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# Economic Feasibility of Using Organic Mulching Materials in *Cowpea* and Maize Cultivation in the Dry Zone of Sri Lanka

M.G. Punyalal, P. Abeygunawardena[1] and P.T. Bandara[2]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya

*ABSTRACT. Continuous cultivation reduces fertility and productivity of soils due to deterioration of physical and chemical properties. Lack of moisture in the dry lands makes this condition worse and organic mulching is one of the suggestions made to improve such properties of the soils while conserving moisture. This study focuses on the economic feasibility of using straw, Glyricidia and their mixtures as mulching materials in cowpea and maize production in the dry zone of Sri Lanka. The study was conducted at the Agricultural Research Station, Mahailluppallama during Yala 1990 and Maha 1990/91. Benefit cost analysis was used in both financial and economic terms to assess the additional costs over incremental benefits of using different mulches.*

*The production of cowpea in Yala season under rainfed conditions in the dry zone with 2 tons of straw and 2 tons of Glyricidia mulching mixture is the only financially feasible practice. But in economic terms, production of cowpea in the same season either with or without mulches at the tested levels is not feasible. At the same time production of maize and cowpea without organic mulches increases the profitability of the crop. But adding mulching materials however, is economically superior to cultivating it. Promoting moisture conservation practices in the dry zone should be done with specific mulching material tested for their economic feasibility.*

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1 Department of Agricultural Economics and Extension. Faculty of Agriculture. University of Peradeniya.

2 Department of Agriculture. Sarasavi Mawatha. Peradeniya.

## INTRODUCTION

Addition of nitrogen fixing tree slash as mulches on field crop cultivation in tropics has attracted considerable attention due to the enhancement of physical, chemical and biological properties of soils. Incorporation of mulches to the soils has a number of agronomically beneficial effects such as increasing of organic matter content, improving the soil structure, improving earthworm activities, increasing nutrient content, increasing nutrient availability to crops and conserving soil moisture (Abeyratne; 1956 Lal, 1975). Therefore, mulches play an important role in maintaining soil fertility in agricultural lands, particularly in areas where application of fertilizer is expensive.

Paddy straw and *Glyricidia* are among the readily available mulching materials in the rural areas of Sri Lanka. Although these materials decompose rapidly under the dry zone conditions and the beneficial effects may be of short duration in relation to the seasonal patterns of crop growth, they can be used as mulches in field crop production (Bandara, 1991). Under tropical conditions *Glyricidia* is a faster decomposing material than straw although it has more nitrogen content than paddy straw. Mixtures of *Glyricidia* and paddy straw extend the period of nitrogen mineralization and improve uptaking by crops and therefore the mixture is superior to each one of them separately (Lal, 1975; Joachim and Kandiah, 1948; Weerakoon and Seneviratne, 1984).

## PROBLEM

When continuous cultivation is practised in lands. the soil become less productive. The structure of the soil disturbed during land preparation and sometimes loses its moisture retaining abilities. Therefore the soils become vulnerable for erosion and may result in increased runoff and reduced infiltration (Abeyratne, 1956; Bandara, 1991; Sangakkara, 1989; Weerakoon, 1982). At the same time nutrient content of soil decreases through runoff and infiltration thereby availability of nutrients to the plants will be reduced. Hence there is a problem of decreasing fertility and productivity of arable lands, especially in the dry zone of Sri Lanka (Bandara, 1991).

Adding mulches reduces the surface run off and improves the moisture retaining capacity of soil that improves nutrient availability to the plants (Weerakoon and Seneviratne, 1984). Therefore adding organic matter as mulches is often recommended as a good agronomic practice. Although it is agronomically sound to add organic matters when and how much of those materials to be added has to be addressed in economic terms. That is because neither the materials nor application itself is free of monetory charge. Thus when technically sound information is processed, it is important to examine the financial as well as economic feasibility of those discoveries before making final recommendations.

## OBJECTIVE

Studies have shown that organic mulching improves the physical and chemical properties of soil and therefore fertility and productivity of arable lands could be maintained through addition of organic materials as mulches. Past studies show that straw and Glyricidia are among the potentially usable organic mulching materials in the rural dry zone of Sri Lanka. Therefore, the objective of this study was to assess the economic feasibility of using straw, *Glyricidia* and their mixtures as mulching materials in *maize* and *cowpea* production in the dry zone as means to increase productivity of arable lands and to conserve moisture.

## METHOD

It is reasonable to expect that a rational farmer invests upto the point where the additional cost incurred on cultivation (MC) equals to the cash value of incremental crop yield (MR) due to that investment. Standard benefit cost analysis measures the overall benefits over the costs of a project, policy or any programme. Therefore, if one takes the marginal change as a decision to be made it is clear that the rational farmer is explicitly using the benefit cost analysis to make decisions on his investments. Therefore the standard benefit cost analysis framework was adopted as the analytical tool in this study. Two general approaches namely financial and economic analyses were taken to compare additional revenue or incremental benefits over the added cost due to different treatments.

The labour cost per hectare was estimated at the market wage rate of labour in the area. Cost of production of maize per hectare was calculated by adding operations cost of labour such as cost of land preparation, dibbing, earthing up and manual weeding, watching and bird scaring, harvesting and transport to threshing floor, threshing winnowing, transport produce to stores and processing (drying), and cost of inputs. Cost of production of *cowpea* per hectare was obtained by adding operational cost of labour such as cost of general land preparation, manual levelling, seeding, weeding and earthing up, pest control, harvesting and transport produce to threshing floor, threshing, winnowing, and cost of material inputs. Mulching cost was obtained by adding costs of materials, labour and transport. Material cost was the cost of materials measured at market prices of straw and *Glyricidia* in the area. Transport cost was separately calculated by obtaining hiring rates of tractors to transport materials from one mile, two miles and three miles distances. The total cost of production (mulching plus production costs) was separately calculated for one mile, two miles and three miles distances for each treatment.

Improvements of physical chemical and biological properties of soil are represented by the yield. Benefits of adding mulches were obtained by using revenues of selling maize and *cowpea* at farm gate prices in the area. The revenues were obtained at the end of the fourth month of cultivation and annual borrowing rates of 16% and 20% was added to the total cost for the four month period. The benefit cost analysis was separately performed for each treatment to assess financial feasibility of adding mulches under rainfed conditions. Since all the transactions were taking place within a period of less than one year undiscounted benefits and costs were used for the benefit cost analysis.

In the economic analysis, all the market prices were converted into shadow prices by using the conversion factors given by the National Policy Planning Division, Ministry of Policy Planning and Implementation (1991). The following conversion factors were used to adjust the relevant market prices for shadow prices and they are (1) agriculture conversion factor = 0.785 (2) surplus labour = 0.722 (3) chemical and petroleum products = 0.650 and (4) road transport = 0.814. As shown by the National Policy Planning Division there is surplus labour in the agriculture sector. Thus, the conversion factor for surplus labour was used in the calculations (Ministry of Planning and Plan Implementation, 1991).

Seed prices, farm-gate prices of *cowpea*, maize and mulching material prices were converted into shadow prices by using the agriculture conversion factor. Labour wages were converted into shadow wages by using the conversion factor given for surplus labour. Shadow prices of pesticides and fertilizers were obtained by using the conversion factor of chemical and petroleum products. Shadow rates of transport were calculated by using the conversion factor given for the road transport. Since the land rent is a redistribution of benefits, zero value was used as the conversion factor to obtain shadow value of land rent.

## THE DATA

The data were obtained from the thesis research titled "The Effect of Mulching Practices on Soil Properties and Processes in an Agro-forestry System, Sri Lanka" conducted by the third author of this paper P.T. Bandara as a partial fulfillment of his M.Sc. degree course. This study was conducted at the Agricultural Research Station, Mahailluppallama, Sri Lanka during the 1990 *Yala* and in the 1990/91 *Maha* seasons. *Cowpea* was grown in both 1990 *Yala* and 1990/91 *Maha* seasons and maize was grown in the 1990/91 *Maha* season only. In both seasons the crops were grown under rain-fed conditions.

In both 1990 *Yala* and 90/91 *Maha* seasons *cowpea* plots were separately applied with different quantities of *Glyricidia*, straw and mixtures of both *Glyricidia* and straw as surface mulches. A control plot without mulch was maintained to compare the treatment effects. The treatments given to *cowpea* were

(1) two tons of straw per hectare,
(2) two tons of *Glyricidia* per hectare,
(3) four tons of *Glyricidia* per hectare,
(4) four tons of straw per hectare,
(5) a mixture of two tons of straw and two tons of *Glyricidia* per hectare,
(6) a mixture of two tons of straw and four tons of *Glyricidia* per hectare,
(7) a mixture of four tons of straw and two tons of *Glyricidia* and
(8) a mixture of four tons of straw and four tons of *Glyricidia*.

With the control alltogether there were nine treatments. In 1991 *Maha* season experimental plots of maize were treated in two different ways with different quantities of *Glyricidia* and straw. The total number of treatments in 1991 *Maha* were nine, including the control (Bandara, 1991). The treatments given were:

(1) two tons of straw added as surface mulch,
(2) two tons of straw and two tons of *Glyricidia* mixture added as surface mulch
(3) two tons of *Glyricidia* added as surface mulch,
(4) two tons of straw incorporated into the soil,
(5) two tons of *Glyricidia* incorporated into the soil,
(6) a mixture of two tons of straw and two tons of *Glyricidia* incorporated into the soil,
(7) two tons of straw added as a surface mulch and two tons of *Glyricidia* incorporated to the soil
(8) two tons of *Glyricidia* added as surface mulch and two tons of straw incorporated to the soil

## RESULTS AND DISCUSSION

At the end of each season crops were harvested separately and the average yield per hectare for each treatment for each crop was calculated. As shown in Table 1, the control plot of *cowpea* which was free from mulch has given the lowest yield in 1990 *Yala* season while the other plots which were mulched with the mixtures of straw and *Glyricidia* give significantly (LSD = 0.05) higher yields than the control plot. Further, the plots which were mulched with the mixture of 2 tons of straw and two tons of *Glyricidia* give the highest yield. The same treatment give the highest benefit cost ratio of greater than one in the financial analysis (Table 2). Eventhough the yield differences between the control and the treatments of 2 tons of *Glyricidia* and the mixtures of straw and *Glyricidia* were statistically significant, the benefit cost ratios of all the treatments including the control were less than one (Table 2). Therefore the treatments cannot be considered as economically acceptable although the 2 tons of straw and 2 tons of *Glyricidia* mulching mixture is financially feasible. However, it is important to note that the plants were attacked by pod borer in the *Yala* season and the potential yields may have be reduced.

Table 1. Average grain yields of cowpea and maize in Yala and Maha seasons.

| Treatment | 1990 Yala cowpea yield kg/ha | 1990/91Maha cowpea yield kg/ha | Maize yield kg/ha |
|---|---|---|---|
| Control | $124^{c}$ | $790^{c}$ | $1543^{de}$ |
| 2t straw mulch | $255^{bc}$ | $869^{bc}$ | $1375^{e}$ |
| 2t Glyricidia mulch | $404^{ab}$ | $912^{bc}$ | $1683^{cd}$ |
| 4t straw mulch | $302^{abc}$ | $884^{bc}$ | - |
| 4t Glyricidia mulch | $357^{ab}$ | $1020^{abc}$ | - |
| 2t straw + 2t Glyricidia | $481^{a}$ | $1228^{a}$ | - |
| 2t straw + 4t Glyricidia | $472^{a}$ | $1249^{a}$ | - |
| 4t straw + 2t Glyricidia | $387^{ab}$ | $1086^{ab}$ | - |
| 4t straw + 4t Glyricidia | $420^{ab}$ | $1265^{a}$ | - |
| 2t straw / Glyricidia mulch | - | - | $1972^{ab}$ |
| 2t straw incorporated | - | - | $1483^{de}$ |
| 2t Glyricidia incorporated | - | - | $2015^{ab}$ |
| 2t straw /2t Gly.incorporated | - | - | $1922^{abc}$ |
| 2t straw mulch 2/t Glyricidia incorporated | - | - | $2044^{a}$ |
| 2t Glyricidia mulch /2t straw incorporated | - | - | $1752^{bcd}$ |
| CV% | 29.65 | 20.45 | 8.21 |
| LSD | 181 | 243 | 247 |

Means followed by a common letter are not significantly different at 5% level.

Table 2. The benefit cost ratios for economic and financial analysis of cowpea grown in 1990 Yala season.

| Treatment | Benefit cost ratios | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial analysis | | | | Economic analysis | | | |
| | Control | 0<1 mile | 1<2 miles | 2<3 miles | Control | 0<1 mile | 1<2 miles | 2<3 miles |
| Control | 0.48 | - | - | - | 0.30 | - | - | - |
| 2t straw | - | 0.69 | 0.67 | 0.65 | - | 0.49 | 0.48 | 0.47 |
| 2t Glyricidia | - | 1.00 | 0.97 | 0.95 | - | 0.72 | 0.71 | 0.70 |
| 4t straw | - | 0.72 | 0.70 | 0.68 | - | 0.53 | 0.52 | 0.51 |
| 4t Glyricidia | - | 0.73 | 0.71 | 0.70 | - | 0.56 | 0.55 | 0.54 |
| 2t straw + 2t Glyricidia | - | 1.05 | 1.03 | 1.01 | - | 0.80 | 0.78 | 0.77 |
| 2t straw + 2t Glyricidia | - | 0.87 | 0.86 | 0.84 | - | 0.69 | 0.68 | 0.67 |
| 4t straw + 4t Glyricidia | - | 0.77 | 0.75 | 0.74 | - | 0.60 | 0.59 | 0.58 |
| 4t straw + 4t Glyricidia | - | 0.71 | 0.69 | 0.68 | - | 0.57 | 0.56 | 0.56 |

In 1990/91 *Maha* season the highest yield of *cowpea* was reported for the plots which were treated with the mixture of 4 tons of straw and 4 tons of *Glyricidia* (Table 1). But this difference was not statistically different to the treated with the 2 tons of straw and 2 tons of *Glyricidia* mixture. The plots treated with both the *Glyricidia* and straw mixtures have given significantly higher (LSD 5%) yields than the control plots. The control gave the lowest yield (Table 1). In the economic analysis, all the benefit cost ratios were greater than one and the highest benefit cost ratio was reported for the treatment in which 2 tons of straw and 2 tons of *Glyricidia* were used. In the financial analysis too, all the benefit cost ratios were greater than one but the highest benefit cost ratio was for the control which was free of mulch. Although the yield differences were statistically significant, economically they were not acceptable (Table 3).

Treatments in which *Glyricidia* was incorporated into the soil and 2 tons of straw and 2 tons of *Glyricidia* mixture added as surface mulch give significantly (LSD = 0.05) higher yields than the control in maize cultivation (Table 1). The highest yield was reported for the treatment in which 2 tons of straw were added as surface mulch and 2 tons of *Glyricidia* incorporated into the soil. As shown in tables 4 all the treatments gave a benefit cost ratio of greater than one in the financial analysis However, the highest benefit cost ratio was reported for the control. This suggests that the production of maize without mulchesd uring *Maha* season under rainfed conditions increases the profitability of the crop. As far as the economic analysis is concerned all the benefit cost ratios were less than one for all treatments except the control and the treatment of 4 tons of *Glyricidia* incorporated into the soil. Therefore, it is clear that some of the recommended treatments as moisture conservation measures are not economically acceptable (Table 4).

## Sensitivity analysis

In this analysis short term borrowing was allowed to overcome cash flow problems for the necessary investments under the interest rate of 16%. It is however, important to examine the stability of the results under different interest rates. Therefore, sensitivity analysis was carried out and it was found that there was no difference in the results of the benefit cost analysis whether 16% or 20% interest rate was used. Thus

Table 3. The benefit cost ratios for economic and financial analysis of cowpea grown in 1990/1991 Maha season.

| Treatment | Benefit cost ratios | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial analysis | | | | Economic analysis | | | |
| | Control | 0<1 mile | 1<2 miles | 2<3 miles | Control | 0<1 mile | 1<2 miles | 2<3 miles |
| Control | 13.06 | - | - | - | 1.88 | - | - | - |
| 2t straw | - | 2.35 | 2.29 | 2.23 | - | 1.66 | 1.63 | 1.60 |
| 2t Glyricidia | - | 2.26 | 2.20 | 2.15 | - | 1.64 | 1.61 | 1.58 |
| 4t straw | - | 2.10 | 2.05 | 2.00 | - | 1.55 | 1.52 | 1.49 |
| 4t Glyricidia | - | 2.08 | 2.03 | 1.99 | - | 1.60 | 1.58 | 1.55 |
| 2t straw + 4t Glyricidia | - | 2.32 | 2.27 | 2.23 | - | 1.83 | 1.80 | 1.78 |
| 4t straw + 2t Glyricidia | - | 2.15 | 2.11 | 2.07 | - | 1.67 | 1.64 | 1.62 |
| 4t straw + 4t Glyricidia | - | 2.13 | 2.09 | 2.05 | - | 1.72 | 1.70 | 1.67 |

Table 4. The benefit cost ratios for economic and financial analysis of maize grown in 1990/1991 Maha season

| Treatment | Benefit cost ratios | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial analysis | | | | Economic analysis | | | |
| | Control | 0<1 mile | 1<2 miles | 2<3 miles | Control | 0<1 mile | 1<2 miles | 2<3 miles |
| Control | 2.76 | - | - | - | 1.08 | - | - | - |
| 2t straw Mulch | - | 1.40 | 1.35 | 1.30 | - | 0.76 | 0.74 | 0.72 |
| 2t Glyricidia mulch | - | 1.50 | 1.46 | 1.41 | - | 0.86 | 0.84 | 0.83 |
| 2t straw/2t Glyricidia mulch | - | 1.51 | 1.46 | 1.31 | - | 0.93 | 0.91 | 0.89 |
| 2t straw buried | - | 1.42 | 1.36 | 1.32 | - | 0.80 | 0.78 | 0.76 |
| 2t Glyricidia buried | - | 1.71 | 1.65 | 1.60 | - | 1.02 | 0.99 | 0.98 |
| 2t straw/2t Glyricidia buried | - | 1.38 | 1.35 | 1.31 | - | 0.87 | 0.86 | 0.84 |
| 2t straw mulch/ 2t Glyricidia buried | - | 1.50 | 1.46 | 1.42 | - | 0.94 | 0.92 | 0.91 |
| 2t Glyricidia mulch/ 2t straw buried | - | 1.29 | 1.25 | 1.21 | - | 0.80 | 0.79 | 0.78 |

findings of the economic analysis of this study are quite stable and they would not change within reasonable fluctuations of market interest rates.

## CONCLUSION

The results indicate that the production of *cowpea* in *Yala* season under rainfed conditions either with or without mulches is economically not feasible. As far as the financial analysis is concerned all the treatments including the control were not feasible except the treatment using 2 tons of straw and 2 tons of *Glyricidia* mulching mixture. At the same time, production of maize and *cowpea* without organic mulches under rainfed conditions during *Maha* season in the dry zone increases the profitability of the crop. During the same season production of maize with 2 tons of *Glyricidia* mixing with the soil as mulching materials and production of *cowpea* with 2 tons of straw and 2 tons of *Glyricidia* mulching mixture are the most preferred based on the economic analysis. Therefore, if any organized body wants to promote moisture conservation practices in the dry zone, the farmer must be assisted to increase his profit margin.

Data for this study were limited only to one *Yala* and one *Maha* season and it was conducted only in a selected part of the island. Therefore, it is various conditions. Therefore one must be careful in using the findings of this study for various policy recommendations.

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