A SEMINAR PAPER

ON

# Effects of Alley Cropping on Soil Fertility

**COURSE CODE: AER 598**

**COURSE TITLE: SEMINAR**


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Summer 2018

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## ABSTRACT

Alley cropping is an agro-forestry technique in which fast growing leguminous trees are planted in dense hedgerows, and annual crops are planted in the "alleys" between the hedges. Before planting crops, the hedges are pruned, and the leaves are added to soil as mulch. This study compared soil nutrients and crop yields of sorghum planted under four nutrient enrichment regimes including root pruned and root intact alley cropping with *Albizia julibrissin*, leguminous winter cover cropping with *Trifolium incarnatum*, and inorganic fertilizer addition. During a drought year alley cropping provided greater nitrogen additions than the other treatments and similar phosphorus additions to the cover crop treatment. Sorghum yields were highest in the fertilizer treatment and lowest in the cover crop treatment. There appeared to be root competition between the hedgerows for nutrients and moisture, but root pruning the hedgerows reduced competition.

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# CHAPTER I

# INTRODUCTION

Since the second half of the twentieth century, world crop yields have increased. Much of this increase has been due to intensification of agriculture through mechanization, use of chemical fertilizers and pesticides, irrigation, and development of high yielding crop varieties (Matson et al. 1997). This increase in food production is unprecedented and supports the world's growing human population. However, high intensity agriculture also comes with costs. Fossil fuel energy is relied upon to produce chemical fertilizers and pesticides as well as to power mechanical equipment. In some cases, energy consumption exceeds food energy production by over ten to one (Kidd 1992). Such heavy reliance on nonrenewable resources may be unsustainable over the long term. Pesticides and fertilizers used in crop production have entered the environment leading to groundwater and surface water pollution. This pollution has both human health and ecosystem health effects (Perkins and Patterson 1997). When chemical nutrient inputs are combined with intensive tillage, soil organic matter decreases, especially in warm, humid areas. Soil organic matter is important because it increases the nutrient holding capacity and moisture retention of soil (Matson et al 1997). As farming becomes more intensified, fields became larger and crop diversity declines. The decline in biodiversity along with other factors, including pest resistance, has led to increases in insect damage despite increases in pesticide use (Pimentel 1997). Modern agriculture has large benefits, but it also has high environmental costs. Concerns about the high cost of intensive industrial agriculture have led to increased interest in low-input or organic agriculture. While these farming systems also have costs, the environmental and human health aspects tend to be less damaging than in conventional farming. Organic farms are often thought of as low yielding, but properly managed organic farms can have similar yields to traditional farms after as little as four years (**Drinkwater et al. 1998**). The problems that chemical fertilizers solve in conventional western agriculture still remain to be solved in alternative ways. Soil amendments are needed to sustain crop yields. Adding organic residues increases retention of soil C and N (Drinkwater et al. 1998). Adding compost or manure is one option but these amendments are produced in other places and then must be transported to the farmers' fields. Interest in cover crops has revived in recent years as a method to maintain soil fertility, reduce fertilizer use, and reduce erosion (Hoyt and Hargrove 1986, Teasdale and Abdul-Baki 1998, Mueller and Kristensen 2001). However, cover crops have a few disadvantages. They must be replanted each season that they are used, and land is taken out of production if the cover crop is used as a nutrient amendment. Also inputs from herbaceous cover crops may not be sufficient at supplying nitrogen and phosphorus to a continuous cropping system. Another organic amendment option is alley cropping or leguminous hedgerow intercropping. Natural systems were guides for the development of alley cropping systems. Ecosystem services that are found in forests are brought to agro-ecosystems by planting trees within fields. While alley cropping has been widely promoted in the tropics as an option for subsistence farmers, few studies have been done of this technique in the temperate zone (Matta-Machado and Jordan 1995, Nair et al. 1999, Seiter et al. 1999). In the United States, alley cropping has greatest potential as a technique on small organic farms. It is easier to incorporate alley cropping into farming systems that rely on light machinery and manual labor. Seiter et al. (1999) found highest interest in alley cropping among small-scale farmers who intensively managed their land. Several factors make alley cropping appropriate for organic growers. Many organic farmers grow multiple crops in their beds. This familiarity with intercropping may make them more accepting of planting hedgerows within their fields. The greatest costs associated with alley cropping are labor costs and loss of productive land due to hedgerows. However, by adapting alley cropping techniques to mechanical methods and introducing alley cropping to areas with low land values, the techniques may be economically viable. Also organic farmers are able to absorb limited increases in costs of production because organic products are high value crops. Leguminous hedgerows provide nutrient additions similar to other on-site organic inputs and help maintain soil fertility. Hedgerows restore some ecosystem functions to fields by increasing nutrient cycling and maintaining levels of soil organic matter. The Piedmont of Georgia is an excellent place to test the appropriateness of alley cropping in the United States. Soils in the Piedmont are similar to the tropical soils in areas where alley cropping was originally developed. Piedmont soils are old, weathered, and acidic with low nutrient holding capacities. The growing season is long which enables the hedgerows to produce large amounts of biomass in a single season. Organic farming is also a growing industry in northeast Georgia as is demonstrated by organic grocery stores, organic farmer's markets, and restaurants serving organic produce. Most organic farms in northeast Georgia are small and intensively managed. In general land values are low and farmers are not land limited. Organic growers and gardeners in the Georgia piedmont are potential adopters of alley cropping techniques. In this study we examine the ability of a mature alley cropping system to provide nutrients to a grain crop. Few, if any, studies have looked at a mature alley cropping system in the temperate zone. In order to determine the appropriateness of alley cropping, it is compared to other cropping systems. One method of soil improvement used by organic farmers is the planting of a winter cover crop. Cover cropping with a winter legume is a similar system to alley cropping because both systems add available N to the agroecosystem through the symbiotic relationship of legumes with Rhizobia. Alley cropping uses perennial legumes while cover cropping systems use annual legumes. *Trifolium incarnatum* L., crimson clover, has a long tradition as a green manure in the southeastern United States. It has been used as a winter cover crop and green manure since the 1800s (Knight 1985). Conventional farming systems use fertilizer and lime to maintain soil fertility. In this study alley cropping is compared to cover cropping with crimson clover and to addition of inorganic fertilizers. This study attempts to determine the effectiveness of hedgerow intercropping at providing nutrients, increasing crop yields, and improving soil quality as compared to other nutrient addition strategies. Nutrient inputs from leguminous hedgerow intercropping are compared to the other systems. N and P are focused on because these nutrients are often limiting to plant growth in the Georgia Piedmont. In order to determine the overall effectiveness of alley cropping, crop yields are compared between alley cropping, cover cropping and fertilizer treatments. One of the advantages of alley cropping is that it increases long-term sustainability by improving soil quality. Both chemical and physical soil properties are examined to determine changes in soil quality. Alley cropping is not effective if there is competition between crops and the hedgerows. Here, the effects of competition are examined by reducing root competition. Finally, a brief economic examination is conducted to determine if costs of alley cropping is higher than other farming systems.

**Objectives:**

I)To evaluate the fertility status of soil in alley cropping system

II) To assess the potentiality of alley cropping as organic farming technique.

# CHAPTER II

## MATERIALS AND METHODS

This seminar paper is a review paper. All data and information has been collected from the secondary sources. During preparation of this paper, it has been prepared by comprehensive studies of various articles published in different journals, books, proceedings, reports, publications and annual report etc. Different published reports of different journals mainly supported in providing data for this paper.

Finally, this seminar paper was prepared with the consultation of my respective major professor and honorable seminar course instructors.

# CHAPTER III

# REVIEW OF FINDINGS

## Plant Properties

### Nutrient Additions

Nutrient inputs were calculated using two methods, alley-based and area-based. Alley-based inputs were the total additions per hectare ignoring the space taken up by hedgerows. Area-based inputs were the total additions per hectare taking into account the space occupied by hedgerows. Because there were no hedgerows in the CC and IF treatment, alley-based inputs and area-based inputs were the same for those treatments. The alley cropping (AC) treatment provided significantly more biomass addition than the cover crop (CC) treatment in 1999 and provided similar amounts of biomass in 2000 (Figure 1). A nutrient analysis was conducted on samples collected in 2000. The mimosa leaves were higher quality additions than the crimson clover residue. The AC additions had higher nitrogen and phosphorus concentrations while the CC additions had a higher C/N ratio (Table 1). Both nitrogen and phosphorus additions were greater in the AC treatment than in the CC treatment.

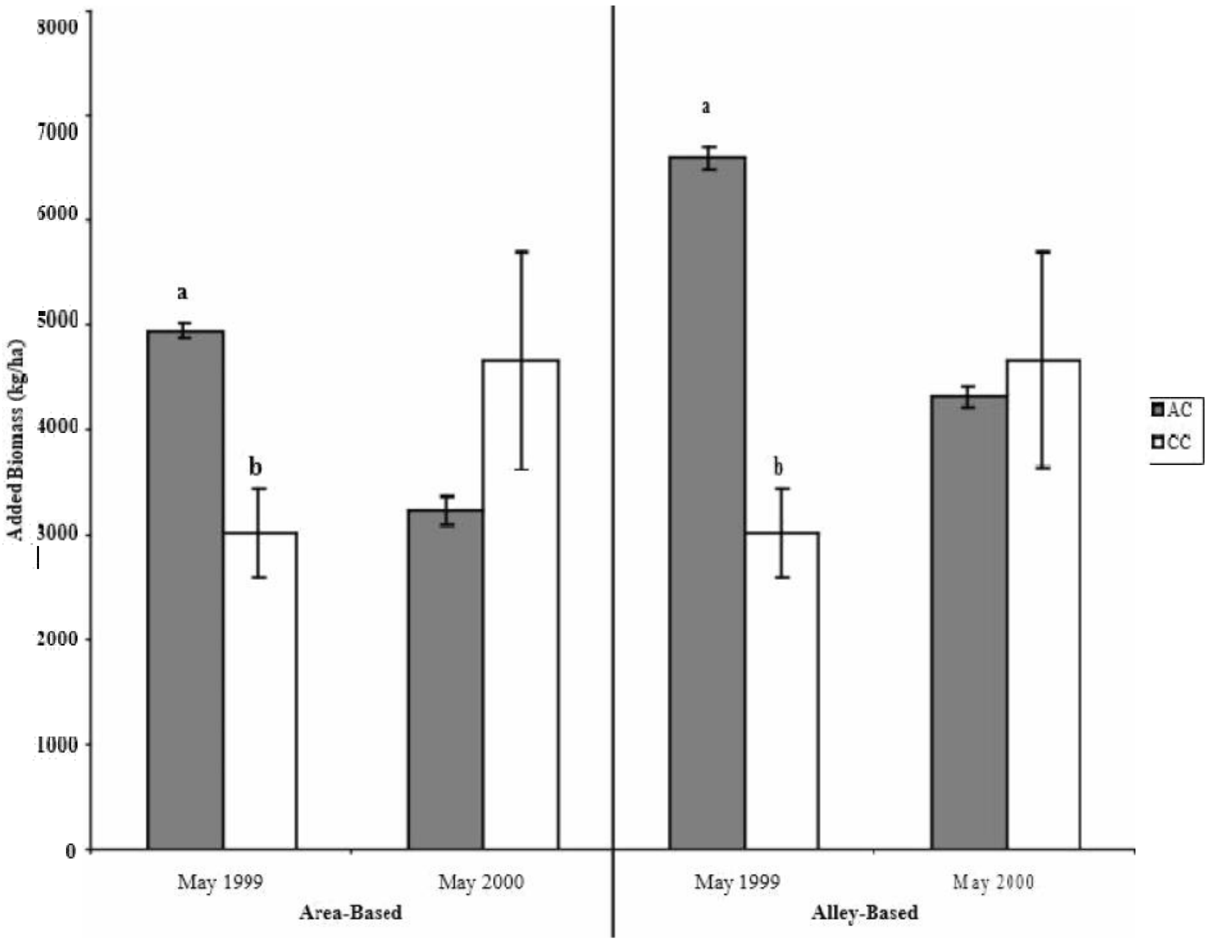
Table 1: Nutrient inputs for 2000 from three addition treatments: *Albizia julibrissin* leaves in the alley cropping treatment, *Trifolium incarnatum* in the cover cropping treatment, and 10-10-10 with

dolomitic limestone in the inorganic fertilizer treatment. Inputs are calculated by two methods. Area-based calculations account for the reduction in inputs due to the space taken up by the hedgerows. Alley-based calculations make no reduction for that space

| Treatment | Total Nitrogen | | | Total Phosphorus | | | C/N Ratio |
|---|---|---|---|---|---|---|---|
| | N (g $kg^{-1}$) | N (kg $ha^{-1}$) Area-Based | N (kg $ha^{-1}$) Alley-Based | P (g $kg^{-1}$) | P (kg $ha^{-1}$) Area-Based | P (kg $ha^{-1}$) Alley-Based | |
| Alley Cropping | 46 a | 149 a | 198 a | 2.4 a | 7.8 | 10.4 | 10.6 a |
| Cover Cropping | 19 b | 84 b | 84 b | 1.2 b | 5.8 | 5.8 | 28.3 b |
| Inorganic Fertilizer | 100 | 45 | 45 | 4.36 | 20 | 20 | — |

(Source: Green, E. V. et al., 2002)

Letters denote differences between Alley Cropping and Cover Cropping treatments at the 0.05 level of significance.




(Source: Green, E. V. et al., 2002)

Figure 1: Comparison of biomass additions between treatments.

Albizia julibrissin leaves were added to the alley cropping (AC) treatments, and Trifolium incarnatum was added to the cover crop (CC) treatments. Biomass was compared using area-based (reduction in yields due to space taken up by hedgerows) and alley-based (no reduction in yields due to hedgerows) analyses. The inorganic fertilizer (IF) treatment was not included in the statistical analyses because there was no recorded variation in nutrient additions for the IF treatment. Letters denote a significant difference in biomass between treatments at 0.05 level of significance.

## Sorghum Biomass

As with nutrient inputs, sorghum yields were analyzed by both alley-based and area-based methods. Yields for CC and IF treatments were the same using both methods because there were no hedgerows in those treatments. Sorghum yields were extremely low and patchy in 1999. There was a slight trend towards lower area-based yields in the AC treatment with an area-based comparison, but the overall low yields and high variance prevented this trend from being significant (Figure 2). There was no difference in alley-based yields between treatments. Sorghum yields were higher in 2000 though still lower than yields found in similar studies (Matta-Machado and Jordan 1995, Rhodes et al. 1998). Despite the low yields significant differences between treatments were found in 2000 (Figure 3). When using the area-based comparison, the sorghum grain yields in the IF treatment were higher than the yields in both the CC and RI treatments. When the space taken up by the hedgerows was not taken into account, alley-based yield, there were significantly lower yields in the CC treatment than in the IF treatment. In contrast, the yields in the both alley cropping treatments (RI and RP) were similar to the yields in the IF treatment. When analyzed with all treatments, grain yields in RI and RP treatments were not significantly different from each other. Since RI and RP plots were paired treatments, a paired t-test was used to compare the means of those two treatments. When grain yields were compared by plot and position within each plot, yields in RP treatments were higher ($\alpha$=0.051). In both the RP and RI treatments, sorghum yields were higher in the middle rows than in rows bordering the hedgerows though the difference was statistically significant only in the RP treatment (Figure 4).

The sorghum stover and root biomass had similar trends to sorghum grain yields (Table 2). Sorghum root and stover biomass was extremely low in 1999. The only significant difference between treatments was found in stover biomass. Area-based stover biomass in IF treatment was almost four times greater than stover biomass in the AC treatment. More differences between treatments were measured in 2000. Area-based stover and root biomass was greater in the IF treatment than in all other treatments. With alley-based comparison, stover and root biomass in the IF treatment was statistically greater than stover and root biomass in only the CC treatment.

Nutrient concentration analyses were conducted on the sorghum harvested in 2000. For sorghum grains, only N differed between treatments (Table 3). Sorghum grain had a higher percentage of N in the RI and CC treatments than in the IF treatment. For sorghum stover and roots, only P differed between treatments. Stover in the IF treatment had a higher P concentration than stover in the RI and RP treatments. This trend was also found in the roots though the difference was not as strong. Roots in the IF treatment had more P than roots in the RI treatment.

Table 2: Sorghum biomass. Area-based calculations account for reduced sorghum biomass due to space taken up by mimosa hedgerows, and alley-based calculations estimate sorghum biomass without adjusting for space occupied by the hedgerows

| Year | Treatment | Grain Biomass | | Stover Biomass | | Roots Biomass | |
|---|---|---|---|---|---|---|---|
| | | ($kg\ ha^{-1}$) Area-Based | ($kg\ ha^{-1}$) Alley-Based | ($kg\ ha^{-1}$) Area-Based | ($kg\ ha^{-1}$) Alley-Based | ($kg\ ha^{-1}$) Area-Based | ($kg\ ha^{-1}$) Alley-Based |
| 1999 | Hedgerows | 75 | 125 | 125 b | 208 | 48 | 80 |
| | Cover Crop | 137 | 137 | 282 ab | 282 | 86 | 86 |
| | Fertilizer | 122 | 122 | 485 a | 485 | 147 | 147 |
| 2000 | Root Pruned | 380 ab* | 1630 ab | 890 b* | 1490 ab | 175 b* | 292 ab |
| | Root Intact | 700 b* | 1160 ab | 750 b* | 1250 ab | 147 b* | 246 ab |
| | Cover Crop | 790 b* | 790 b | 950 b* | 950 b | 198 b* | 198 b |
| | Fertilizer | 2030 a* | 2030 a | 2270 a* | 2270 a | 520 a* | 520 a |

(Source: Green, E. V. et al., 2002)

Letters denote differences between treatments at 0.1 level of significance.

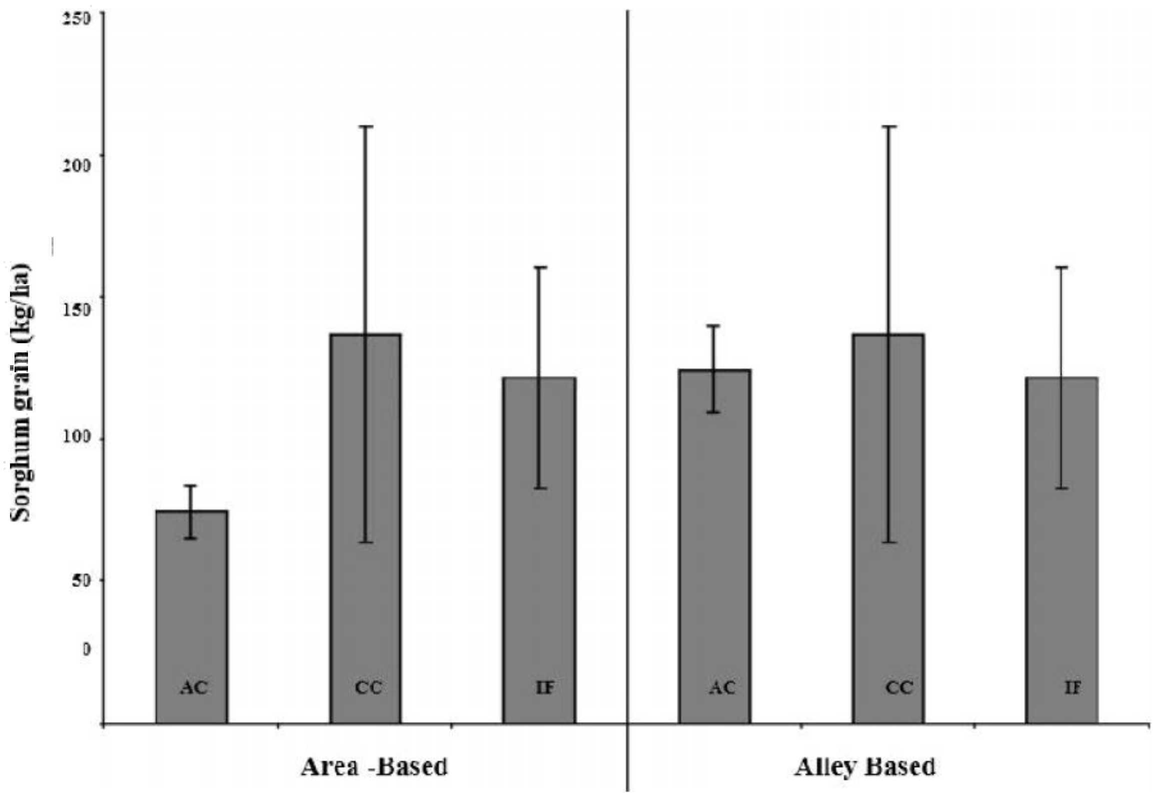
Letters with * denote differences between treatments at 0.05 level of significance.

Table 3: Nutrient concentration in the dry matter of sorghum in 2000

| | Treatment | N (g kg$^{-1}$) | P (g kg$^{-1}$) | C/N |
|---|---|---|---|---|
| Grain | Root Pruned | 16.3 ab | 2.5 | 26.8 |
| | Root Intact | 17.0 a | 2.4 | 33.0 |
| | Cover Crop | 17.1 a | 2.6 | 28.3 |
| | Inorganic Fertilizer | 14.1 b | 2.6 | 29.3 |
| Stover | Root Pruned | 15.6 | 2.6 b* | 26.4 |
| | Root Intact | 16.5 | 2.6 b* | 28.7 |
| | Cover Crop | 15.1 | 2.8 ab* | 28.1 |
| | Inorganic Fertilizer | 13.9 | 3.3 a* | 26.2 |
| Roots | Root Pruned | 9.5 | 3.1 ab | 32.5 a* |
| | Root Intact | 9.8 | 2.8 b | 25.6 b* |
| | Cover Crop | 8.5 | 2.9 ab | 31.7 a* |
| | Inorganic Fertilizer | 6.6 | 3.4 a | 32.5 a* |

(Source: Green, E. V. et al., 2002)

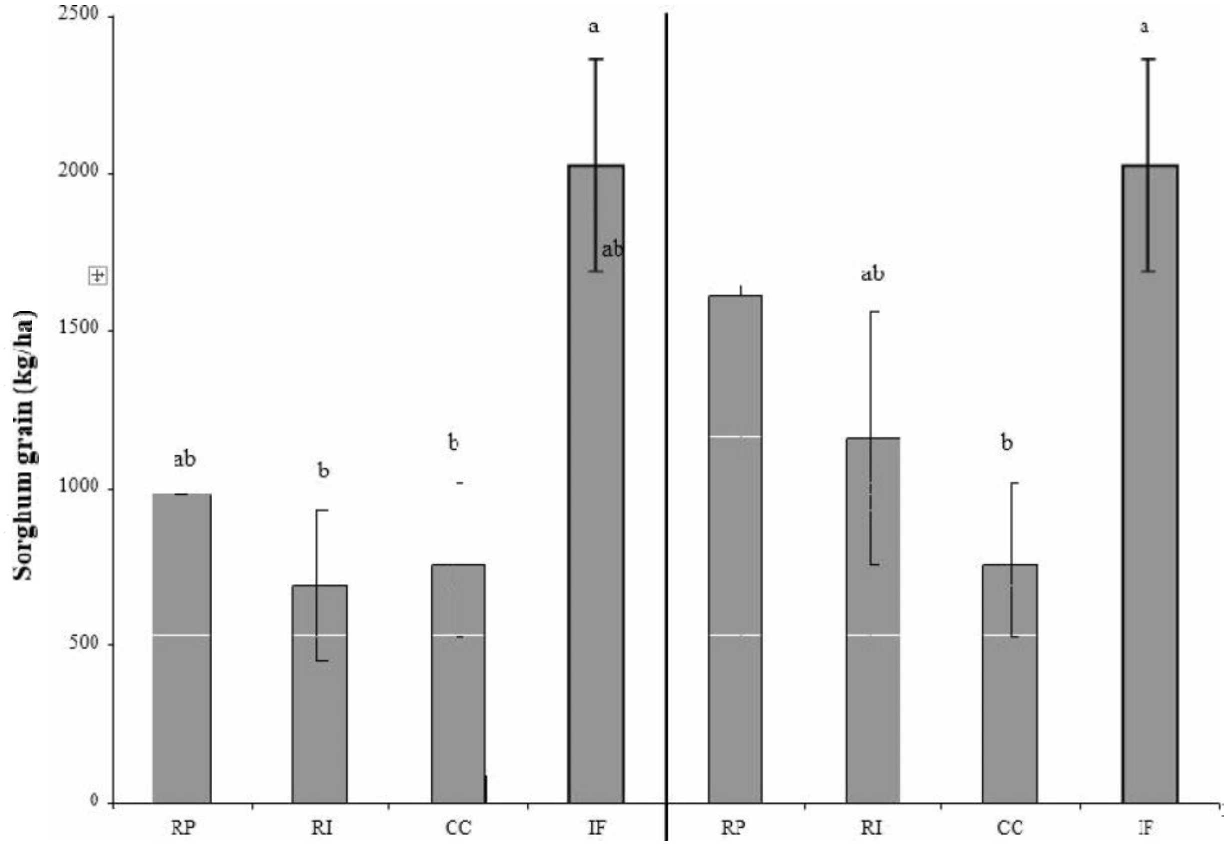
Letters denote differences at 0.1 level of significance. Letters with * denote differences at 0.05 level




(Source: Green, E. V. et al., 2002)

Figure 2: Sorghum grain yields summer 1999.

Yields were compared using area-based (reduction in yields due to space taken up by hedgerows) and alley-based (no reduction in yields due to hedgerows) analyses. There was no significant difference between treatments. AC=ally cropping treatment, CC=cover crop treatment, IF=inorganic fertilizer treatment. level of significance.

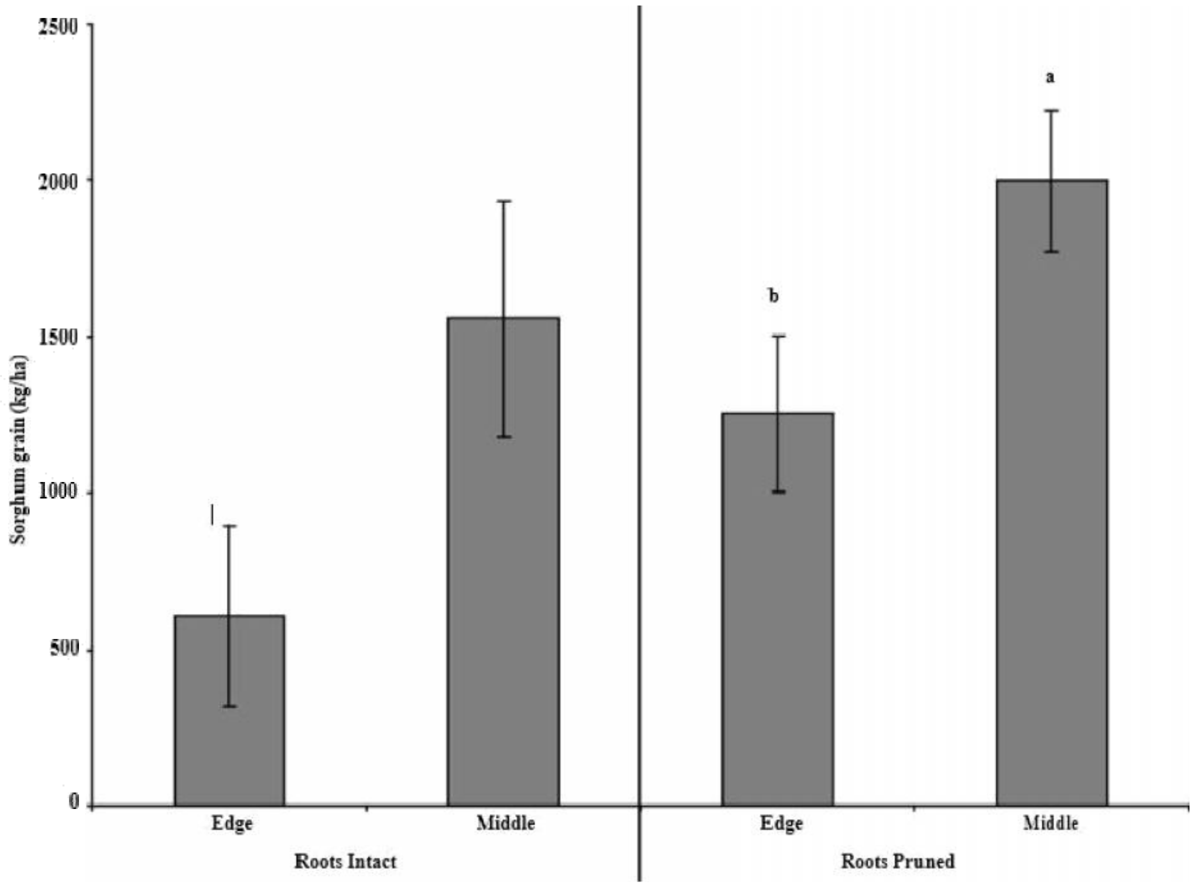



Area Based Alley Based

(Source: Green, E. V. et al., 2002)

Figure 3: Sorghum grain yields for summer 2000.

Yields were compared using area-based (reduction in yields due to space taken up by hedgerows) and alley-based (no reduction in yields due to hedgerows) analyses. Letters denote significant differences at 0.1 level of significance. RP=root pruned treatment, RI=root intact treatment, CC=cover crop treatment, IF=inorganic fertilizer treatment



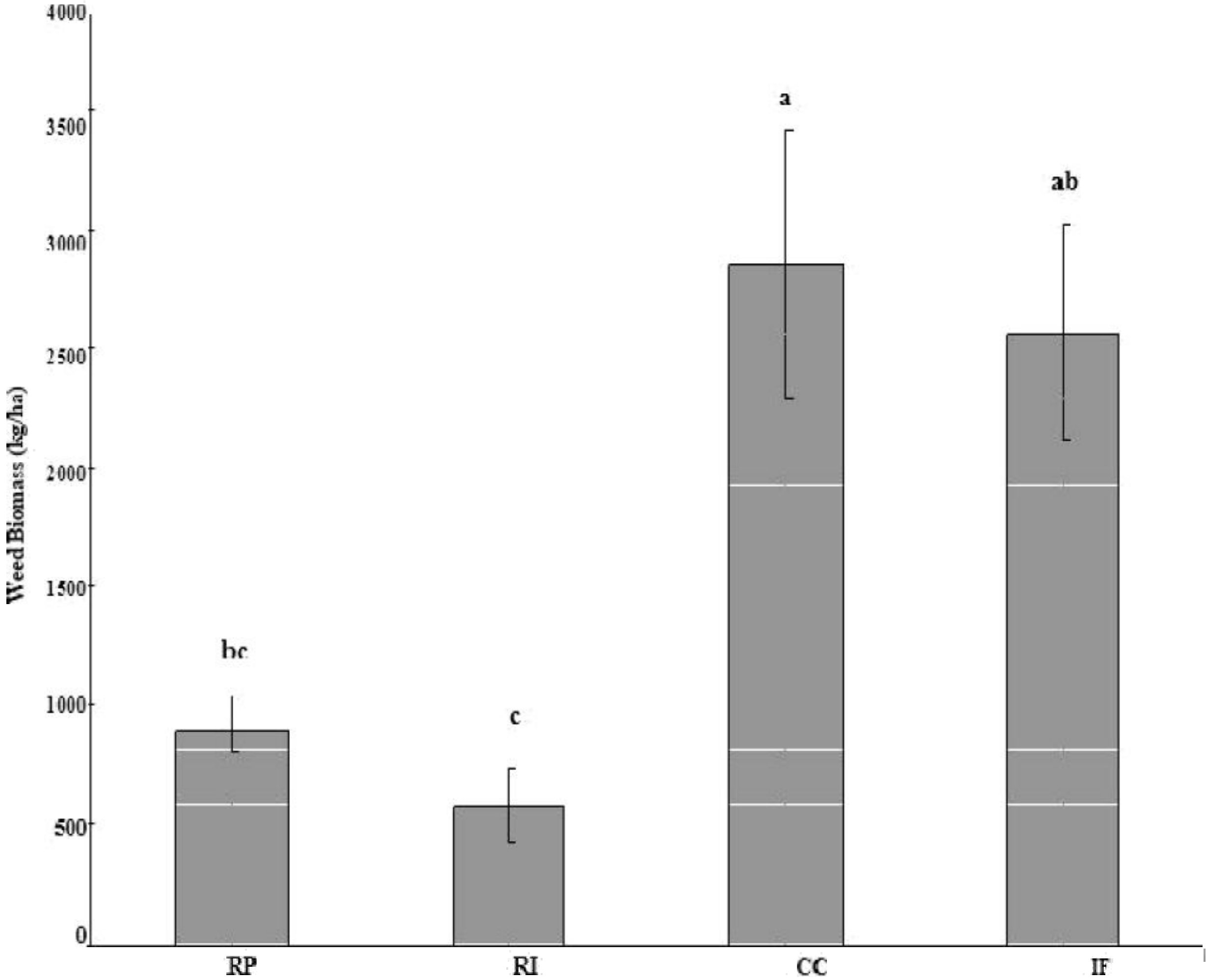

(Source: Green, E. V. et al., 2002)

Figure 4: Sorghum grain yields comparing yields in rows bordering hedgerows on one side, edge, and in rows bordering sorghum on both sides, middle.

Roots Pruned = mimosa roots were pruned with sub-soil in May 2000. Roots Intact = mimosa roots were left intact. Letters denote significant difference at 0.01 level of significance.

### Weed Biomass

Weed biomass was compared using an alley-based comparison. In 2000 cover crop and fertilizer treatments had more weeds than both of the alley cropping treatments (Figure 5) did. The cover crop treatment had significantly greater weed biomass than both of the alley cropping treatments while the IF treatment was greater than only the RI treatment at 0.05 level of significance and both alley cropping treatments at 0.1 level of significance.




(Source: Green, E. V. et al., 2002)

Figure 5: Weed biomass between treatments.

Measurements were based on 1 m2 quadrat samples. Letters denote significant differences at 0.05 level of significance. RP=root pruned treatment, RI=root intact treatment, CC=cover crop treatment, IF=inorganic fertilizer treatment

## Soil Properties

### Soil Chemical Properties

Soil N was greatest in the alley cropping treatments. At the start of this study in October 1998, total soil nitrogen was greater in the alley cropping treatment than in the other treatments. There continued to be a trend of higher total N in the hedgerow treatment, though the difference was not significant during the first field season. In May 2000, soil total N in the RI ($\alpha$=0.1) and RP ($\alpha$=0.05) treatments was greater than total N in the IF treatment (Table 4). After harvesting of sorghum, that trend continued. However, only the RP treatment was significantly greater than the IF treatment in October 2000. The C/N ratios were consistently lower in the hedgerow treatments during all sample periods. Available phosphorus (PO4–P) was similar between all treatments but increased during the second year of the study (Figure 6). Nitrate was analyzed in soil samples from the 2000 field season. Nitrate nitrogen was similar between treatments before planting (Table 4). Nitrate nitrogen was higher after harvest in all treatments, and alley cropping treatments had significantly higher levels of NO3–N than the IF treatments. Soil pH was low in the RI, RP, and CC treatments for both the spring and fall of 2000. Soil pH was much higher in the IF treatment.

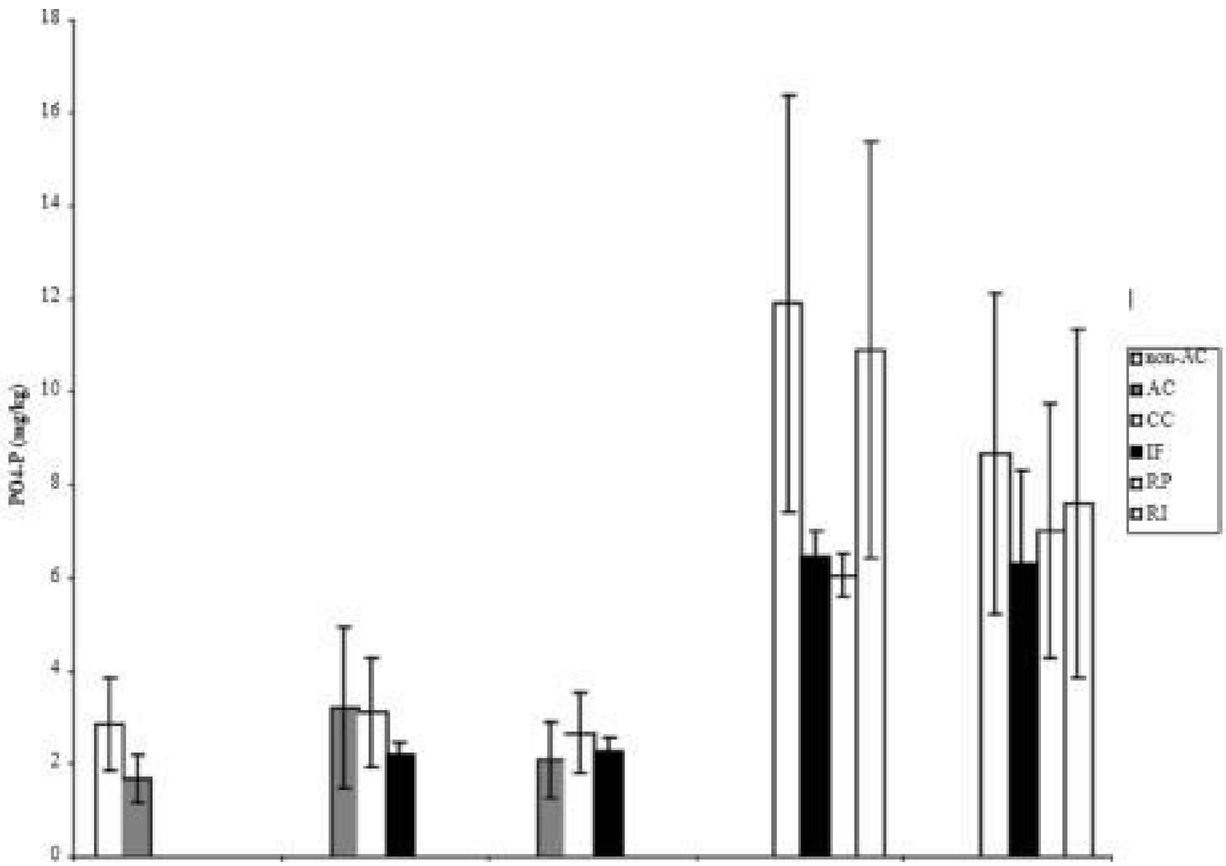
Table 4: Soil Chemical Properties in 2000. All soil was collected in composite samples at 0-5 cm depth

| Treatment | pH | | Total N ($g\ kg^{-1}$) | | C/N Ratio | | $NO_3$-N ($mg\ kg^{-1}$) | | $PO_4$-P ($mg\ kg^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | May | October | May | October | May | October | May | October | May | October |
| Root Pruned | 5.08 b* | 5.33 b* | 2.39 ab* | 2.36 a | 13.5 b* | 13.5 ab* | 3.35 | 30.9 a* | 6.09 | 7.03 |
| Root Intact | 5.01 b* | 5.22 b* | 2.36 a* | 2.16 ab | 13.4 b* | 13.0 b* | 4.86 | 30 ab* | 10.93 | 7.63 |
| Cover Crop | 4.90 b* | 5.23 b* | 1.89 ab* | 1.91 ab | 13.7 ab* | 14.0 ab* | 2.57 | 26.5 ab* | 11.92 | 8.71 |
| Fertilizer | 6.81 a* | 5.98 a* | 1.69 b* | 1.64 b | 15.0 a* | 14.4 a* | 1.86 | 20.2 b* | 6.48 | 6.32 |

(Source: Green, E. V. et al., 2002)

Letters denote differences between treatments at 0.1 level of significance.

Letters with * denote differences between treatments at 0.05 level of significance.

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(Source: Green, E. V. et al., 2002)

Figure 6: Total available phosphorus levels at 0-5 cm depth.

In October 1998-October 1999, no distinction was made between root pruned and root intact treatments and they were both included in the AC treatment. In October 1998, the cover crop treatment and the inorganic fertilizer treatment were grouped together as non-AC. In May 2000-October 2000 alley cropping plots were subdivided into root pruned and root intact treatments. AC=alley cropping treatment, RP=root pruned treatment, RI=root intact treatment, CC=cover crop treatment, IF=inorganic fertilizer treatment. There were no significant differences between treatments although phosphorus levels in all treatments rose during the second field season.

## Physical Properties

Soil physical properties were also analyzed. While there was a trend towards lower bulk density in the AC treatment, the difference was not statistically significant with only three replicates (Table 5). There were also no significant differences in percent water stable aggregates between treatments though all treatments had low percentages of stable aggregates.

Table 5: Soil Physical Properties in October 2000. All samples were 0-5 cm depth

| Treatment | Bulk Density ($Mg\ m^{-3}$) | Water Stable Aggregates (Percent stable aggregates) |
|---|---|---|
| Root Pruned | 1.06 | 54 |
| Root Intact | 1.09 | 49 |
| Cover Crop | 1.18 | 52 |
| Fertilizer | 1.23 | 50 |

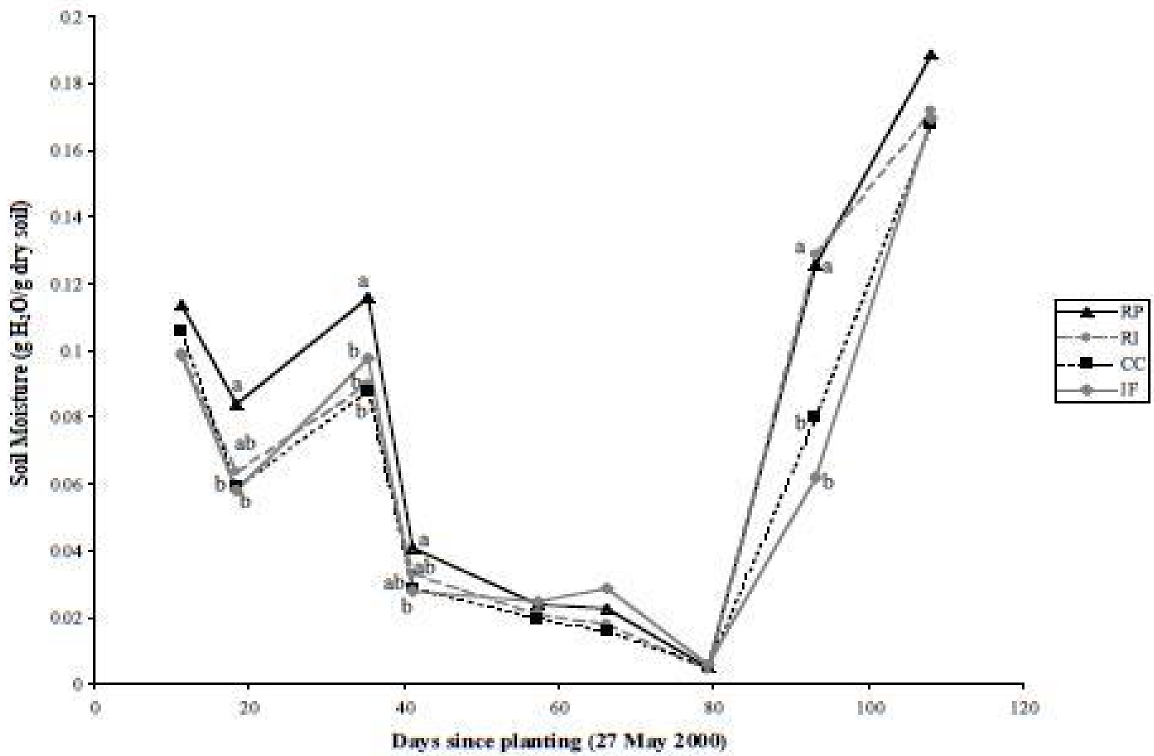
(Source: Green, E. V. et al., 2002)

No significant differences between treatments.

## Moisture Analysis

Because soil moisture was heavily influenced by weather, the date sampled and the treatment were used in the analysis (Figures 11). Soil moisture values at 0-5 cm depth and 5-10 cm depth were averaged and soil moisture was analyzed at 0-10cm depth. Treatment and date sampled explained 94% of the soil moisture variation in samples. Treatment and date were both significant effects.

Taking the date sampled into account, soil in the RP treatment was moister than soil in the CC and IF treatments at a 0.05 level of significance. There was no significant difference between RP and RI treatments when plots within treatments were pooled because of inter-plot variation within treatments. However, when soil moisture was paired by plot and date, the soil moisture in the RP treatment was significantly greater than the soil moisture in the RI treatment (α=0.0002). It was only possible to compare RP and RI treatments using a paired t-test because those treatments had paired plots.




(Source: Green, E. V. et al., 2002)

Figure 7: Gravemetric soil moisture for all treatments at 0-10 cm, 2000.

Day 0 is the day sorghum was planted in each plot, 27 May 2000. RP=root pruned treatment, RI=root intact treatment, CC=cover crop treatment, IF=inorganic fertilizer treatment. At each date samples were analyzed using One-way ANOVA and Tukey-Kramer HSD test to determine differences between treatments. Letters denote significant differences between treatments at 0.1 level of significance.

**Cost Analysis**

When total costs were compared, there were no significant differences between treatments (Table 6). Nutrient addition costs were highest in the AC treatment and lowest in the CC treatment. Weeding costs were highest in the IF treatment and lowest in the AC treatment. Human labor was the major cost in all treatments and labor trends were similar to cost trends (Table 7). This study was done in a labor-intensive fashion. In 1999 the removal of woody biomass from the three AC plots took over a week of intense effort involving multiple people, a chainsaw, a hatchet and three machetes. The labor was reduced the following year, but hedgerow trimming still took nearly a week. During both years' fertilizer and lime were added by hand in the IF treatment. All weeding was done by hand and there was no use of herbicides.

Table 6: Yearly costs on a per plot basis. Each plot was 120 $m^2$. Cost analysis were based on labor costs ($7.00 $hr^{-1}$), and costs of external inputs (fertilizer, lime, clover seed, diesel fuel). Costs identical in each treatment, such as sorghum seed were not included. Costs sustained before the study period were not include (land price, equipment purchase). Harvesting costs were not included because entire sorghum plants were harvested for study purposes resulting in labor intensive harvesting techniques

| Treatment | Nutrient Addition (dollars $plot^{-1}$) | Planting (dollars $plot^{-1}$) | Weeding and Hedge Trimming (dollars $plot^{-1}$) | Total Costs (dollars $plot^{-1}$) |
|---|---|---|---|---|
| Alley Cropping | 46.10 a | 1.90 | 25.10 b | 73.10 |
| Cover Crop | 10.10 b | 3.90 | 47.10 ab | 61.00 |
| Fertilizer | 21.00 b | 3.90 | 62.40 a | 87.30 |

(Source: Green, E. V. et al., 2002)

Letters denote differences at 0.05 level of significance.

Table 7: Comparison of labor between treatments in 2000. All measurements were man hours plot$^{-1}$. Each plot was 120m$^{-2}$

| Treatment | Nutrient Addition (hours plot$^{-1}$) | Planting (hours plot$^{-1}$) | Weeding and Trimming (hours plot$^{-1}$) | Total Labor (hours plot$^{-1}$) |
|---|---|---|---|---|
| Alley Cropping | 6.6 a | 0.3 | 3.6 b | 10.4 |
| Cover Cropping | 1.3 b | 0.5 | 6.7 ab | 8.6 |
| Inorganic Fertilizer | 2.2 b | 0.5 | 9.4 a | 12.0 |

(Source: Green, E. V. et al., 2002)

Letters denote differences between treatments at 0.05 level of significance

# CHAPTER IV

# CONCLUSION

Alley cropping with *A. julibrissin* hedgerows provided sufficient N for a summer grain crop. However, P additions were low, and outside P inputs may be needed over the long term for continuous cropping. During a drought year, alley cropping supplied greater N and P additions than an annual leguminous cover crop. Sorghum yields were comparable to yields using other nutrient inputs. Root pruning of *A. julibrissin* hedgerows reduced root competition between hedges and sorghum and increased grain yields. Root competition may have been for nutrients and water. However, soil moisture was higher in alley cropping treatments than in the other treatments. Because of reduced weeding, costs for the alley cropping system were similar to costs of other treatments. Further studies should be conducted to refine alley cropping techniques and reduce competition between hedgerows and crops, reduce labor costs, and improve P availability. Alley cropping with mimosa hedgerows has potential as an organic farming technique.

# CHAPTER V

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