

Agroforestry - An Alternate Land Use Option for Sustainable Dryland Agriculture

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Introduction

Agroforestry, as an approach to integrated land management or alternate land use system, is widely thought to have enormous potential as a source of technological solutions to problems of rural development. Although, agroforestry is an ancient form of land use practice by many generations of rural people in many parts of the country, it is relatively a new field of organized scientific activity. Well-designed agroforestry systems can contribute to the improvement of rural welfare through a variety of direct Production roles (food, fodder, fuel, fiber and small timber etc) as well as through whole range of indirect service roles (soil and water conservation, fertility improvement, microclimate amelioration etc.). Farmers of rural areas in the country are not familiar with improved food, fodder and fuel production techniques due to various reasons. The situation, therefore, need to be tackled by producing most sustainable food-forage-fuel-finance from marginal, sub marginal and less productive and problematic sites in rural areas by development of suitable agroforestry systems like agrisilviculture, alley cropping, agrihorticulture etc.

To explore the potentialities of multipurpose tree species especially nitrogen fixing tree species in different agroforestry systems, experiments at field level were initiated on red chalka soils at Student Farm, College of Agriculture, Rajendranagar, Hyderabad under dryland situation.

Agroforestry practice for soil buildup of poor and marginal soils through ley farming

A field experiment has been conducted for two years (1993 and 1994) during *Kharif* season to study the performance of sunflower in rotation with stylo intercropped with three years old *Dalbergia sissoo*. The results revealed that sunflower when grown after two years stylo and after three years stylo in sissoo plantation gave more or less same seed yields than that of sole cropped sunflower. The cropping after fallow either for 2 or 3 years and continuous cropping in sissoo trees did not prove effective in enhancing the seed yield of sunflower. Growing of legume fodder i.e. stylo for a period of two or three years helped in enhancement of production of sunflower crop, because of improvement in soil build up. Hence an advantage to the intercrops may be taken in the agroforestry system through low cost management by adopting integrated approach of growing leguminous tree species with legume pastures specially poor and marginal soils (Table-1).

Similar experiment at field level was conducted during *Kharif* 2000 to study the performance of rainfed sunflower with six-year-old *Hardwickia binata*. The results of this trial clearly indicated that the seed yield of sunflower was found significantly higher under solecropped sunflower than intercropped sunflower. However, sunflower when intercropped in *Hardwickia* after stylo grown for a period of three years recorded higher seed yields than sunflower intercropped after fallow in *Hardwickia*. The total monetary returns from tree and crop considerably were found higher in intercropped sunflower. This was mainly due to considering the expected returns from the tree at that particular age from the value added products like fuel, pole etc. from the trees (Table-2).

Agroforestry practice for improvement of crop productivity in dry lands

A field experiment was conducted in six years old sissoo plantation to study the performance of rainfed castor in *Dalbergia sissoo* based alley cropping system during 1996 and 1997. The results clearly indicated that seed yields of castor were markedly higher under alleycropping (in pollarded trees) than that of solecropped castor respectively. Application of greenleaf manure under both solecropping and alleycropping increased the seed yields considerably over no greenleaf manure. Monetary returns were also found higher in alley cropping system during both the years, because of value added products obtained from the trees (table-3).

From the field studies conducted during 2003, in 9 years old *Hardwickia binata* plantations, it was observed that the seed yield of sunflower when grown as intercrop in pollarded trees of *Hardwickia* was comparable with that of solecropped sunflower. But the seed yield was reduced considerably under intercropped of sunflower in unpollarded trees. In case of total monetary returns from the system, were found maximum when sunflower grown as intercrop in pollarded trees of *Hardwickia*, but the returns from the system obtained under intercropping of sunflower in unpollarded trees were more or less same as that obtained under sole cropping of sunflower (Table-4)

From the study conducted in *Faidherbia albida* based cropping system during 2001 in 13-years-old plantation it was observed that the seed yield of maize when grown as intercrop in *Faidherbia albida* was markedly increased when compared to that of sole cropped maize without trees. However, the maize equivalent yields of system with combination of cowpea, field bean, soyabean and groundnut grown in *Faidherbia albida* were also found higher than that of sole cropped maize. Total net monetary returns from the system (tree + crop) were increased considerably when maize grown alone or in combination with legume crops in *Faidherbia albida* over maize grown as sole crop. The increased monetary returns under maize based cropping system in association with trees were mainly due to complimentary effect of trees for crop growth coupled with additional income obtained from the tree products like small timber wood, fuel wood etc. (Table-5)

It was clearly evident from the results that the nitrogen fixing trees like *Dalbergia sissoo*, *Hardwickia binata*, *Faidherbia albida* etc., would benefit the dry land farmer in improvement of economic status when grown along with crops in different ways like site enrichment, crop productivity improvement, provision of wide range products (fuel, fodder, green manure and small timber etc.) and finally additional income from the trees.

Agroforestry practice for economic gain for medium dry land farmers

The field study conducted during 2002 in 5 years old guava & curry leaf plantations revealed that the seed yield of soyabean when grown as intercrop either in guava or curry leaf plantation was comparable with that of sole cropping of soyabean. Whereas the total net returns obtained from the system (tree + crop) was found maximum under intercropping of soyabean in curry leaf increased the total net returns from the system in comparison with soyabean grown as sole crop without trees (Table-6)

Hence integration of fruit or economically important trees with arable crops is intended to maximize the land use efficiency to generate supplemental income to medium level farmers in semi arid tropics.

Bio-Diesel plants-An alternative for the development of rural livelihood

Bio diesel is an environmental friendly, renewable fuel that is non-toxic and easy to handle. Blending 20% biodiesel with regular diesel reduces undesirable emissions by 30%, while it is reduced by 90% when pure biodiesel is used.

In India, since there is no surplus production of edible oil, there is a need to promote non edible oil by involving the participation of rural masses for their production. The most suitable species are *Pongamia pinnata* and *Jatropha curcus*. Proper agrotechnologies are essential for utilizing the waste and marginal lands effectively for enhancement of biodiesel production. Further biodiesel plants like Pongamia and Jatropha should find place in agroforestry especially in dry lands, which will help socio-economic development of farmers and finally improve their rural livelihood.

Agroforestry, by virtue of inclusion of perennials and herbaceous plants in the same land management unit, can provide multitude of products and services, can help the resource poor farmers to improve productivity and meet the rural needs like fuel, fodder, green manure, small timber etc., thus act as an alternate land use system for sustainable dry land agriculture.

Table-1: Seed yield of Sunflower (Kg/ha) intercropped with Sissoo

Cropping Systems	1993	1994
Sole cropping	500	485
Continuous cropping in Sissoo	327	337
Cropping after 2 years fallow in Sissoo	292	238
Cropping after 2 years stylo in Sissoo	443	376
Cropping after 3 years fallow in Sissoo	----	268
Cropping after 3 years stylo in Sissoo	----	487

Table-2: Seed yield (Kg/ha) and Total net monetary returns (Rs/ha) from sunflower intercropped with Hardwickia

Cropping Systems	Seed yield (Kg/ha)	Total net returns (Rs/ha)
Sole cropping of sunflower	636	4134
Intercropping of sunflower after stylo in Hardwickia	342	6593
Intercropping of sunflower after fallow in Hardwickia	248	5287

Table-3: Seed yield (Kg/ha) and Total net monetary returns (Rs/ha) from castor alleycropped in Sissoo

Cropping Systems	Seed yield (Kg/ha)		Total net returns(Rs/ha)	
	1996	1997	1996	1997
Sole cropping				
No green leaf manure	435	484	869	1435
<i>Leucaena</i> green leaf manure	549	655	719	1685
<i>Dalbergia</i> green leaf manure	510	633	413	1541
<i>Mean</i>	498	591	667	1553
Alley cropping				
No green leaf manure	589	569	2968	3595
<i>Leucaena</i> green leaf manure	704	754	2532	3921
<i>Dalbergia</i> green leaf manure	671	710	2494	3548
<i>Mean</i>	655	678	2665	3688

Table-4: Seed yield (Kg/ha) of sunflower and Total net monetary returns (Rs/ha) from the system (tree + crop) in *Hardwickia binata* based alleycropping system.

Cropping Systems	Seed yield (Kg/ha)	Total net returns(Rs/ha)
Intercropping in unpollarded trees	306	3231
Intercropping in pollarded trees	688	7523
Sole cropping	717	3433

Table-5: Maize equivalent yield (q/ha) and Total net monetary returns (Rs/ha) from the system in *Faidhebia albida* based agri-silviculture system.

Cropping Systems	Maize equivalent yield (q/ha)	Total net returns(Rs/ha)
Maize alone with trees	26.6	10301
Maize + cowpea with trees	25.6	8891
Maize + field bean with trees	29.2	10126
Maize + soyabean with trees	29.4	11276
Maize + ground nut with trees	21.0	6715
Sole maize without trees	16.7	3764

Table-6: Seed yield (Kg/ha) of Soyabean and Total net monetary returns (Rs/ha) from the system in guava and curry leaf based Agrihorticulture system

Cropping Systems	Seed yield (Kg/ha)	Total net returns (Rs/ha)
Intercropping of Soyabean in guava	739	8021
Intercropping of Soyabean in curry leaf	740	4845
Sole cropping of Soyabean	800	3269