# LEGUME RESEARCH NETWORK PROJECT NEWSLETTER

KENYA AGRICULTURAL RESEARCH INSTITUTE
P.O. BOX 14733, NAIROBI, TEL. 254-440935, FAX 254-449810
E-MAIL Address: jmureithi@net2000ke.com

**Issue No 4** **December 2000**

## CONTENTS



## ABOUT THE NEWSLETTER

In this issue we continue sharing experiences on performance of green manure legumes on-farm and the effects they have on the associated food crops. Effects of the legumes on soil erosion control and as a livestock feed are highlighted in two articles based on research work conducted at the University of Nairobi and KARI, Mtwapa, respectively. In an effort to introduce edible lima bean (*Phaseolus lunatus*) varieties to smallholders in the semi-arid Kenya, eight varieties were obtained from the USA. Currently they are being bulked at the KARI-NARL site. An article based on their phenology data is included in this issue. We are indeed grateful to all those who contributed articles and especially our NGOs collaborators. We thank the Rockefeller Foundation for the financial support it has continued to give the Network. We are also grateful to Director, KARI for the support he has given the Network since its inception.

## EDITOR'S NOTE

The LRNP newsletter is published to provide a forum for highlighting Network activities and sharing its findings with other projects involved in similar work in Kenya. The newsletter also publishes short articles on legume research, especially those based on research aimed at integrating legumes into small-holder agriculture. This is a biannual newsletter and is published in June and December. Your contributions (short articles) and constructive comments are welcome and they should be addressed to: D.M.G. Njarui, the Editor, LRNP newsletter or Joseph G. Mureithi, LRNP Coordinator, P.O. Box 14733, Nairobi, e-mail address is jmureithi@net2000ke.com.

# EFFECT OF GREEN MANURE LEGUME ON THE YIELD OF MAIZE AND BEANS IN MATUNDA FARM, TRANS NZOIA DISTRICT, KENYA

**Kamidi M[1], Gitahi F[2]., Osore P[1]., Cheruiyot D[1]., Okumu M[2]. and Barasa G[2].,**

*[1]KARI, NARC-Kitale, P.O. Box 450 Kitale*
*[2]DAO-Kitale, P.O. Box 178 Kitale*

### *Introduction*

Matunda farm is situated at the lower slopes of Mt Elgon. It lies in the upper midland zone four (UM4). The soils are ferralsols and are prone to erosion. The annual rainfall is 900 - 1600 mm and falls in bimodal pattern with peaks in May and August. The main crops grown are maize and beans and sometimes they are intercropped. The average farm size is 2 acres and a few households keep one or two indigenous cattle. Declining soil fertility has been identified as a major cause of low crop yields in Matunda; the average maize yield is 2 t ha$^{-1}$. One of the causes of declining soil fertility is continuous cropping without the use of either organic manures or inorganic fertilisers. Since 1994 several workshops have been held to train farmers on compost making and storage and farmyard manure (FYM) storage in order to preserve quality. However, farmers preferred compost making as a method of replenishing plant nutrients because only a few of them own livestock. Unfortunately, most farmers cannot make enough compost for the whole farm in one season because of labour limitations and unavailability of plant material. To improve yields of maize in Matunda, which is planted in large plots, alternative sources of nutrient besides inorganic ones have to be sought. One such source is the use of green manures. Green manuring involves growing of plant material, usually legumes for the purpose of incorporating it into the soil (Muller-Sumann, 1994). Green manures add nitrogen to the soil and organic matter which improves soil water holding capacity, nutrient content, nutrient balance, friability and pH (Bunch, 1995).

The objective of this study was to determine the effect of several legume green manure species on the yield of maize and beans at Matunda area in Western Kenya.

### *Materials and Methods*

In 1997, farmers planted maize and beans using 30 kg N, 30 kg $P_2O_5$ plus 5 ton compost per hectare. The maize variety planted was H614D, and the bean variety used was GLP92 (Mwitamania). Maize was planted in early April at a spacing of 0.75 m by 0.35 m. Beans were planted between the rows of maize at a spacing of 0.75 m by 0.15 m, two plants per hill. Land preparation, weeding and dusting against stalk borer were done by the participating farmers who volunteered to take part in the study. Stalkborer were controlled using Bulldock at the rate of 10 kg ha$^{-1}$. Planting and harvesting of maize were done by both researchers and the farmers. Beans were harvested in July and legume green manures were planted in August. The green manures planted were velvet bean (*Mucuna pruriens*), soyabean (*Glycine max*), dolichos (*Lablab purpureus*), sunnhemp (*Crotolaria ochroleuca*) and cowpeas (*Vigna unguiculata*). A single row of legume green manure was planted between two rows of maize. The intra-row spacing was 0.20 m for velvet bean and 0.15 m for soyabean, cowpea and dolichos. Sunhemp was drilled at a seed rate of 13 kg ha$^{-1}$. The green manure legumes were incorporated in mid December using a hoe. Maize and beans were planted in April 1998 using half the recommended rate of inorganic fertilizers, 30 kg N plus 30 kg $P_2O_5$ ha$^{-1}$. Planting was done by researchers and participating farmers. Weeding, stalkborer control and harvesting was done by farmers.

In 1998, cowpea was replaced with purple vetch (*Vicia benghlanesis*). Velvet bean, dolichos and purple vetch were planted in August. Purple vetch was planted at a spacing of 0.75 by 0.05 m. Sunhemp and soybeans were planted in November so that they would still be green at the time of incorporation. The legumes were incorporated into the soil at the end of March 1999 and maize and beans were planted in early April 1999 without any fertilizer. Dry matter production of legumes was determined before incorporation.

### *Results and Discussion*

*Legume yield*

Soil cover was taken in December 1997, four months after planting the legume.
Velvet bean had the highest ground cover followed by sunhemp and dolichos (Table 1). Soybeans and cowpeas gave the lowest ground cover. Velvet bean produced the highest dry matter while soybeans produced the least dry matter (Table 1). One reason the dry matter yields were low was was

due to great variations in establishment of the legumes across the plots and due to poor weed management. These variations are captured by the high coefficient of variation for biomass data (Table 1).

*Maize yield*

Yield of maize in the mucuna plot during the year of legume establishment was significantly different from the other plots (Table 2).

**Table 1. Legume establishment and biomas production in Matunda, TransNzoia district**

| Legume | Soil Cover (%)[a] | Biomass production [b] (t $ha^{-1}$) |
|---|---|---|
| Mucuna | 72 a | 2.1 a |
| Soyabean | 32 c | 0.2 b |
| Dolichos | 54 abc | 1.5 a |
| Crotalaria | 63 ab | 1.2 ab |
| Cowpea | 38 abc | - |
| Vetch | - | 0.4 b |
| Mean | 52 | 1.1 |
| SE | 8.9 | 0.3 |
| CV% | 41.92 | 96.93 |

**Key** [a]Ground cover assessed 4 months of establishment in 1997.
[b] Legume biomass at incorporation 2 weeks prior to planting maize in 1999.
Figures followed by the same letter in the same column are not significant different at 0.05%

**Table 2. Effect of incorporating legume green manure into the soil on maize and bean grain yields (t $ha^{-1}$)**

| Legume species | Maize yield[a] | | | Maize and bean yields[b] | |
|---|---|---|---|---|---|
| | 1997 | 1998 | | 1999 | |
| | Maize | Maize | Beans | Beans | Maize |
| Mucuna | 4.6b | 7.2a | 0.4a | 0.6a | 4.47a |
| Soyabeans | 5.0a | 6.9a | 0.4a | 0.5a | 4.65a |
| Dolichos | 4.7ab | 6.6a | 0.3a | 0.5a | 4.29a |
| Crotolaria | 4.9ab | 7.4a | 0.4a | 0.5a | 4.47a |
| Cowpeas | 4.8ab | 7.1a | 0.4a | - | - |
| Vetch | - | - | - | 0.5a | 3.67a |
| Farmer practice | - | 4.8b | - | 0.4a | 3.88a |
| Mean | 4.8 | 6.8 | 0.4 | 0.5 | 4.23 |
| SE | 1.39 | 0.44 | 0.04 | 0.07 | 0.34 |
| CV % | 7.15 | 13.35 | 21.05 | 43.10 | 29.86 |

[a] yield during legume establishment. [b] yield after incorporation of legumes biomass
Figures followed by the same letter in the same column are not significant different at 0.05%

This difference is attributed to the variations between plots rather than the effects of the legumes on the maize crop.
There were no significant differences in the yields of maize and beans between the different species of green manures, but in 1998 they all gave higher maize yields than the farmers' practice (Table 2). Farmer practice varied from farmer to farmer. All of them used inorganic fertilizers but amounts varied. However, in 1999 there was no difference between the green manures and the farmers' practice. In 1998 the yields were much higher than in 1997 and 1999. In 1998 greenmanures were used together with half the recommended rate of inorganic fertilizers and in 1999 green manures were used on their own. Although the 1999 maize yields are low they are comparable with those reported by Osei Bonsu and Buckles (1993) who obtained maize yields of 3-4 t $ha^{-1}$ with mucuna without application of commercial nitrogen.

***Conclusion and way forward***

Mucuna produced more biomass than the other species. Green manure legumes increased maize yields when used together with half the recommended rate of inorganic fertilizers. There is need to investigate further the effect of combining green manure legumes with compost, farm yard manure and inorganic fertilizers on maize yields and other important smallholders crops.

***Acknowlegements***

The authors are grateful to the Rockefeller Foundation for funding, the Director KARI, and the Centre Director NARC - Kitale and Matunda farmers.

***Refrences***

**Bunch R. 1995.** The use of green manures by villager farmers; what we have learned to date. Technical Report No. 3, 2nd Edition.

**Muller-Sumann, Karl M. and Kotschi Johannes, 1994.** Sustaining growth: Soil fertiliser Management in tropical smallholdings. Karl M. Muller-Sumann, Johannes Kotschi (Ed) CTA; GT2. Trans/: Christine Ernsting and Simon Chater} - Weikersheim: Margraf, 1994.

**Osei Bonsu P. and Buckles D. 1993.** Controlling weeds and improving soil fertility through the use of cover crops: Experience with mucuna spp. In Benin and Ghana. WAFSRN Bulletin No. 14 December 1993.

## INTRODUCTION OF IMPROVED PIGEON PEA (*CAJANUS CAJAN*) IN THE MARGINAL AREAS OF LAKE VICTORIA REGION OF SOUTHWEST KENYA

**Okal Okoko, KARI, RRC- Kisii,**
**P.O. Box 523 Kisii.**

***Introduction***

The marginal area of the Lake Victoria falls within LM3 and LM4 agro-ecological zones (Jaetzold and Schmidt, 1982). The annual rainfall is erratic and low; 700-1000 mm. The soils are in-fertile and can only support low production of cereals and legumes like maize and bean, respectively. A crop like pigeon pea (*Cajanus cajan*) that withstand low rainfall and low soil fertility can be suited to this region. Pigeon pea is an important pulse crop that performs well in semi-arid tropics where moisture availability is unreliable or inadequate (Reddy *et al.,* 1993). The crop can withstand low moisture conditions and perform well in areas receiving less than 1000 mm of rainfall annually. Rao and Willey (1981) showed that pigeon pea can contribute about 40 kg N $ha^{-1}$ through leaf fall and roots. This biological source of N is valuable to smallholder farming systems where resource-poor farmers cannot afford inorganic fertilizers. The grain of the crop is rich in protein and good for the rural communities whose diet is cereal based. The protein content of pigeon pea, especially the dry split (*Dhal*) and green grains ranges between 24-26 % (Singh *et al.,* 1993). In 1997 pigeon pea was introduced in the Lake Victoria region through an on-farm study and the objectives were; a) to assess the adaptability of improved pigeon pea varieties, b) to involve farmers in bulking the seed for sustainability and, c) to involve the farmers in the evaluation process and to promote the utilization of the crop as a protein rich food.

***Implementation***

Seven varieties of pigeon pea, categorized into short, medium and long maturity types were obtained from ICRISAT, Nairobi for this trial. They were three long maturity varieties, ICPL 9145, ICEAP 00040 and ICEAP 00020; two medium maturity varieties, ICEAP 00068 and ICP 6927; and two short maturity varieties, KAT 60/8 and ICPL 87091. The varieties were planted in lower Nyakach and East Karachuonyo in Nyando and Rachuonyo districts, respectively. Twenty-one farms were planted in Karachuonyo and 12 in Nyakach in 1997 and 1998. Two varieties of different maturity periods were planted in each farm. The trials were farmer-managed while researchers took data on crop vigor, pest and disease incidence. At the end of the seasons, the farmers were involved in pre-harvest and post-harvest evaluation of the crop, using their own criteria.

**Table 1: Matrix ranking of pigeon pea by farmers in Karachuonyo in 1998**

| Variety | Characteristic | | | |
|---|---|---|---|---|
| | Vigor | Pest tolerance | Grain appearance | Taste |
| ICEAP 00068* (M) | 1 | 1 | 2 | 2 |
| ICEAP 00040 (L) | 2 | 3 | 5 | 7 |
| KAT 60/8 (S) | 3 | 7 | 7 | 5 |
| ICEAP 6927 (M) | 4 | 5 | 6 | 3 |
| ICEAP 00020 (L) | 5 | 2 | 4 | 1 |
| ICPL 87091 (S) | 6 | 4 | 1 | 5 |
| ICPL 9145 (L) | 7 | 6 | 3 | 4 |

**The lower the number in the same column, the higher the ranking**
***S-Short maturity; M. Medium maturity; L-Long maturity**

### *Results*

Evaluation by the farmers gave both long and medium maturity varieties higher ranking than the short maturity types. The former two were more tolerant to pests and had longer harvesting period. The short maturing varieties were more susceptible to pests such as pod sucking bugs. Another drawback to the short maturity types was the short harvesting period.
The average yield for each variety was below expected potential yield. While the expected yield range from 500 to 1500 kg $ha^{-1}$ the yield in the region ranged bet-ween 150-300 kg $ha^{-1}$. This drastic reduction was mainly due to poor crop management by the farmers especially delayed weeding. Other factors were high pests and diseases incidence, livestock damage and flooding in some fields in Nyakach site.

### *Future*

The proposed work for the next phase will include intercropping the pigeon pea with cereals like maize and sorghum, and monitor the effect of this legume on soil fertility changes and other intercropping benefits.

### *Reference:*

**Jaetzold, R. and Schmidt, H. 1982.** Farm management handbook of Kenya, Volume IIA and B. Farm management branch, Ministry of Agriculture, Nairobi. pp 411.
**Rao, M. R., Willey R. W. 1981.** Stability performances of pigeon pea/sorghum intercrop system. Proceedings of the international workshop on Intercropping. 10-13 Jan 1979, ICRISAT, Hyderabad, India. Patancheru, A.P. 502 320, India: International Crops Research Institute for the Semi-Arid Tropics.

**Reddy, M. V. Raja, T. N; Sharma, S. B, Nene, Y. L and McDonald, D. 1993.** Abstract of Handbook of pigeon pea diseases.

**Singh, F. *et al*., 1993.** Nutritive value and uses of pigeon pea and groundnut. Human resource development program, skill development series, No.14 ICRISAT.

## EFFECT OF INCORPORATING SOIL IMPROVING LEGUMES IN FINGER MILLET AND WHEAT UNDER HIGH POTENTIAL ENVIRONMENT OF SOUTHWEST KENYA

**S.N. Maobe, N.L. Kidula and A.R. Ondicho, KARI, RRC- Kisii, P.O. Box 523 Nairobi.**

### *Introduction*

Small grain cereals, *Eleusine coracana* (finger millet) and *Triticum aestivum* L. (wheat) are among the most important food crops after maize in high potential areas of South-west Kenya. Cultivation of finger millet is mainly in small scale farming while wheat production is predominantly large scale. The cereals are produced in rotation systems; finger millet or wheat following maize. In this production system, it is assumed that small grain cereals benefit from residual effect of fertilizer applied to maize grown in the rotation. Finger millet and wheat are normally grown without application of organic or inorganic fertilizers. It is recommended by researches that a farmer should apply 40 kg N $ha^{-1}$and 20 kg $P_2 0_5$ $ha^{-1}$ to finger millet to obtain 2000 kg $ha^{-1}$ or more of grains per season. This recommendation has only been used by a few farmers because of the high cost of inorganic fertilizer. Therefore, search of low-cost alternatives to improve soil fertility and the yield of the cereal crops is imperative.

A study was conducted in 1996 short rains to evaluate herbaceous legumes as a low cost method of improving soil fertility for enhanced finger millet and wheat production. The objectives of the study were to;

a) determine biomass production of the legumes and

b) to evaluate the effect of incorporating legume biomass on finger millet and wheat production

### *Materials and method*

The research was conducted in farmers fields at Bogetaorio village of Nyamira district, southwest of Kenya. The area is 1800 m above sea level with mean annual rainfall of 1800 to 2100 mm. The predominant soil type is humic nitisols with an average pH of 5.5. The soils are deficient in nitrogen and phosphorus and the use of fertilisers is encouraged. The region is densely populated with an average of 800 persons per $km^2$. Farming is intensive and mixed, leaving no land fallow. Participatory approaches were used in the research as means of involving farmers in technology development. They participated right from problem diagnosis, experimental design, and data collection up to technology evaluation. Sixteen farmers were randomly selected during farmers' workshops. They provided land and labour for the experiments while researchers gave technical know-how and production inputs. The trials were managed jointly by the farmers, extensionists and researchers.

The green manure legumes that were tested included, velvet bean (*Mucuna pruriens*), Lana vetch (*Vicia dasycarpa*), Silverleaf desmodium (*Desmodium uncinatum*) and Trapper pea (Pisum sativum).
A local finger millet cultivar (*Enyaikuro*) widely cultivated in the village was used in the trial.

The millet and wheat were intercropped with legumes giving the following treatments:

- Finger millet or wheat and velvet bean,
- Finger millet or wheat and lana vetch,
- Finger millet or wheat and silverleaf desmodium,
- Finger millet or wheat and trapper pea,
- Control (finger millet or wheat without legume intercrop)

The treatments were arranged in randomized complete block design and replicated four times in each participating farm, using plot sizes of 3.75 m x 6 m. The legumes were planted in between finger millet or wheat rows using recommended plant densities. The data collected were, cereal grain and straw yield and legume yield at harvest time of the cereals.

The control was the farmers' plot of millet or wheat that was cultivated without legume intercrop. Planting was done by drilling the millet or wheat in rows spaced 30 cm apart. There was no fertiliser applied in the experiments to mimic the prevailing smallholder farmer circumstances.

## ***Results and discussion***

### *Green manure / biomass production*

The green manure production of the herbaceous legumes intercropped with the finger millet and with wheat are presented in Tables 1 and 2. The production of green manure was generally low in all the species. Similarly, the yield of grain, and millet straw were also low. This was probably because the green manure legumes were harvested at the same time as millet and wheat, which was at the end of the first cropping season. Normally the legumes are not harvested at this stage for green manuring but are left to continue growing as a sole crop in the field during the short fallow period before on-set of the following cropping season. Before the cereal crop is planted the legumes are ploughed into the soil as green manure. The yield of legume biomass in such a system is likely to be much higher than the yield shown in Tables 1 and 2. The results show that the green manure yields from the various legume species were the same except silverleaf desmodium that gave substantially low production. The latter being a perennial species is slow in establishment and is expected to give low green manure at harvest time of millet and wheat. From the results, the velvet bean and the lana vetch can be better options for intercropping with millet and wheat because of higher green manure production.

### *Straw production*

Straw production was used as measure of finger millet growth. The results in Table 1 show that the presence of green manure

**Table 1: Performance of intercropped finger millet and legume in farmers' field at Bogetario village, Nyamira district, southwest Kenya (Short rains season, 1996)**

| Finger millet (FM) and legume intercrop | Green manure DM (kg ha$^{-1}$) | Straw DM (kg ha$^{-1}$) | Grain yield (kg ha$^{-1}$) |
|---|---|---|---|
| FM velvet bean | 520$^{a}$ | 1957$^{b}$ | 1860$^{a}$ |
| FM and lana vetch | 505$^{a}$ | 3921$^{a}$ | 1438$^{b}$ |
| FM and trapper pea | 160$^{ab}$ | 2884$^{ab}$ | 1768$^{a}$ |
| FM and Silverleaf Desmodium | 136 | 3208$^{ab}$ | 1960$^{a}$ |
| FM without legume (farmers' practice) | - | 2408$^{b}$ | 1803$^{a}$ |
| Mean | 257 | 2876 | 1765 |
| LSD(P=0.05) | 332 | 1355 | 217 |
| C.V.% | - | 39.1 | 10 |

**Means followed by the same letter in the same column do not differ significantly at P = 0.05**

species as intercrop with millet did not depress straw production. This suggested that the velvet bean, trapper pea, silverleaf desmodium and lana vetch can be grown for green manure without reducing growth of intercrop millet. The vetch significantly improved millet straw production. This is possibly because the species grows rapidly and covers the ground faster than the other legumes.

*Grain yield*

The effect of green manure species on grain yield of intercropped millet or wheat

**Table 2: Performance of intercropped wheat and legume in farmers' field at Bogetario village, Nyamira districts, southwest Kenya (short rains season, 1996)**

| Wheat and legume intercrop | Green manure DM (kg $ha^{-1}$) | Grain yield (kg $ha^{-1}$) |
|---|---|---|
| Wheat and velvet bean | $420^{ab}$ | $945^{a}$ |
| Wheat and trapper pea | $413^{ab}$ | $800^{a}$ |
| Wheat and lana vetch | $1090^{a}$ | $800^{a}$ |
| Wheat and Silverleaf | $80^{b}$ | $872^{a}$ |
| Wheat without legume (farmers' practice) | - | $781^{a}$ |
| C.V. % | 79 | 21 |

**Means followed by the same letter in the same column do not differ significantly at P = 0.05**

are shown in Tables 1 and 2. The results show that with the exception of the lana vetch in millet, all the other species evaluated did not have negative influence on grain yield. The vetch, which showed fastest growth amongst the tested species, reduced the grain yield of the millet possibly because of competition.

***Conclusion***

The research findings have shown that the green manure legumes, velvet bean, lana vetch and trapper pea can be incorporated in finger millet and wheat cropping without adversely affecting the grain yield. The silverleaf desmodium has least potential because of its slow establishment.

## PERFORMANCE OF GREEN MANURES LEGUMES IN TWO CONSTRASTING SITES IN EMBU AND MBEERE DISTRICTS OF MOUNT KENYA REGION.

**J.N.Gitari, S.K.Karumba and K. Mwaniki, KARI, RRC-Embu, P.O Box 27 Embu**

***Introduction***

Legume green manure technology was introduced in the maize-based cropping system areas of Embu and Mbeere districts on the south-eastern slopes of Mount Kenya region. The technology was introduced as an alternative method of supplementing the animal manures and mineral fertilizers currently used by farmers for soil fertility improvement in the region. The technology offers a low cost opportunity for maintaining soil fertility by improving nitrogen supply in the soil (Yost and Evans, 1988). Best results are achieved if the legume species chosen for green manuring are compatible with climatic conditions and soil characteristics of the area. In order to determine the best species, screening of herbaceous legumes with a potential for soil fertility improvement in the mid altitude areas of mount Kenya region was conducted for four seasons in 1995/96. A total of 25 short and long-lived annuals and perennials legumes species were evaluated. Legumes chosen for screening were suitable for either human food, animal fodder or for soil improvement through green manuring (Dyck, 1997). Germination, nodulation, phenology as well as dry matter accumulation data was collected for each legume. This study was followed by another one of combining promising legume green manures with others sources of nutrients available in the region which was based on the concepts of integrated nutrient management (INM).

***Methodology***

These studies were conducted between March 1995 and March 1997 as part of the Legume Research Network project activity in Karurina and Gachoka in

Embu and Mbere districts, respectively. The rain is bimodal and the short rains occurs in October - December and the long rains March - August. The site characteristics are given in Table 1. Average land holding at Karurina is about 2-3 ha per farm family. The major food crops in the area include maize, beans and bananas with coffee and pawpaw being the main cash crops. Limited quantities of inorganic fertilizers are used in maize and coffee. In Gachoka, the farming system consists of small-scale farmers with an average of 4-6 ha of land. Maize and cowpeas are the main food crops.

*Legume screening study*

There were two planting dates for the legumes in both the long as well as short rains seasons. The first and third planting dates were done at the onset of long or short rains seasons. The second and fourth plantings were done about two weeks after the initial planting. The list of species planted at both sites is shown in Table 2. The legumes were evaluated in plots of 0.5 by 4 m replicated twice and data was collected from the whole plot. Prior to planting, each of the legumes was inoculated with the appropriate rhizobial. Triple super phosphate (TSP) fertilizer was applied at 20 g per plot. The plots were kept weed free through manual weeding. Sampling was done using a 0.5 by 0.5 m quadrant at 2, 3, 6 and 12 months after planting. The trial was laid out as a completely randomized design.

*INM study*

Ten farmers were chosen at each of the two sites in September 1997. Each farmer participated in the evaluation of the treatments at various stages of crop development. Maize cultivar, Pioneer hybrid 3253, was planted at both sites. During land preparation legume residue of either *Mucuna pruriens* or *Crotalaria ochroleuca* were incorporated. In order to compare the performance of the two GM legumes, the following treatments were applied at both trial sites.

1. Recommended rate of inorganic fertilizer at 50 kg $ha^{-1}$ N.

2. Recommended rate of animal or Farm Yard Manure (FYM) at 5.0 t $ha^{-1}$

3. Legume residue only

4. Legume residue with half rate of animal manure

5. Half recommended inorganic N plus half recommended rate of animal manure

6. Legume residue plus half rate of inorganic N.
7. Legume residue plus half rate of animal manure plus half rate of inorganic N

8. Farmer Practice (FP).

Each of the eight treatments was applied commencing long rains 1998. During the initial starting season of short rains 1997 maize was planted without any form of fertilization. Farmer practice consisted of the soil amendment method which the farmer uses in his/her own crop husbandry.

## *Results and Discussions*

*Growth and development of the legumes*

The species which exhibited a fast (one month) establishment include, *M. pruriens*, *C. ensiformis, D. biflorus, C. ochroleuca and M. atropurpureum.* The species which exhibited slow (2-3 months) establishment include, *S. guianesis, N. wightii, and C. mucunoides*. Germination and establishment at the two sites was similar. Nodulation results showed that *C. ochroleuca* and *C. juncea* had the highest number of nodules. All legume species except *Cicer arietinum* and *Physeolus vulgaris* were able to form effective nodules in all seasons at both sites. No nodules were found on *Canavalia ensiformis.* Most of the phenological characteristics of the best bet species at both sites were similar. In Karurina, the shortest and longest period to flowering was 55 and 150 days after germination observed in common bean and stylo respectively. Seed maturity of the legumes extended between 103 and 273 days after germination. In Gachoka, flowering periods extended between 46 and 221 days after germination for *D. biflorus* and *S. guianensis* respectively. In general, most annuals took 2 months to flower while the period between flowering and seed maturity was about one month in both sites. Long-lived annuals such as velvet bean and lablab took 2-3 months to flower and about 6 months to reach seed maturity.

*Phenology and Dry Matter (DM) accumulation*

Phenology data on various legumes tested at both sites showed that flowering, podding as well as seed development were not affected by the climatic conditions prevalent at both sites. Flowering during the long and short rains seasons did not show any specific trend for both sites. As expected, food legumes such as *Phaseolus* and *Vigna* species were the most prolific in floral and seed formation.

Biomass accumulation was fastest during the initial two months in *G. max* at Gachoka whilst *C. ensiformis, M. pruriens* and *P. vulgaris* accumulated highest DM at the Karurina site. *Stylosanthes guianesis, P. vulgaris* and *V. benghalensis* were slow in biomass accumulation. Thus, early DM accumulation appear to have been closely related to the ease in germination and establishment. Long-lived annuals such as *M. pruriens,* and *C. ensiformis* exhibited a high degree of biomass formation. Thus, on the basis of grams per square metre, it is evident that *Mucuna pruriens, Stylosanthes guianesis, Crotalaria ochroleuca* as well as *Neontonia wightii* were good in biomass accumulation which can be used or incorporation into the soil as green manure for fertility enhancement in the subsequent crop. Table 1. shows the best bet species identified at the end of the screening exercise at each of the two sites.

***INM study***

Legume biomass obtained in SR 1997 was high due to favourable quantities of rainfall (due to *El-nino* rains) which were obtained at both sites.
On average mucuna achieved 10.0 and 9.2 t $ha^{-1}$ dry matter whereas sunnhemp accumulated 7.1 and 6.3 t $ha^{-1}$ at Karurina and Gachoka respectively.

In LR 1998, maize grain yield was 6.48 and 3.14 t ha,$^{-1}$ where only legume residue was used as a source of nitrogen, at both Karurina and Gachoka sites respectively (Table 3). Farmer practice at both sites gave the lowest maize yields of 3.49 and 2.71 t $ha^{-1}$ for Karurina and Gachoka sites. These yields were significantly lower (P=0.05) than all the other treatments at the Karurina site (Table 2). Maize grain yields at Karurina were highest in plots where legume GM was used alone or in combination with either animal manure or mineral fertilizers. Similar trends were observed at the Gachoka site although the results were not as dramatic

**Table 1 Site Characteristics of Karurina and Gachoka, south eastern slope of Mt Kenya**

| | Karurina | Gachoka |
|---|---|---|
| Altitude (masl) | 1280 | 1070 |
| Agro-ecological zone | UM3 | LM4 |
| Mean annual rainfall (mm) | 1100 | 950 |
| Soil type | Humic nitosols | Nito-rhodic Ferrassols |

when compared with those of the wetter Karurina site. Thus, the effect of using legume GM was similar to the use of either animal manure or mineral fertilizer at Gachoka. Short rains seasons during 1998 and 1999 were characterized by crop failures due to low amounts of rainfall. Results obtained in LR 1999 showed similar trends to those of LR 1998.

***Conclusion***

These studies have identified suitable green manure legume crops for the maize-based cropping systems of the mid altitude areas of Mount Kenya region.

In periods of favourable moisture regimes, GM legume residue alone has been shown to be able to provide adequate nitrogen for the growth and development of a maize crop.

**Table 2. Best bet legume species for Karurina and Gachoka sites**

| Legume species | Karurina | Gachoka | Use(s) |
|---|---|---|---|
| 1. Mucuna pruriens | | | Green manure |
| 2. Crotalaria ochroleuca | | | Green manure |
| 3. Vigna unguiculata | - | | Human food |
| 4. Stylosanthes guinensis | | | Fodder and green manure |
| 5.Macroptilium atropurpureum | | | Fodder and green manure |
| 6. Phaseolus vulgaris | | | Human food |
| 7. Neontonia wightii | | - | Fodder and green manure |
| 8.Lablab purpureus | - | | Human food and green manure |
| 9. Glycine max | | | Human food |

**Table 3.Comparison of legume GM with other sources of N as they influence maize grain yields at Karurina and Gachoka in 1998 long rains.**

| Treatment | Site | |
|---|---|---|
| | Karurina Grain weight (t $ha^{-1}$) | Gachoka Grain weight (t $ha^{-1}$) |
| Inorganic N | 4.72 | 3.11 |
| Farm Yard Manure (FYM) | 5.12 | 2.72 |
| Legume Green Manure | 6.48 | 3.14 |
| Legume residue + 2.5 t $ha^{-1}$ FYM | 6.29 | 3.02 |
| 25 kg ha-1 inorganic N + 2.5 t $ha^{-1}$ FYM | 6.09 | 2.93 |
| Legume residue + 25 kg $ha^{-1}$ inorganic N | 6.40 | 3.23 |
| Legume residue + 2.5 t $ha^{-1}$ FYM + 25 kg $ha^{-1}$ inorganic N Inorganic | 6.35 | 3.12 |
| Farmer's Practice | 3.49 | 2.71 |
| LSD (P=0.05) | 1.21 | 0.59 |

### *Reference*

**Yost R. and Evans D. 1988.** Green manure and legume covers in the tropics. HITAHR, College of Tropical Agriculture and Human Resources, University of Hawaii. HITAHR Research Series 055 pages 44.

**Dyck, E., 1997.** Screening legumes for potential for soil productivity improvement in Kenya. Poster presented at Green Manure Cover Crops conference in Santa Catarrina, Brazil April 6 to 12, 1997.

## EFFECT OF SOIL EROSION ON SOIL PRODUCTIVITY AND SUBSEQUENT RESTORATION OF PRODUCTIVITY USING GREEN MANURE COVER CROPS: DATA SUMMARY OF A LONG TERM FIELD EXPERIMENT

**C.K.K. Gachene[1] N.K. Karanja[1] and J.G. Mureithi[2]**

[1]*University of Nairobi, P.O. Box 30179 Nairobi;*
[2]*-KARI/NARL, P.O Box 14733 Nairobi*

### *Background*

Water erosion has been considered a major risk to agricultural sustainability in Kenya. Available information shows that soil loss can drastically reduce potential soil productivity (Gachene, 1995). There has been a concerted effort to encourage farmers to carry out soil and water conservation measures for sustained soil productivity. A number of technological measures exist for water erosion management. These are agro-based and engineering methods. In general, physical soil and water conservation structures are expensive and time consuming and a suitable option is the use of biological soil conservation. Biological measures of soil conservation (e.g. cover crops) provide a continuous ground cover, which is an effective means to ensure soil-moisture conservation and prevent soil erosion (Gachene and Haru, 1999). Studies on badly eroded land in Indonesia showed that legume cover crops were effective in rehabilitating badly degraded land in Indonesia (Suwardjo *et al*., 1991). The objectives of the study were to, a) monitor erosion - induced plant nutrient losses as erosion progresses, b) assess the effect of erosion on selected soil properties and crop growth and, c) assess the effect of selected GMCC in controlling soil erosion and rehabilitating eroded soils.

### *Approach*

This is a long-term experiment located at Kabete, Kenya. The site is representative in terms of soils (nitisols) and climate (bimodal rainfall and cooler temperatures), of large areas of Central Kenya Highlands. Soil loss has been monitored for the last 19 seasons using 3 by 10 m runoff plots.
In addition, changes in soil properties due to erosion and crop growth have been monitored since the inception of the experiment. The research activities that have been undertaken at the site are given in Table 1. The green manure cover crops (GMCC) namely, velvet bean (*Mucuna pruriens*), Tanzanian sunnhemp (*Crotalaria ochroleuca*), jackbean (*Canavalia ensiformis*) and purple vetch (*Vicia benghalensis*) were introduced in 1996 and these were rotated with maize in subsequent seasons.

**Table 1. Research activities undertaken in the long - term experimental site at Kabete farm, University of Nairobi**

| Year | No. of seasons | Acitivities |
|---|---|---|
| 1990 SR* | 1 | Soil sampling, uniform maize crop without fertilizer |
| 1991 - 1992 | 4 | Plots subjected to different rates of erosion |
| 1993 - 1995 | 6 | Maize with or without fertilizer |
| 1996 - 1999 | 8 | Maize/green manure cover crops (seasonal rotations) |

*SR short rains

**Table 2. Soil properties before erosion and in eroded soil material**

| | % organic carbon | % total nitrogen | Phosphorus (mg$^{-kg}$) |
|---|---|---|---|
| Before erosion | 3.00 | 0.31 | 0.56 |
| Eroded material | 3.90 | 0.37 | 5.80 |
| Enrichment ratio | 1.30 | 1.19 | 10.36 |

**Table 3. Seasonal rainfall and soil loss at Kabete, Kenya**

| Season | Rainfall (mm) | Soil loss (t ha$_{-1}$) |
|---|---|---|
| 1997 long rain | 550 | 220 |
| 1997 short rain | 700 | 54 |

**Table 4.Maize grain yields (t ha$^{-1}$) after introducing GMCC in previously eroded soils at Kabete, Kenya**

| GMCC species | 1996 long rains* | 1997 short rains** |
|---|---|---|
| Mucuna | 0.60 | 1.72 |
| Vetch | 1.00 | 2.58 |
| Crotalaria | 0.49 | 2.17 |
| Jack bean | 0.86 | 2.17 |

*** after subjecting plots to erosion,**
**** after planting GMCC during the 1997 long rains - see also Table 1**

***Summary of research observations***

Rainfall varied in both amount and distribution, the highest obviously recorded during the *El Nino* (1997 short rains).
Cumulative soil loss during the 9 year period ranged from 430 - 996 t ha$^{-1}$.
Phosphorus was the most affected by erosion than the other plant nutrients elements (Enrichment ratio was > 10; ER is the ratio of nutrients in the eroded sediment to that of the original soil). This indicates that the soil lost through erosion is the most fertile than what is left in the field (Table 2). Similar observations were made in farmers' field in Gatanga.

All the GMCC tested have the potential of controlling erosion; post-harvest cover was maintained up to the subsequent season, thus minimizing soil losses during the critical period when the ground is bare and prone to erosion. e.g. During the 1997 long rain season, average soil loss (220 t ha$^{-1}$) was four times more than the 1997 short rain season (54 t ha$^{-1}$) despite the fact that there was more rain in the latter (*El Nino*) than in the former season (Table 3). This dramatic reduction was attributed to post-harvest crop cover provided by the GMCC (vetch, mucuna, jack bean and crotalaria) which were planted during the 1997 long rains. This post harvest cover was effective in controlling soil loss during the on - set of the *El Nino* rains of 1997 short rains.

Grain yield increased two times (without fertilizer) after rehabilitating the soils with GMCC. Average yield in 1990 was 5 t ha$^{-1}$ and this had declined to 0.74 t ha$^{-1}$ in 1996 after subjecting the plots to different rates of erosion. However, there was an increase in yield after planting the GMCC (Table 4).

***Conclusions***

The above summary data show that erosion adversely affects soil properties and depresses yields and that some GMCC e.g., *Mucuna pruriens*, *Crotalaria ochroleuca* and *Vicia benghalensis* have the potential of improving soil fertility of badly degraded soils.


### *Acknowledgment*

Initial research grants to undertake this work was provided by SAREC (Swedish Agency for Research Cooperation with developing countries while part of the study was funded by the Rockefeller Foundation.


### *References*


**Gachene, C. K. K., 1995.** Effects of Soil Erosion on Soil Properties and Crop Response in Central Kenya highlands. Ph. D Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.

**Gachene C. K. K. and Haru, R., 1997.** Controlling Seasonal Soil Loss Using Purple Vetch (Vicia benghalensis). African Crop Science Conference Proceeding, Vol 3 Pp 369-373

**Suwardjo, H., Dariah A. and Barus, A. 1991.** Some Studies on Rehabilitation of Degraded Lands In Indonesia. In: W. C. Moldenhauer, N. W. Hudson, T. C. Shavy and San-Wei Lee (Eds.). Development of Conservation Farming on Hillslopes, Pp. 210-217.


## MILK PRODUCTION FROM JERSEY COWS FED A NAPIER GRASS AND MAIZE BRAN BASAL DIET SUPPLEMENTED WITH MUCUNA, LABLAB, CLITORIA OR GLIRICIDIA IN COASTAL KENYA.


**R. W. Muinga, Saha, H. M., Njunie, M. N. and Bimbuzi, S., KARI, RRC- Mtwapa, P.O. Box 16 Mtwapa**


### *Introduction:*

The coastal lowland Kenya is a milk-deficit region, which depends on highland Kenya milk supply to satisfy its daily consumption (Staal and Mullins, 1996). To increase milk production in the region several forages have been screened both on-station and on-farm, for their dry matter (DM) production. In a study by Njunie *et al.,* (1994) to evaluate herbaceous legumes for their adaptability in the coastal lowland environments, DM production and survival after harvesting, siratro (*Macroptilium atropurpureum*) and clitoria (*Clitoria ternatea*) were among the most productive herbaceous legumes for coastal lowland Kenya. lablab (*Lablab purpureus*), *Macrotyloma axillare* and calopo (*Calopogonium mucunoides*) showed good performance during early cuts. The study recommended further evaluation of the legumes for livestock feeding.
Further studies (Saha *et al.,* 1997) recommended mucuna (*Mucuna pruriens*), stylo (*Stylosanthes guianensis*), siratro, clitoria, calopo, and lablab as the most promising herbaceous species for soil fertility improvement. Since small-holder dairy farmers in the region practice mixed farming, a study was proposed to assess the value of herbaceous legumes for milk production. Herbaceous legumes mucuna, clitoria and lablab were compared with gliricidia, a well studied multi-purpose tree legume.

### *Materials and method:*

The trial was carried out at the Regional Research Centre, (RRC) Mtwapa. Three herbaceous legumes, mucuna, clitoria, and lablab were compared with gliricidia (*Gliricidia sepium*), a multi-purpose tree legume recommended for livestock feeding in the region. The forage legumes were established between April to June 1999. They were harvested four months after planting. Napier grass and gliricidia were harvested from plots established in 1989. The Napier grass and gliricidia were cut back and harvested for the experiment after four weeks of re-growth. Maize bran was purchased in bulk from a local maize miller.

Sixteen Jersey cows in their second or third month of lactation were selected from a herd grazing natural pastures at RRC Mtwapa. All the cows calved within a two months period (20 April and 27 June 1999). One week prior to the start of the experiment all the cows were offered Napier grass *ad libitum* and supplemented with 8 kg fresh gliricidia and 4 kg maize bran. The 16 cows were divided into four groups balanced for milk yield and parity at the beginning of the experiment. The daily average milk yield per cow per treatment group one week prior to the start of the experiment was 7.2 kg and the mean live weight was 275 kg (range 235 to 340 kg). The cows were housed in well ventilated stalls with individual feeding facilities. They were weighed and sprayed with acaricide every fortnight to control ticks.

During the experimental period all the cows were fed Napier grass *ad-libitum* together with 3 kg maize bran in two equal parts daily. Water was provided at all times. A mineral lick (Macklic super) was offered to all the cows. The experimental diets were 8 kg of gliricidia, clitoria, mucuna or lablab in two equal parts daily. Fresh Napier grass was chopped every morning with a tractor driven forage cutter to pieces of about 20 mm to ensure that cows did not select leaves from the stems. Any refusals were collected and weighed before offering fresh feed the following day. The legumes were harvested daily and chopped manually to about 20 cm except for gliricidia where the leaves and twigs less than 5 mm were separated from the branches before feeding. Feed intake was recorded daily. The cows were hand milked twice daily and the milk was weighed and recorded. The forages were sampled once per week. Maize bran was also sampled for nutrient analysis. Twelve weeks data on feed intake, live-weight change and milk production was recorded. Data was analysed using SAS (1987).

***Results and discussion***

The nitrogen concentration in gliricidia, mucuna, lablab and clitoria was 4.3, 3.5, 3.5 and 3.4 % respectively. Total DM intake of Napier grass and legumes are shown in Table 1. All the cows consumed 3 kg maize bran offered and the total intake includes this amount for all the treatments. There were no significant treatment differences in Napier grass intake. Cows offered gliricidia consumed all the legume forage (2.1 kg) while cows on the other treatments consumed significantly less (clitoria 1.7 kg, mucuna 1.4 kg, and lablab 1.2 kg). There was no significant difference in total DM intake between the treatments. However, cows fed on mucuna tended to consume less DM than cows on the other treatments. There were no significant live-weight changes during the experimental period. Cows fed on mucuna tended to lose weight from a group average of 280 to 260 kg at the end of the experiment. This may be explained by the lower DM intake recorded for this treatment. Similarly, cows fed mucuna tended to produce less milk than cows fed the other legumes. Milk yield decreased from 7.2 at the start of experiment to 6.4, 6.4, 6.3 and 5.3 at the end of the experiment for cows fed gliricidia, lablab, clitoria and mucuna, respectively.

***Conclusion***

Results from this study indicate that the herbaceous legumes (lablab, clitoria and mucuna) can give a similar lactation performance to that of gliricidia. There is therefore need however, to evaluate the long term effect of the legumes on milk production. Clitoria is a perennial legume, which can be grown on pure stand or in between Napier grass rows. Lablab and mucuna are annuals and there is need to have a source of seed every year. Farmers have the option to use the herbaceous legumes as a source of N for their crops or feed them to livestock and use the animal manure for crop production. There is need to compare the two options.

**Table 1. Mean daily DM intake of Napier grass and legume and milk yield (kg) for Cows fed *ad-libitum* napier grass and 2.6 kg maize bran supplemented with 8kg Fresh gliricidia, clitoria, lablab or mucuna for twelve weeks**

| | Treatments | | | | |
|---|---|---|---|---|---|
| **DM intake** | Gliricidia | Mucuna | Lablab | Clitoria | LSD |
| Legume | 2.1 | 1.4 | 1.2 | 1.7 | 0.12 |
| Napier grass | 4.1 | 4.1 | 5.0 | 4.2 | 1.31 |
| Total | 8.8 | 8.1 | 8.8 | 8.5 | 1.31 |
| Milk yield | 7.1 | 6.3 | 6.8 | 7.1 | 1.78 |

***References***

**Njunie, M. N., Reynolds, L., Mureithi, J. G. and Thorpe, W. 1994.** Evaluation of herbaceous legume germplasm for coastal lowland East Africa. In: Ndikumana, J. and P. de Leeuw (Ed). *Proceedings of the second Biennial Conference of the African Feed Resources Network (AFRNET), Harare, Zimbabwe. 6-10 December 1993. AFRNET, Nairobi, Kenya. 45-50.*

**Saha, H. M., M. N. Njunie, and N. M. Tsanje, 2000.** Legume screening for soil fertility improvement in the coastal lowlands of Kenya.
In Mureithi J.G., Mwendia C.W., Muyekho F.N., Onyango M.A., and Maobe S.N. (Eds.) Participatory Technology Development for Soil Management. A special Publication of the Soil Management and Legume Research Network Projects. Pp. 87-99

**SAS 1987.** Statistical analysis Systems. Guide for personal computers. Version 6 edition. SAS Institute Inc. Cary, North Carolina, USA 551-640.

**Staal, S. and Mullins, G. 1996.** Dairy consumption and its determinants in Coastal Kenya. KARI/ILRI Collaborative Research Project. 47pp.

## BULKING OF LIMA BEAN *(PHASEOLUS LUNATUS*) VARIETIES AT THE KABETE (NARL) SITE

**F. Gitahi, C. Nekesa and J.G. Mureithi, KARI/NARL, P.O Box 14733, Nairobi**

### *Introduction*

Lima bean is an annual legume grown for green or dried shell beans that are eaten after cooking (Duke, 1981). It is native to tropical America; Mexico, Guatemala, south Brazil, Peru and Argentina. Lima bean varieties can be grouped into bushy and climbing (pole) types. The beans do not tolerate frost, are drought tolerant and require well-aerated and well-drained soils (Duke, 1981). Lima bean was one of the legumes evaluated by the LRNP for green manure and found to do well in the semi-arid eastern Kenya (Machakos) and Mt. Kenya rain shadow side (Matanya in Laikipia (Gachene and Makau, 2000; LRNP, 1999). In 1999 it was introduced to farmers in Machakos for evaluation as green manure legume in maize fields. The evaluation is still continuing but farmers indicated that they would prefer lima bean varieties that they could also use as food. Efforts were taken in 2000 by the Network to source for edible varieties from U.S.A. Seven varieties were obtained; five bushy types and 2 pole types (Table 1). Because only small quantities of seeds were supplied it was decided to first multiply the seeds to get enough seed that could be used in an evaluation and adaptation study.

### *Materials and Method*

Bulking commenced in October 2000 at the NARL Kabete site. The legumes were planted on 21/10/2000 after the on-set of short rains in plots measuring 2 x 2 m at a spacing of 50 x 15cm. Phosphorus was applied at the rate of 20 kg P $ha^{-1}$ and mixed with soil before planting of the seeds. The seeds were not inoculated during planting. Apart from variety Christmas Pole and Fordhook which were replicated twice and thrice respectively, the other varieties were replicated four times. The local lima bean that was introduced on-farm was included in the bulking for comparison with the other varieties. Data to be collected during bulking include, germination percentage, phenology data; days to first flowering, days to 50% flowering, days to first podding, days to 50% podding, days to seed set and grain yield. In this article data on germination and phenlogy is reported. Data on seed yield is not yet available.

### *Observation and Results*

Rainfall was low and poorly distributed. The bushy varieties grew upright and had a better ground cover while the pole varieties produced tendrils and climbed on stakes. The bushy varieties flowered more heavily compared with the pole varieties. Seedling emergence ranged from 1.1 % for Sieva Pole to 24.3% for the Bush Henderson 17 days after planting. After 25 days, emergence was highest for Dixie Butter pea and Jackson Wonder (90%) and lowest for the Fordhook variety (60%) (Table 3). For majority of varieties onset of flowering occurred 60 days after planting. This coincided with a dry spell that stressed the legumes and affected the vigor observed in the early emergence period. Christmas Pole flowered 13 days after all the other varieties had flowered. It is noteworthy that 50% flowering occurred after 73 days for all the varieties except Christmas Pole which occurred after 6 days later and

**Table 1: Lima bean varieties and their uses (**Willhite Seed Inc., 2000**)**

| Lima bean varieties | Description and usage |
|---|---|
| Bush varieties | |
| Bush Henderson | Widely used for canning, freezing and as dry beans. It is white seeded. |
| Jackson Wonder | Also referred to as “Speckled Bush Lima”. The plants are hardy with dark green foliage, very vigorous and productive. The seed is medium small, thick flat, broad oval and mottled with purplish black. |
| Dixie Butterpea, speckled | Slightly curved, broad oval pods containing 3-4 seeds. Small red speckled and almost round seeds. |
| Early Thorogreen | Seed small, flat and light green. Widely adapted and prolific. Excellent for canning and freezing. Pods borne in clusters. Dry seed green to white. |
| Fordhook | A heat resistant variety, heavy producer. Seeds are large, plump, mealy and pale green, used for fresh market, canning and freezing. |
| Pole varieties | |
| Christmas pole | A long season bean. When cooked, either green shell stage or dry, they turn a pink brown color. The seeds are large and flat. |
| Sieva | A pole type Henderson with small and dull white seeds. Pods contain 3 - 4 medium green seeds when young. |

**Table 2: Seed emergence of different varieties of Lima bean (Phaseolus lunatus) variety planted on 21st October 2000**

| Lima bean varieties | Seedling emergence percentage (%) | | |
|---|---|---|---|
| | Days after planting | | |
| | 17 | 21 | 25 |
| ***Bush varieties*** | | | |
| Bush Henderson | 24.3 | 86.1 | 88.2 |
| Dixie Butter pea | 13.6 | 88.6 | 89.6 |
| Early Thorogreen | - | 69.7 | 76.8 |
| Fordhook | - | 32.8 | 60.2 |
| Jackson Wonder (speckled) | 1.8 | 83.9 | 89.3 |
| ***Pole varieties*** | | | |
| Christmas pole | - | 34.3 | 88.8 |
| Sieva pole | 9.1 | 83.7 | 88.9 |
| ***Local*** | 1.1 | 71.4 | 78.6 |

**Table 3: Days to flowering and podding of different Lima bean varieties planted on 21st October 2000**

| Lima bean varieties | Days to flowering and podding | | | |
|---|---|---|---|---|
| | Onset of flowering | 50% flowering | Onset of podding | 50% podding |
| Bush varieties | 60 | 73 | 73 | 79 |
| Bush Henderson | 60 | 73 | 73 | 79 |
| Dixie Butter pea | 60 | 73 | 73 | 80 |
| Early Thorogreen | 60 | 73 | 73 | 80 |
| Fordhook | 60 | 73 | 73 | 81 |
| Jackson Wonder (speckled) | 60 | 73 | 73 | 81 |
| Pole varieties | | | | |
| Christmas pole | 73 | 79 | 76 | 87 |
| Sieva pole | 6 | 7 | 73 | 82 |
| Local | 60 | 73 | 73 | 80 |

that onset of podding occurred at the same time as on-set of 50% flowering. Generally 50% podding was achieved 80 days after planting. The pests observed to attack the legumes were aphids, grasshoppers and caterpillars. They were controlled by Dimethoate 40EC, applied at the rate of 30 ml per 20 litres of water.

***Conclusion and way forward***

Observations are still continuing and so far no major differences have been noted on phenology between the bushy, the pole type and the local variety. The variety referred to as local was also originally obtained from the USA and it is likely that it is one of the seven varieties being bulked. Going by the profuse flowering and podding observed in all the varieties, it can be deduced that the varieties have a high potential for seed production. The bushy type provided a better ground cover than the pole varieties and therefore can be suitable for green manuring and weed suppression.

Once enough seeds are available, the varieties will be tested for cookability and palatability. Those promising for food will be introduced on-farm for testing in intercropping studies with maize. Because of their suitability for green manuring the bushy types will be evaluated for soil fertility and weed control in maize fields.

***Reference***

**Duke A.J., 1981.** Handbook of Legumes of World Economic Importance. Plenum Press, New York, Pp 345.

**Gachene C.C.K and Makau M., 2000.** Screening legume cover crops for dry-season survival in a semi-arid environment of Kenya. In Mureithi J.G., Mwendia C.W., Muyekho F.N., Onyango M.A., and Maobe S.N. (Eds.) Participatory Technology Development for Soil management. A special Publication of the Soil Management and Legume Research Network Projects. Pp. 77- 86.

**LRNP, 1999.** Legume Research Network Project Newsletter, Issue No.1. June 1999,
Kenya Agricultural Research Institute, National Agricultural Research Laboratories. Pp. 12.

**Willhite Seed Inc., 2000.** Catalogue for 2000. Poolville, Texas 7648, Pp. 64.

## IMPROVING SOIL FERTILITY IN SOUTH NYANZA WITH GREEN MANURE LEGUMES

**Nyakora C.O. and Oduwo A. O, C-MAD, P.O Box 155, Rongo**

### *Introduction*

The Community Mobilization Against Desertification (C-MAD) is a Non-Govern-mental Organization, initiated to improve resource management and alleviate poverty in southwest Kenya. Currently, C-MAD is working with small-scale farmers in Rachuonyo, Homa Bay, Migori and Suba Districts of Nyanza Province.

This study was conducted to combat low soil fertility which is one of the major factors responsible for declining crop yields in lower potential South Nyanza. Yields of staple food crops (maize and sorghum) are too low to meet the food needs of the population throughout the year. Farmers in the area have tried various interventions to improve soil fertility, mainly using organic compost. While these have proved to be successful on small plots their impact on larger maize and sorghum fields have been minimal due to the large quantities of material and the high labour required to make enough compost for application in such fields.

### *Methodology*

In 1996, C-MAD and KARI-RRC Kisii introduced farmers to the use of green manure legumes for improving soil fertility after conducting PRA. The legume species introduced were mucuna, dolichos and sunnhemp. The legumes were planted as pure stands for one season then their residues incorporated into the soil, two weeks before planting subsequent cereal crops. A pure stand of sorghum or maize was planted uniformly on plots as a subsequent crop. The yields of cereals from the various legume treatments were compared with a control plot. The trials were replicated on at least four farms in each agro-ecological zone. The trials were conducted on 50 farms in different agro-ecological zones ranging from LM2 to LM5. Trial farmers were selected in a participatory manner by the villagers in an open meeting. Each selected farmer was treated as a replicate. The selected farmers were required to provide land and labour. The project staff provided seeds and technical advise. At the end of the season the farm produce was left for the farmer after recording yield measurements.

### *Findings*

At the end of every season, farmers conducted participatory evaluation to determine effectiveness of the different legumes in improving soil fertility. This was done by comparing yields of cereals on the various plots. Based on results obtained from comparing the three legumes, over a period of three years it was found that mucuna was the most effective in terms of improving soil fertility.

This was mainly attributed to its high biomass production content and high soil conserving capacity. Dolichos was rated second best in terms of soil fertility improvement followed by sunnhemp.

### *Farmer Preferences*

Even though mucuna was found to be the most effective legume in improving soil fertility, most farmers preferred to plant dolichos and sunnhemp. Because the two are source of food (vegetable & pulses) while mucuna is not edible. Sunnhemp is a traditional vegetable, which is also medicinal, while dolichos is a delicacy and a high protein food fed to lactating mothers in the local communities.

### *Challenges*

Despite the fact that green manuring is a new technology for improving soil fertility in this area, over the short period of its application, it has been realised that it requires additional labour and inputs in terms of seeds. This is a constraint to many farmers considering their low income and is a major challenge to scaling up of the technology. Sunnhemp, dolichos and mucuna are not native plants in this agro-ecological zone. Their seeds are not abundant enough to serve farmers who may need them to scale up the technology. There is a need for seed multiplication to make legume seeds available at prices that farmers can afford.

***Conclusion***

Green manuring has a potential to in-crease food production in the less fertile soils of South Nyanza. Compared to other interventions, such as chemical and organic fertilizers, its use is more economical. However, there is need for more research on how best to grow the legume considering that land and labour are limiting factors. Research is required to investigate on how to integrate these legumes in the farming system and the associated benefits. Finally, there is need to create awareness of the technology to more farmers through demonstrations, field days and farmer workshops.

## INTRODUCTION OF LEGUME COVER CROPS TO COMMUNITIES IN WESTERN KENYA

**John Mukalama, TSBF, Maseno Agro-forestry Center, P.O Box 25199 Kisumu**

***Intodcution***

Farmers in western Kenya are faced with declining crop yields due to limited use of both inorganic and organic fertilizers. The resource poor farmers do not have means to purchase inorganic fertilizers. A few who use fertilizers in the region are unable to supply the required amount for crop production. Use of organic fertilizers (farmyard manure and green manures) is not common because livestock numbers are limited by Tsetse fly infestation and limited knowledge on plant species suitable for soil fertility improvement as green manures. Research scientists form Tropical soil biology and fertility program (TSBF) has worked in partnership with CARE, Siaya KWAP, Busia and social groups in Kabras to strengthen farmers capacity in adaptive research work on soil fertility improvement. In a meeting involving farmers and scientists, mainly from TSBF, to discuss alternative methods of improving soil fertility, it was agreed that legume cover crops be introduced in the region for soil fertility improvement. Advice was sought from the Legume Research Network Project (LRNP) on the types of legumes suitable for the region and agronomic practices for their established. The Network provided seeds of five legume cover crops; white and black seeded velvet bean (*Mucuna pruriens*), sunnhemp (*Crotalaria ochroleuca*), Lablab (*Lablab pupureus*) cv Rongai and Jackbean (*Canavalia ensiformis).*

***On-farm introduction of legume cover crop***

On-farm trials involving the five legumes were conducted in 9 farms selected from three districts; Siaya three farms, Busia four farms and Maseno two farms. The trials were established during the long rains of April 1998. Farmers participating in the trial were involved in site selection, plot layout, ploughing, planting, weeding and monitoring of the trials. In September, 1998 the cover crops were harvested to determine biomass production (leaves + stems). Seedyield was also determined.
A maize crop succeeding the legume cover crops was established on 7 farms in Busia and Siaya Districts. Prior to planting the maize crop, the legume biomass was chopped and incorporated into the soil. The trial plots were divided into two portions, one side received 15 kg P $ha^{-1}$ applied as DAP and other side received no P. Although the season failed due to low rainfall, measurements on maize biomass yields were taken. Farmers and researchers monitored the effect of the legume cover crops on maize performance.

During the trial period farmers organized on-farm demonstrations and field days to sensitize the other community members on the value of legume cover crop as a strategy for improving soil fertility.

***Results***

Generally all the legumes produced over 3 t $ha^{-1}$ of legume green biomass (Figure 1). Lablab and Jack bean gave the highest average biomass production. *Canavalia* produced the highest yield of seeds and pods; > 4.5 t $ha^{-1}$. *Crotalaria* and *lablab* produced the lowest yield, < 1 t $ha^{-1}$.

Due to failed rains maize grain was not harvested. However, maize biomass was harvested and results are shown in Figure 2. Higher maize biomass (>3 t $ha^{-1}$) was obtained after incorporation of Canavalia and white seeded mucuna, followed by incorporation of black seeded mucuna and lablab. The lowest maize biomass yield (<2.5 t $ha^{-1}$) was obtained with Crotalaria. Surprisingly, adding P fertilizer did not increase maize biomass yield appreciably.

***Farmer evaluation***

In September 1998, farmers were involved in an exercise to evaluate performance of the legume species and their potential for soil fertility improvement. During that time some of the species had reached maturity and had already produced

seeds. Farmers evaluation was based on the following criteria, a) leave biomass production, b) ground surface cover, c) soil moisture retention, d) litter fall and decomposition, e) growth characteristics, and f) pest and disease susceptibility.
Ranking of the legume species varied according to districts but black and white seeded velvet bean were rated first in all districts. This is because they produced high biomass, provided better good ground cover that could deter soil erosion, had high litter fall, was least attacked by pests and appeared to retain soil moisture better.  However, white seeded velvet bean appeared to mature faster than the black one.

**Figure 1: Green biomass and seed production of legume cover crops 5 months after establishment**

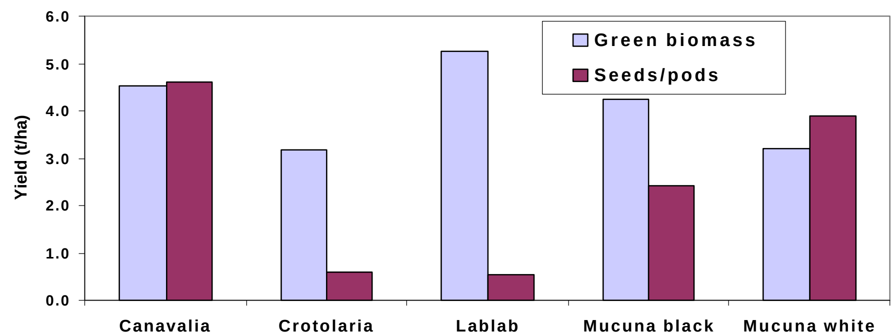
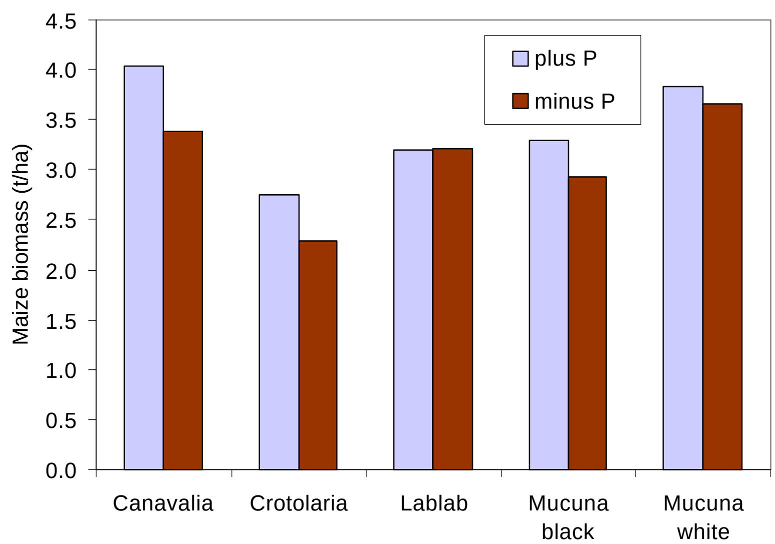



**Figure 2: Comparison of average maize biomass following incorporation of various legume cover crops.**




The only disadvantage with both velvet beans is that they are climbers and therefore can only be intercropped with a few selected crops.

This ranking by farmers appears to contradict the trials results but this is so because the farmers' exercise was done earlier when legumes were still green and mucuna growth was vigorous. The harvesting of legume biomass was done much later when mucuna had reached maturity and was already showing signs of dieback.

In Busia, *lablab* was ranked second because of its non-climbing nature, provided good soil cover and because of its value as human food. In recognition of farmer's need for legume species that also give them food, lablab cv. Rongai (brown seeded and not preferred as food) was replaced by black seed lablab that is widely used as grain legume in central and eastern Kenya and has potential for soil fertility.

In Siaya, *Canavalia* was ranked second because of determinate growth habit and appeared less susceptible to pest attack although it was attacked by two pests, black beetle with yellow spots and another green one. It also produced high biomass. Farmers in Siaya and Busia districts reported that Canavalia plot had less soil moisture retention and the soil was hard to work on during ploughing. Farmers had encountered the legume before and reported there was a believe that it protects farms from evil spirits; They said, *"People with bad eyes will not destroy the crops with mysterious powers they possess".* Also, it was associated with mole control. In both districts crotalaria was ranked last despite having high biomass production because it is highly susceptible to aphid attack, has less ground surface cover and its soils are hard to work on during the ploughing. Apart from the above observations, some farmers preferred crotalaria because it is eaten by humans as a vegetable and can be fed to livestock.

### *Seeds production efforts*

During the on-farm demonstrations and field days most farmers in the communities were impressed by the biomass production of the legumes and were anxious to obtain seed. In Siaya, women groups in Kagilo, Mutumbo and Nyabeda sub-locations discussed possible ways of availing preferred legume seed of black and white seeded mucuna, lablab cv Rongai, black seeded lablab and Canavalia to the community. Since the amount of seed available was small, a few groups were given the small quantities of each species seed to bulk. The groups were to produce seed for their own use and supply to other groups within their communities. In Busia, there are Umbrella Development Groups initiated by Kenya Woodfuel Program (KWAP) in Bukhalalire catchment in Butula Division, Muyafwa catchment in Matayos division and Aludeka catchment in Chakol Division. These groups already have the skills in production of quality seed and were asked to bulk legume seeds and sell them within the community and to other neighbouring communities. In Kabras, TSBF used the schools for bulking legume cover crops so that the pupils could be used as entry point into communities of legume cover crop technologies.

### *Conclusion and way for ward*

Green legume cover crop technology has potential for adoption in western Kenya so long as the seed production and exchange mechanisms at the community level are sustainable. One way of attaining this is by training farmers involved in seed production and promotion. Another area of concern is creation of awareness among the farming communities on the use of legume cover crops as a strategy for improving soil fertility. For those institutions dealing with legume cover crops, methods should be developed to fit legume cover crop technologies into the existing farming system i.e. appropriate crops to intercrop with the legume cover crops and time to establish these cover crops since in western Kenya, maize is always grown together with beans. Studies need to be carried on the use of some legume cover crops for soil fertility versus the secondary uses such food and fodder i.e. Lablab and Crotalaria. Farmers need to know the trade off in order to make informed judgement.

## RESEARCH FOR MASTER OF SCIENCE DEGREE TRAINING IN KENYATTA UNIVERSITY

### *Efficacy of 5 leguminosae species against root-knot and lesion nematodes on beans and maize, respectively*

**Supervisor: Dr. Waceke Wanjohi Kenyatta University, P.O. Box 43844, Nairobi**

### *Research Summary*

Root-knot and lesion nematodes impact heavily on bean and maize production, respectively, in Kenya (Ngundo, 1974; Kimenju *et al.,* 1998). Besides causing significant yield reductions, the nematodes interact synergistically with other plant pathogens resulting in disease complexes that impact more heavily on crop yields. Continuous cropping on the same piece of land further aggravates the nematode menace as the populations increase above the economic threshold levels. Environmental degradation, health risks and costs associated with the most effective methods of nematode control (nematicides), make search for a more economically viable strategy among the resource-poor farmer imperative. Crop rotation is the best known cultural practice both in traditional and subsistence agriculture that lowers nematode pests and other pathogen populations (Bridge, 1996). Although emphasize has been on use of food crops as rotation crops, use of other crops that have multiple uses should be considered. For example, food or forage legumes which are known to improve soil fertility, reduce soil erosion and suppress weeds (LRNP, 1999; 2000) can be used as rotational crops. Besides, the legumes can be used as intercrops in maize-based cropping systems in place of the common bean *(Phaseolus vulgaris L.*) or for short improved fallow. The adoption of this strategy will reduce challenges associated with adaptability of strategic research findings and will enhance efficient use of the meagre resources as this will further broaden the use of the legumes. *Crotalaria* spp., for example has been reported to exhibit nematicidal activities against root-knot and burrowing nematodes (Atu, 1984) and has therefore been recommended for use as an antagonistic and a trap plant (Bridge, 1996). Burning residues of sunnhemp (*C. juncea*) at 10kg/1.44 m2 was reported to control *Meloidogyne* spp. in tomato seed beds (Patel *et al;* 1989). Hairy vetch (*Vicia villosa*) was reported to reduce *Meloidogyne incognita* on tomatoes (Haroon, 1993). A literature search has revealed that the efficacy of some of the legumes (currently being tested for soil fertility improvement by the LRNP in Kenya) in suppressing lesion and root-knot nematodes in Kenya has not been assessed. The legumes to be screened will include Jackbean (*Canavalia ensiformis*), sunnhemp, *Lablab purpurens, Mucuna pruriens* and *Vicia villosa.* The objectives of the study are

i) evaluate responses of legumes to both root-knot and lesion nematodes,

ii) assess effects of intercropping maize with the poor or non-host legumes on lesion nematodes on maize, and

iii) assess effects of rotating beans with the poor or non-host legumes on root- knot nematodes on beans.

### *Reference*

**Atu, U. G. 1984.** Effect of cover crops in fallow lands on root-knot nematode population.

Bietrag-zur-Tropischen landwirtschaft und Veterinarmedizin 22, 275-280

**Bridge, J. 1996**. Nematode management in sustainable and subsistence agriculture. Annual Review of Phytopathology 34, 210-225.

**Haroon, S. A. 1993.** Effect of hairy vetch (*Vicia villosa*) and four different kinds of grasses as mulches (cover crops) in the production of tomatoes and control of *Meloidogyne incognita.* Journal of Agricultural Sciences 24, 19-34

**Kimenju, J. W., Waudo, S. W., Mwang'ombe, A. W., Sikora, R. A. and Schuster, R. P. 1998.** Distribution of lesion nematodes associated with maize in Kenya and susceptibility of maize cultivars to *Pratylenchus zeae*. African Crop Science Journal 6, 367 -375.

**Ngundo, B. W. and Taylor, D. P. 1974.** Effect of Meloidogyne spp. on bean yields in Kenya. Plant Disease Reporter 58, 1020-1023

**Legume Research Network Project, 1999** and 2000. Newsletters, issue Number 1and 2, respectively. Kenya Agricultural Research Institute, National Agricultural Research Laboratories.

## ANNOUNCEMENTS

### *LRNP (Legume) Database*

In August 2000 the LRNP undertook an exercise to develop a database based on the performance of the 40 legume species involved in the country wide legume screening studies conducted in the Network's eleven sites (LRNP Newsletter, Issue 1). A technician with proven computer skills and wide experience in data management using data processing software like Microsoft Excel was hired to assist in this exercise. The first activity was to request all the sites to send the screening data to the Coordinator. The data was received from Kitale, Kakamega, Kisii, Gatanga, Karurina, Embu, Matanya, Machakos and Mtwapa. Data from Kendu Bay and Kabete was not available. This was followed by entering the data into Excel files and this activity is now complete. Currently, we are cleaning the data and checking with site coordinators the validity of some entries that appear way off the mark. After this, we will prepare summary reports for each site that will include information on, seedling emergency, groundcover, nodulation, phenology, DM yield, tissue chemical analysis and pest and disease incidences. This will be followed by the development of a database that can be used to provide information on performance of legume species in different agro-ecological zones of Kenya. This database will be updated continuously as the Network continues to screen more legume germplasm to increase the range of available legume options for farming in Kenya.

### *Legume seed bulking*

The table below shows the amount of seeds available in the LRNP store. Mucuna tops the list of the seeds that have been demanded most followed

| SPECIES | Amount of seed received by 30th June 1999 (kg) | Amount of seed issued out to date (kg) | Amount of seed in store by 26th Feb 2001 (kg) |
|---|---|---|---|
| Canavalia ensiformis | 393 | 216 | 177 |
| Crotalaria juncea | 8 | 0.5 | 7 |
| Crotalaria ochroleuca | 84 | 80 | 4 |
| Desmodium uncinatum | 3.3 | 3 | 0.3 |
| Lablab purpureus: (brown) | 86 | 78 | 8 |
| (black) | 13 | 7 | 6 |
| Phaseolus lunatus | 10 | 6 | 4 |
| Macroptilium atropurpureum | 39 | 21 | 18 |
| Mucuna pruriens: (white) | 480 | 474 | 6 |
| (black) | 39 | 10 | 29 |
| Neontonia wightii | 37 | 4 | 33 |
| Vigna unguiculata:(cowpea K80 ) | 19 | 17 | 2 |
| (cowpea M66) | 8 | 8 | - |
| Vicia villosa | 9 | 7 | 2 |
| Phaseolus coccineus (black) | 2 | - | 2 |
| (white) | 2.8 | - | 0.3 |
| Vicia benghalensis | 6 | - | 5 |
| Vicia dasycarpa | 2 | - | 1 |

by *C. ochroleuca* and *Lablab purpureus*. Network sites in Embu, Katumani, and KARI-Kabete are currently bulking white and black seeded *mucuna, crotalaria, dolichos* and *stylosanthes*. Other Network sites will resume seed bulking during the coming long rainy season.

***The 18th Conference of the Soil Science Society of East Africa (SSSEA).***

This conference was held in Mombasa from 4th to 8th December 2000 and participants came from the three Eastern Africa countries. Over 120 participants attend the conference and majority came from Kenya. The conference was officially opened by Dr. R.M. Kiome and during the opening Dr. John Lynam gave a stimulating paper on behalf of "Friends of the SSSEA". Day 1, 2, and 4 were devoted to plenary presentations. Over 100 papers were presented and to accommodate them all, parallel sessions were organized for day 2 and 4. Day 3 was set aside for field excursion that began with a soil classification exercise of two selected soils of coastal Kenya, followed by visits to smallholder and large-scale farming systems in the coast and ended up in an internationally renowned rehabilitation program of vast areas belonging to Bamburi Cement Factory where coral rock has been mined for cement making. Rehabilitation was made by afforestation with *Casuarina equisetifolia and Prosopis spp* and now the area looks like a natural forest. In Day 5, 18th SSSEA AGM was held and later followed by celebrations to mark the end of the millennium. During the AGM several important issues were discussed which included, formation of SSSEA permanent secretariat, establishment of SSSEA journal and intellectual property rights of microbial prospecting in east Africa. The end of millenium celebrations included, four keynote papers, awards to recognize individuals and institutions that have made outstanding contribution to soil science in the region and to the well being of the SSSEA. The following are the resolutions of the 18th SSSEA AGM.

***Recognizing the seriousness of the need for sustainable use of land resources to alleviate poverty in the East African region as well as noting that there was still:***

- *•Inadequate utilization of soil scientistsin the region,*
- *•Inadequate application of soil and water technologies,*
- *•Ineffective soil and water management by-laws,*
- *•Need to strengthen existing policies onland management,*
- *A need to recognize the potential of soilscientists in planning and execution of land development program,*
- *•Inadequate transfer of existing land management technologies, particularly to small hold farmers,*
- *Great heterogeneity of problems/constraints facing farmers in the region,*

- *•Need for increased funding for research and dissemination of technologies and*
- *The urgent need to protect the intellectual property rights of scientists in the region*

***The 18th Soil Science Society of East Africa (SSSEA) conference held at Mombasa, Kenya, resolved that:***

- *The soil scientists in the region will, in their studies, continue to ensure that they come up with well- tested and economical land management technologies based on integrated and multi-disciplinary approaches, taking into consideration indigenous knowledge.*

- *•The soil scientists will continue to work closely with policy makers, extension workers, NGOs, individual farmers and farmers' groups and other development groups in their activities to promote dis semination and utilisation of improved land management technologies.*

- *Soil scientists in the region will continue to pursue basic, strategic, applied and adaptive research in a continuum.*

- *•The society would establish mechanisms to protect the intellectual property rights for its members.*

- *In order to be able to fulfill the above resolutions, the soil scientists need facilitation. While recognizing the steps that have been taken by governments, the 18th SSSEA conference recommended that:*

- *Regional governments should place well-qualified personnel in soil science at regional and district levels.*

- *Governments should strengthen the soil testing and advisory services and bring them closer to the farmers (at least at the provincial/district level, and in all agricultural universities).*

- *Governments should facilitate in availing efficient means of transferring the existing land management technologies to the farmers. Strengthening the linkages between policy makers, researchers, extension workers and farmers can effect this.*

- *Governments should formulate and put in place a land use policy, review and enforce land use and soil management by-laws.*

- *Governments should strengthen and support land and soil resources databases including soil surveys.*

- *Governments should include soil scientists in decision making, regulatory bodies and in implementing development programs.*

The 12th World Fertilizer Congress: Fertilization in the third millenium, Fertilizers, Food security and Ecology. Venue- the International Convention Centre, Beijing, China, August 3rd to 9th, 2001. For more information, please write CIEC20001@iae.syb.ac.cn. or Fax +86 24 2384 3313.

The 17th World Congress of soil science, 14th - 20th August 2002, Bangkok, Thailand, For more information write to the office of the 17th World Congress of soil Science Kasetsart Golden Jubilee Administration and Information centre (1st Floor) Kasetsart University, P.O. Box 1048, Bangkok 10903, Thailand.
E-mail: o.sft@nontri.ku.ac.th
http://www.17wcss.ku.ac.th.