. Every development program initiated by the government in the irrigated tracts uses Babul as the main species to be planted. Because the water supply is assured in irrigated plantations, the areas have been planted with Babul even on the problem soils.

Farmlands

Babul is such a popular tree in Sindh that it is hard to find any agricultural field where it is not grown. Due to its multiple uses such as small timber, fuelwood production, fodder, and its role in improving the soil fertility, it is considered the darling tree of the farmers. The people having large land holdings set aside some area for growing Babul block plantations. Due to variety of

uses, immediate returns, economically beneficial, socially acceptable and climatically suitable, Babul has traditional significance to the farmers of Sindh. It is widely distributed, from scattered trees to sizeable chunks of plantations throughout the Indus river basin.

Fig. 19: Acacia nilotica (Babul or Kikar) on farmlands

Government and Private Wastelands

The areas which are not managed for either agriculture or forestry are termed as wastelands. Their ownership is both government and private. Most of these lands have tree growth and the predominant species is Babul. Though its growth is stunted due to heavy grazing pressure, dry conditions, and overuse for fuelwood collection, Babul still finds its place in these areas. Due to the presence of Babul in wastelands, the value of land increases when these are put to auction by the government or sold by the private people. In the prevailing climatic, edaphic and biotic conditions the present and future use of wastelands is growing of Babul trees.

Linear Plantations

The trees grown along highways, roads, irrigation channels strips/banks and railway tracks are termed as linear plantations. Sindh has a sizeable such areas under these plantations. Here also the predominant species grown is Babul. It is estimated that every year an area of 500 avenue miles is planted with Babul. This forms 90 percent of the total planted area each year under linear plantations. All the linear plantations are managed by the government through concerned departments and looking to their importance a separate forestry wing in the highways department has been created for managing these plantations in Sindh.

Babul in Reclamation Forestry

In Sindh waterlogged and saline soils constitute large areas and have become either un-productive or are at the verge un-productive. Since the Babul has ability to grow in such

Fig. 20: Babul as component of linear plantation on canal banks

problem lands for soil reclamation and making such lands productive for wood production. Babul is planted in such soils/sites in the form of block plantations.

Agroforestry leases by land owners and Sindh Forest Department

Babul and agricultural crops are commonly planted together in a variety of systems. It has been a common practice for farmers to lease lands for 1-4 years for agriculture and sowing of Babul. Sindh Forest Department under Agroforestry Lease Policy, 2004 also prefers to grow Babul as a tree component with crops. Under this policy the lease holders are bound to grow trees preferably Babul in block plantation on 25% area of total leased area. In this system mostly Babul is either planted through seedlings or broadcasted by seed.

Bibliography

- ENFO, Bangkok, (1997) Valuation of carbon credits of mature tree. A circulation to the Ministry of Environment, Government of Pakistan

- G. R. Keerio and M. A. Bhatti (1998). Woodfuel Production and marketing in Pakistan. Paper presented in National Workshop organized by FAO under Regional Wood Energy Development programme in Asia.

- Keerio G. R. (1998). Financial and Economic Analysis of Babul Hurry Plantation. A paper presented at Pakistan Forest Institute, Peshawar, Pakistan.

- Ghulam G. R. (1993). Soil Fertility and Economic Studies of Acacia nilotica Hurry Agroforestry System in Sindh, Pakistan. A dissertation presented in partial fulfillment of degree of Doctor of Philosophy (Ph.D) at University of Idaho, USA.

- Ghulam R. Keerio, Ehrenreich J. H and Mahler R. L (1993). Acacia nilotica Hurry plantation Agroforestry System: Effect on some Physical and Chemical soil Properties. Proceedings of Third North American Agroforestry Conference, 16-18 August, 1993.

- Ghulam R. Keerio, Ehrenreich J. H and Mahler R. L (1993). Soil Fertility Dynamics and Crop performance after Harvesting Acacia nilotica Hurry Agroforestry System without fertilization. Proceedings of Third North American Agroforestry Conference, 16-18 August, 1993.

- Keerio G. R (1976). Genetic Improvement of Babul for high growth rate and frost hardiness through selection and mutation. A thesis submitted to the University of Peshawar for fulfillment of degree of master of Science.

- Keerio G. R. (1989). Prospects of Babul in Agroforestry in Sindh. A project paper (unpublished).

- Keerio G. R. (1989). Agroforestry programme in Sindh Province of Pakistan.

- Keerio G. R. (1990). Artificial regeneration of indigenous species in riverine forests of Pakistan. A paper published in Idaho Forester.

- Keerio G. R. (1990). Opportunities and problems of Agroforestry – My Pakistani Experience. Published in Agro Forestry Today, Nairobi, Kenya.

- Keerio G. R (1991). Analysis of Ecological and Socio-economic factors Influencing Growth and Establishment of Acacia nilotica in Lower Indus Basin, Pakistan. A professional paper submitted for MS degree in Agroforestry at University of Idaho, USA.

- Keerio G. R (1996). Woodfuel production in Sindh with reference to Hurries. A paper presented in
- Manzoor A. Sangi (1987). Survey of Hurry Plantings in Hyderabad district of Sindh.A paper submitted in Forest Education Division of Pakistan Forest Institute, Peshawar, Pakistan.
- Sheikh M. I. (1986). A case study of block plantations (Hurries) in Sindh Pakistan.
- Sheikh M. I. (1989). Acacia nilotica, its Production, Management and Utilization in Pakistan. Food and Agriculture Organization (FA0) of United Nations, Bangkok.
- Siddiqui K. M and G. R. Keerio (1976). Genetic Improvement of Babul through selection and mutation breeding. A paper presented at national seminar.
- Siddiqui K. M. and G. R. Keerio (1978). Mutation beeding in Acacia nilotica through gamma rays. Annual progress report of Pakistan Forest Institute, Peshawar, Pakistan.
- Sirhindi. B and G. R. Keerio (1985). Position Paper on Forestry in Sindh. A report submitted to The World Bank.
- Sirhindi. B and G. R. Keerio (1987). Proposals for Forestry Development in Sindh. A Report submitted to Canadian International Development Association (CIDA)

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Research and Development Foundation (RDF)
A. 50, Sindhi Muslim Cooperative Housing Society, Qasimabad, Hyderabad Sindh
Ph: 92-22-23 227 3201, Fax: 22 265 3219
info@rdfoundation.org.pk