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LEUCAENA LEUCOCEPHALA HEDGEROWS INTERCROPPED WITH MAIZE AND BEANS: An *ex ante* analysis of a candidate agroforestry land use system for the semi-arid areas in Machakos District.

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LEUCAENA LEUCOCEPHALA HEDGEROWS INTERCROPPED WITH MAIZE AND BEANS. AN *EX ANTE ECONOMIC* ANALYSIS OF A CANDIDATE AGROFORESTRY LAND USE SYSTEM FOR THE SEMI ARID AREAS IN MACHAKOS DISTRICT, KENYA

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Introduction

The number of experiments with *Leucaena leucocephala* mulch to add nutrients to the soil is gradually increasing. Usually, *leucaena* is grown in hedges between annual crops and lopped regularly to provide a leafy mulch for the crops grown in the alleys.

Fuelwood is reported as a by-product of such a land use system, i.e. the woody stems of the leucaena are collected from the fields after the leaves and twigs have been shed or removed.

Torres (1983) reviewed some of the literature on this research and estimated that, on average, about 45 grams of organic N is produced meter $^{-1}$ of hedgerow year $^{-1}$ in the lowland humid tropics and maize production increased by about 5 to 16 kgs for each kg of organic N added.

These results are rather promising; however, so far, very few such experiments have been conducted for the semi-arid regions, where potential biomass production, and therefore nutrient production from leucaena hedgerows, is much lower. Some data are therefore simulated for an *ex ante analysis* of this land use system for the semi-arid areas in Machakos District, where rainfall is bimodal and averages about 600 mm year $^{-1}$.

MULBUD, a micro computer program for the analysis of agroforestry land use systems, has been used to conduct the analysis. Since the program is still under development, some printouts had to be amended to facilitate their reading.

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Assumptions

To analyse whether or not it is beneficial for a farmer to adopt a leucaena hedgerow land use system, a comparison of the farmer's resources in the *with* and *without* hedgerow system is required.

In this analysis, it will be assumed that the existing land use will form the basis for the *without* hedgerow situation. The application of artificial fertilizers as an alternative non-agroforestry technology has not been considered because of its rather high cash requirements as well as the inadequate input supply infrastructure in the area.

Traditionally, maize and beans have been intercropped twice a year in most of the semi-arid areas of Machakos District. Yields fluctuate from one season to the next, as well as from one year to the next, mainly because of low and erratic rainfall. The average seasonal yield is estimated at around 800 kgs of maize and 200 kgs of beans hectare $^{-1}$. It is not expected that these yields will decline much further, since the nutrient status of the soil as well as the organic matter content are already at a very low level.

The introduction of a leucaena hedgerow system within the maize and beans field will reduce the area available for cropping. The land lost for annual crops depends on the spacing between the hedgerows as well as the width of such rows. Torres' paper indicates that within certain limits, a narrower spacing leads to better overall results per hectare. A 2-meter spacing between rows has been assumed for this analysis. Torres, furthermore, assumed a hedgerow width of 0.75 m, however; this has been increased to 1 meter to account for the increased competition for moisture between the annual crops and the hedgerows in the semi-arid areas. Therefore, at the 2-meter spacing, 50% of the field area will be used for hedgerows and the remaining 50% for maize and beans. Because of the semi-arid conditions, it was assumed that the hedgerows will be established with seedlings (1 meter in-row spacing). Replacement of one fifth of the seedlings is assumed to take place in the second season.

The initial harvest is expected to take place 18 months after transplanting and the first crop to benefit is therefore the second maize/beans mixture in the second year. From then on, the hedges are lopped every six months until year 10, when they are assumed to have lost their vigor and have to be replaced by new rows or by a newly developed technology.

The lopping is assumed to take place 2 to 3 weeks before preparing and planting the land with maize and beans. The branches would be spread in the alleys and the woody components would be removed just before ploughing and be used for fuelwood. The remaining, already decomposing, leaves and small twigs would be ploughed into the soil to add nutrients.

It is assumed that total dry matter production m^{-1} $year^{-1}$ is only half of that in the lowland humid tropics, i.e. 0.9 kg. The estimated annual dry matter production from the hedgerows spaced at 2 meters would therefore be 4,500 kg ha^{-1}.

Forty per cent of the dry matter consists of woody components and is assumed to be used for fuelwood, i.e. 1,800 kg per $year^{-1}$ or 900 kg $season^{-1}$.

The remaining sixty per cent is leafy material and small branches, which have a nitrogen content of about 3.75%. The seasonally produced organic N is therefore estimated at about 50 kg ha^{-1}.

At a base yield of 800 kg of maize ha^{-1}, Torres computed an increase of 13.5 kg of maize for every kg of organic N added. Total maize production from the remaining 0.5 hectare is therefore estimated at 400 + 50 x 13.5 = 1,075 kg $season^{-1}$.

The effect of the organic N on the bean yield has not been measured; however, it is generally assumed that the effect of adding N is rather low. The beans may benefit from the organic P obtained from the leucaena mulch (0.27% of dry matter) and it is therefore assumed, in the first instance that from the fourth season onwards the combined effect of the added N and P will offset the reduction in bean production because of the reduced acreage.

Labour and material inputs required for both systems were partly estimated and partly derived from literature.

Results

The *graphical displays* (printout 1) produced by MULBUD illustrate the differences in labour use and flow of net revenue of the two land use systems, i.e. traditional maize beans (model 1) and the leucaena hedgerow system (model 2).

While the first year shows a negative balance of the leucaena hedgerow system, labour use decreases and net revenue flow increases after this initial period. This reduction in labour is mainly caused by the greatly reduced labour requirements for field preparation and weeding, since only half of each hectare is cultivated. Furthermore, lopping of hedgerows which requires additional labour, takes place in a period when demand on labour for other uses is low.

Since all farm resources were costed, the net revenue flow should not be interpreted as a cash flow.

The following three tables, i.e. *material requirements*, (printout 2) *labour requirement and cost* (printout 3) and *summary results* (printout 4) give a detailed account of all inputs and outputs per hectare for both the new and the old land use systems.

The next two printouts (5 and 6) show the net present value of the two systems at varying rates of discount as well as under different assumptions with regard to in/or decreases in assumed costs and revenues. The printouts show that the N.P.V. for the leucaena hedgerow systems at all 4 discount rates is almost double that of the traditional maize/beans mixture. Even if a 20% reduction in gross revenues and a 20% increase in costs is assumed, the N.P.V. of the new land use system is still 25% higher than of the maize/beans mixture.

The sensivity of the N.P.V. of the leucaena hedgerow system to changes in some of the earlier assumptions was also tested.

First of all, a new model (no. 3) was constructed for a leucaena/maize/beans hedgerow system in which the bean yield in the alleys is assumed not to increase as a result of the leafy mulch, i.e. bean production 100 kg ha^{-1} $season^{-1}$ for a period of 10 years. The N.P.V.'s of this model at different discount rates are presented in printout 7, while Graphkit, another micro computer program, was used to plot the N.P.V.'s of the 3 models at different discount rates for a visual comparison (printout 8). The three curves illustrate clearly that at each of the selected discount rates, model 3 results in a significantly higher N.P.V than the traditional maize/beans mixture (model 1).

The sensitivities of both model 2 and 3 was also tested for assumed changes in the organic N production of the hedgerows as well as changes in the conversion rate of organic N into maize.

It was computed that the N.P.V.'s of both models dropped respectively by Kshs 1,459, 977, 716 and 537 at discount rates of 8, 16, 24 and 32% with each drop in maize production of 100 kg $season^{-1}$ (sum discounted value 100 kg maize minus discounted harvest labour cost 100 kg maize from second season second year until year 10).

Based on these declines in the N.P.V., the break-even organic N production and conversion rates were computed for model 2 and 3 at different rates of discount. (Break-even is used here for that organic N production or that conversion rate at which the N.P.V. of model 2 and 3 equal the N.P.V. of model 1).

Table 1 : Results break-even analysis model 2 and 3

Discount	Break-even organic N production (1)		Break-even conversion rate (2)	
rate	Model 2	Model 3	Model 2	Model 3
8	8.0	24.2	2.2	6.5
16	11.1	27.3	3.0	7.4
24	14.5	30.7	3.9	8.3
32	18.4	34.6	5.0	9.3

(1) at a conversion rate of 13.5 ; originally assumed production 50 kg ha^{-1} $season^{-1}$.

(2) at an organic N production of 50 kg^{-1} ha^{-1} $season^{-1}$; originally assumed conversion rate 13.5.

So far, a comparison has been made between the two land use systems on the basis of the N.P.V. per hectare, which is adequate if land is the scarcest resource on the farm. However, this may not be the case on the larger farms, where labour during field preparation/planting and weeding time as well as draught animal power are considered to be the most limiting constraints. Therefore N.P.V.'s were also computed per unit of draught animal power and per man-day.

At a 12% discount rate, the traditional system showed an N.P.V. of Kshs. 9.6 man-day $^{-1}$, while the new system (model 2) showed Kshs. 15.2 man-day $^{-1}$, and the leucaena hedgerow system therefore seems to make a better use of the available labour resources than the traditional maize beans system.

The same was found to be true for the draught animal power resources, since the N.P.V. per unit of draught power was Kshs. 1.459 in the new system and Kshs 435 in the old system.

Conclusion

Land, labour and draught animal power are all used more beneficially in the leucaena hedgerow system than in the traditional maize/beans cropping system.

However, some caution is called for with the interpretation of the results:

(i) Many of the data and management practices of the leucaena hedgerow system had to be simulated and are therefore subject to discussion.

(ii) Seedlings were priced at a very low level because government subsidises them heavily. The real costs are therefore much higher and an analysis from a society's point of view may lower the competitive advantage quite considerably. However, it can be argued that a reduction in the cost of seedlings may be obtained if farmers made use of self-sown seedlings around some early established trees.

(iii) A negative impact on the beans and maize production may occur because of a possible increase in bird, rodent, termite and/or insect population caused by the hedgerows and or mulch. On the other hand, the hedgerows may also favour the annual crops by creating a better micro climate in the alleys.

Nevertheless, the system seems promising enough and should, therefore, be researched so as to pass a more objective judgement on it with an *ex poste analysis*.

References

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Printout 1.

GRAPHICAL DISPLAY

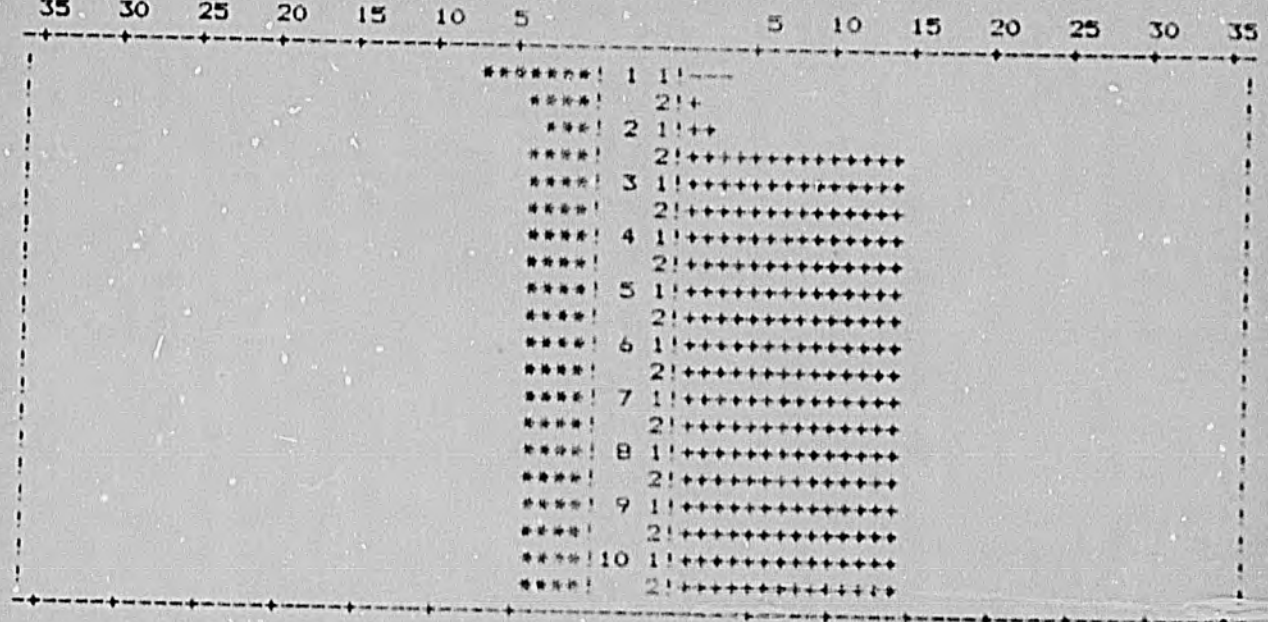
CROP: leuc/maizebean (Model 2)

TOTAL LABOUR
(LABOUR HOURSx10**2)

* S
* E
Y A
E S
A O
Y N

AREA UNIT: Hectare

NET REVENUE
CASH FLOW
(shx10**2)
(+ if +ve - if -ve)



(By MULBUD)

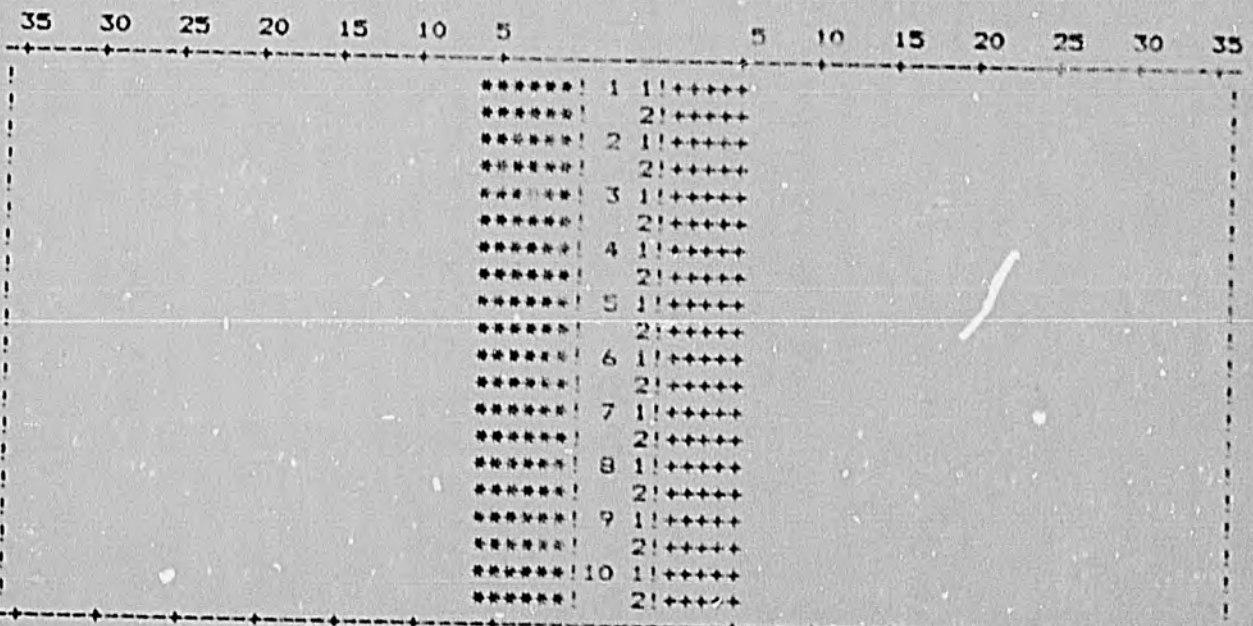
CROP: maizebean (Model 1)

TOTAL LABOUR
(LABOUR HOURSx10**2)

* S
* E
Y A
E S
A O
Y N

AREA UNIT: Hectare

NET REVENUE
CASH FLOW
(shx10**2)
(+ if +ve - if -ve)



(By MULBUD)

CROP: leuc/maizebean (Model 2) AREA UNIT: Hectare

Printout 2.

* YEAR	* SEASON	MATERIAL REQUIREMENTS: PLANTING lo	PLANTING sh	WEEDING lo	WEEDING sh	FERTILIZERS org N lo	FERTILIZERS org N sh	FERTILIZERS lo	FERTILIZERS sh	CHEMICALS lo	CHEMICALS sh	CHEMICALS lo	CHEMICALS sh	OTHER lo	OTHER sh	TOTAL MATERIAL VARIABLE COSTS sh
1	1	15	90	0	150	0	0	0	0	0	0	0	0	5	200	440.00
	2	15	90	0	150	0	0	0	0	0	0	0	0	1	40	280.00
2	1	15	90	0	150	0	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
3	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
4	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
5	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
6	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
7	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
8	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
9	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
10	1	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00
	2	15	90	0	150	50	0	0	0	0	0	0	0	0	0	240.00

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CROP: maizebean (Model 1) AREA UNIT: Hectare

1	1	30	180	1	300	0	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	0	0	0	0	0	0	0	0	0	0	480.00
2	1	30	180	1	300	0	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
3	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
4	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
5	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
6	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
7	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
8	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
9	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
10	1	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00
	2	30	180	1	300	50	0	0	0	0	0	0	0	0	0	480.00

(By MULBUD)

Explanatory Notes:

- planting column contains maize and beans seed valued at Shs. 5 and 10/kg
- other is leucaena seedlings in units of 1000
- weeding column contains draft animal cost; physical quantity model 2 too small to be printed (0.5)

CROP: leuc/maizebean (Model 2)

AREA UNIT: Hectare

Printout 3.

* SEA YEAR		LABOUR REQUIREMENTS PRP **	PLT * * *	WED	FRT LABOUR	PST	PRN	OTH HOURS	HRV	PRS	SEL * * * * * * * * *	TOTAL LABOUR *******	FAMILY LAB SUP-PLY	LABOUR COSTS HIRED sh	FAMILY sh	TOTAL sh
1	1	320	72	216	0	0	168	0	0	0	0	776.00	0	0	0	807.04
	2	64	72	120	0	0	168	0	0	0	0	424.00	0	0	0	440.96
2	1	0	72	120	0	0	168	0	0	0	0	360.00	0	0	0	374.40
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
3	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
4	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
5	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
6	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
7	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
8	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
9	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
10	1	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84
	2	0	72	96	0	0	224	104	0	0	0	496.00	0	0	0	515.84

(By MULBUD)

CROP: maizebean (Model 1)

AREA UNIT: Hectare

1	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
2	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
3	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
4	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
5	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
6	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
7	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
8	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
9	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
10	1	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88
	2	0	144	192	0	0	336	0	0	0	0	672.00	0	0	0	698.88

(By MULBUD)

Explanatory Notes:

PRP - labour required to establish hedgerows of leucaena

PLT - labour for field preparation and planting of maize and beans

OTH - labour required to lop the hedgerows and to spread the mulch

PRN - harvesting and processing labour maize and beans

Printout 4. ! S U M M A R Y - R E S U L T S !

Leucaena/maize/bean (Model 2)

YEAR	SEASON	TOTAL LABOUR (Hours)	* VARIABLE COSTS * LABOUR COSTS (sh)	MATERIAL COSTS (sh)	TOTAL COSTS (sh)	GROSS REVENUE (sh)	NET REVENUE (sh)	N.R./LABOUR HOUR (sh)	OUTPUT (kg)	PRICE (sh)
1	1	776.00	807.04	440.00	1247.04	860.00	-387.04	-.50	500.	1.72
	2	424.00	440.96	280.00	720.96	860.00	139.04	.33	500.	1.72
2	1	360.00	374.40	240.00	614.40	860.00	245.60	.68	500.	1.72
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
3	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
4	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
5	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
6	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
7	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
8	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
9	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
10	1	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01
	2	496.00	515.84	240.00	755.84	2196.75	1440.91	2.91	2175.	1.01

CROP: maize/bean (Model 1) AREA UNIT: Hectare

1	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
2	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
3	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
4	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
5	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
6	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
7	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
8	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
9	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
10	1	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72
	2	672.00	698.88	480.00	1178.88	1720.00	541.12	.81	1000.	1.72

Explanatory Notes:

Output: maize beans - 800kg of maize, 200 kg of beans

leucaena/maize beans : first 3 seasons, 400 kg maize, 100 kg beans

remaining period, 1075 kg maize, 200 kg beans, 900 kg of fuelwood

Price: weighted composite price - maize Shs. 1.4/kg

- beans Shs. 3/kg

- fuelwood Shs. 0.1/kg

Printout 5.

CROP: leuc/maizebean (Model2) AREA UNIT: Hectare

S E N S I T I V I T Y A N A L Y S I S

Sensitivity Analysis on Discount Rates

Discount Rate %	SNPV sh	ANNUITY sh
8.00	15687.17	2337.85
16.00	10688.69	2211.50
24.00	7655.74	2079.31
32.00	5708.23	1947.93

Internal Rate of Return is greater than 100%.

Sensitivity Analysis of Costs and Returns

SNPV in sh at 12.00 percent per annum

Horizontal axis = % change in MATERIAL COST
Vertical axis = % change in GROSS REVENUE

20.0 %	10.0 %	0.0 %	-10.0 %	-20.0 %	
16649.00	16950.59	17252.18	17553.76	17855.35	20.0%
14452.66	14754.24	15055.83	15357.42	15659.00	10.0%
12256.31	12557.90	12859.48	13161.07	13462.66	0.0%
10059.97	10361.55	10663.14	10964.72	11266.31	-10.0%
7863.62	8165.21	8466.79	8768.38	9069.96	-20.0%

(By MULBUD)

Printout 6.

CROP: maizebean (Model 1) AREA UNIT: Hectare

S E N S I T I V I T Y A N A L Y S I S

Sensitivity Analysis on Discount Rates

Discount Rate %	SNPV sh	ANNUITY sh
8.00	7404.36	1103.47
16.00	5432.17	1123.92
24.00	4210.87	1143.68
32.00	3407.54	1162.82

Internal Rate of Return is greater than 100%.

Sensitivity Analysis of Costs and Returns

SNPV in sh at 12.00 percent per annum

Horizontal axis = % change in MATERIAL COST
Vertical axis = % change in GROSS REVENUE

20.0 %	10.0 %	0.0 %	-10.0 %	-20.0 %	
9177.35	9735.58	10293.81	10852.04	11410.28	20.0%
7177.01	7735.25	8293.48	8851.71	9409.94	10.0%
5176.68	5734.91	6293.14	6851.38	7409.61	0.0%
3176.34	3734.58	4292.81	4851.04	5409.28	-10.0%
1176.01	1734.24	2292.48	2850.71	3408.94	-20.0%

(By MULBUD)

Printout 7.

CROP: leuc/maizebean (Model 3) AREA UNIT: Hectare

S E N S I T I V I T Y A N A L Y S I S

Sensitivity Analysis on Discount Rates

Discount Rate %	SNPV sh	ANNUITY sh
8.00	12504.66	1863.56
16.00	8514.97	1761.76
24.00	6093.39	1654.98
32.00	4537.92	1548.56

Internal Rate of Return is greater than 100%.

Sensitivity Analysis of Costs and Returns

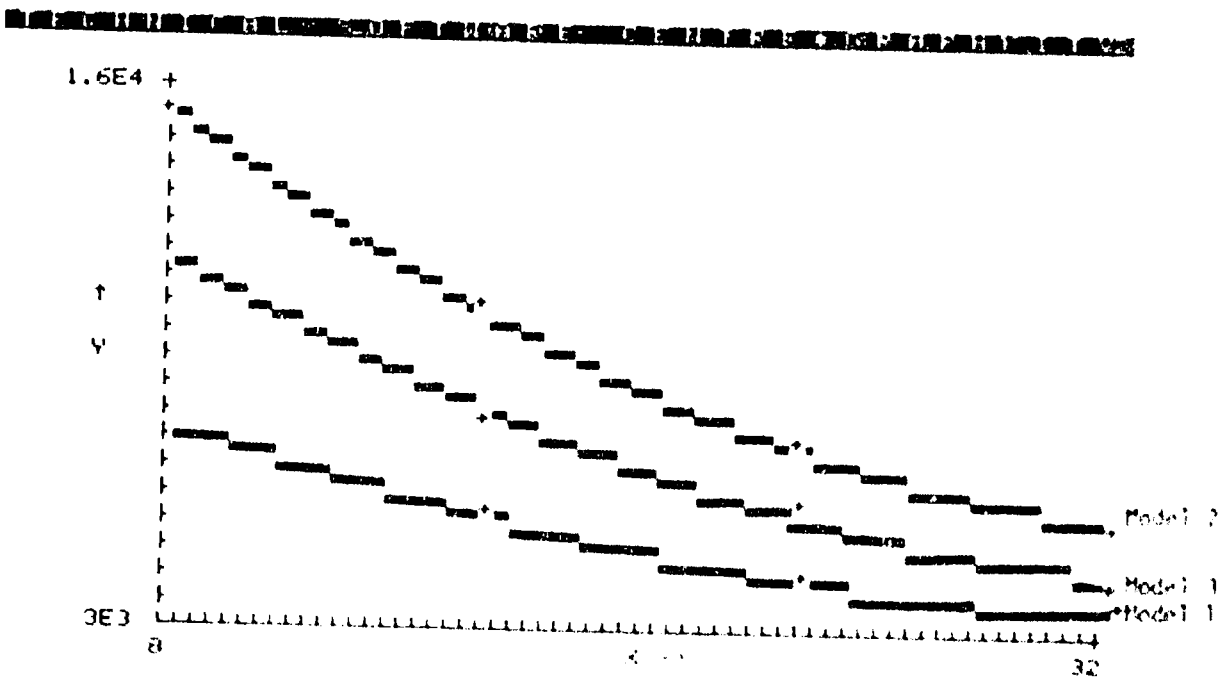
SNPV in sh at 12.00 percent per annum

Horizontal axis = % change in MATERIAL COST
Vertical axis = % change in GROSS REVENUE

20.0 %	10.0 %	0.0 %	-10.0 %	-20.0 %	
13483.21	13786.79	14088.38	14389.96	14691.55	20.0%
11564.91	11866.50	12168.09	12469.67	12771.26	10.0%
9644.63	9946.21	10247.80	10549.39	10850.97	0.0%
7724.34	8025.93	8327.51	8629.10	8930.68	-10.0%
5804.05	6105.64	6407.23	6708.81	7010.40	-20.0%

(By MULBUD)

Printout 8.



LEUCAENA/MAIZEBEANS

WHERE:- X IS DISCOUNT RATE

Y IS NPV