LEGUME RESEARCH NETWORK PROJECT NEWSLETTER

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ABOUT THE NEWSLETTER

The Network has continued to work very closely with smallhold farmers, especially on multipurpose use of green manure legumes (GML). Articles on the use of GML in conservation agriculture in smallhold farms, and use of GML as human food are presented in this issue. The use of GML for improving soil fertility in large-scale farms is gaining momentum. Already three such farms have approached the network to be provided with legume seeds for replenishing soil fertility. This issue includes an article from DWA, one of the large-scale farms which is evaluating GML cover crops for soil fertility improvement in sisal fields. Three extended abstracts of completed Ph.D studies on green manure cover crops from students affiliated to the LRNP are included. The studies were based on GML-maize-cassava and crop–legume–livestock production systems. As earlier mentioned in Issue No.2 (Feb 2000), these PhD studies will complement the on-farm research currently being undertaken by the Network. On behalf of the network members, we take this opportunity to congratulate Drs. M.N. Njunie, E.M. Nyambati and D. M. Mbugua for having successfully completed their Ph.D studies. The Network is once again grateful to the financial support it has continued to receive from the Rockefeller Foundation. The support the Network has received from Director KARI is gratefully acknowledged.

EDITOR'S NOTE

The LRNP newsletter is published to provide a forum for highlighting Network activities and sharing research findings with network members and other projects, individual researchers and farmers who are involved in similar work in Kenya. This is a biannual newsletter and is published in June and December of each year. Your contributions and constructive comments are welcome and should be addressed to the Editors of LRNP Newsletter, CKK Gachene or LRNP Coordinator, JG Mureithi.

Contents

Cover Crops in Conservation Agriculture: A Case Study with Farmer Groups in Machakos, Kenya

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Introduction

Decline in land productivity is, in most cases, associated with mismanagement of cropland. Organic matter, an important component affecting soil quality, is lost through intensive conventional tillage practices, with little or no return of crop residues back to the soil. Proper tillage methods are necessary for successful farming. A good tillage system should improve soil and water conservation, maintain soil organic matter content, and preserve soil structure. Conservation agriculture (CA) is based on the integrated management of water, soil and agricultural resources. CA relies on three principles, namely, permanent soil cover, minimal soil disturbance and crop rotations. Unlike conventional tillage which results in soil compaction, increased soil erosion, and decreased soil organic matter, CA results in improved soil structure, water infiltration and soil organic matter. It is a practice which has been widely adopted especially in South America, North America and Australia. Permanent soil cover can be attained through use of multi-purpose cover crops.

Most green manure cover crops play a significant role in covering the ground thus protecting the soil against erosion. An ideal green manure cover crop for CA is one that meets most of the following criteria:

- Fast growing (accumulates much biomass within a short period)
- Fixes nitrogen from the air
- Deep rooting and thus leads to improved soil structure and recycling of nutrients
- Covers the soil quickly, thus controlling erosion and suppressing weeds
- Produces many leaves and no hard, woody stems
- Easy to establish and also to remove when necessary
- Does not compete much for moisture and nutrients with food crops
- Has multiple uses, e.g. food, fuel, fodder, control of pests

The objective of this study was to sensitize and train farmers on CA methods using dolichos (*Lablab purpureus*) in order to reduce soil moisture loss, control weeds and increase crop yields.

Study area

Kalama Division of Machakos District has a population of 42,000 people who are mainly subsistence farmers. Types of crops grown are maize, dry beans, pigeon peas, cassava, sweet potatoes, local mangoes, sorghum, cow peas and kales. There are a number of farmers also growing green peas, tomatoes and bananas. Beans, pigeon peas, tomatoes and mangoes are major cash crops for the area while maize is the main staple food.

The division receives bimodal rainfall with the most reliable rains occurring in October to December (short rains -SR). The long rains (LR) occurring in April to May are unreliable in both amounts and distribution. A lot of rainfall is lost through water surface runoff and this, together with poor farming practices have resulted in low crop yields. To address this problem, appropriate CA technologies were introduced in the area. The objective was to sensitize and train farmers on the methods of CA using cover crops in order to reduce soil moisture loss, control weeds, reduce labour in weed management and increase yields.

Methodology

To enhance dissemination of conservation agriculture among smallhold farmers, trials were set out in 19 sites. Eight farmers were selected in Kola focal area (4 men and 4 women) and 11 farmers from Kyangala (2 registered women groups and 6 men). The resources required were subsoilers, dolichos seeds, herbicides, Magoye ripper planter, mechanical weeder, knapsack sprayer, land, draught animals and a farm plan. The implements were given to farmer groups and each group was to agree on how to share the implement amongst members. Each participating farmer was given 2 kg of dolichos seeds. Each farm had 4 treatments namely:

- maize + conventional weeding
- Maize + dolichos
- Dolichos alone and
- Maize + herbicide

The farmers monitored and evaluated labour requirement and time taken to undertake trial operations. All plots were subsoiled and Magoye ripped before dry planting in October 2002. Fertilizers Diammonium phosphate (DAP) and Calcium ammonium nitrate (CAN) were used at the recommended rates of 150 kg ha^{-1} for planting and top dressing maize, respectively. Plot sizes were dependent on land availability. Germination counts, number of weeding, method of weeding, pest damage and crop vigour were recorded.

Trial observations

The dolichos established a good canopy but the rate of canopy development differed among the 19 farmers. Good canopy was observed in ten farms. In some areas dolichos was damaged by bean flies and other pests particularly in uphill Gomeni, while in the lower areas of Kyangala, water stress and insect problem affected the crop severely. In Kola, the insect problem was severe even where a number of pesticide applications was done, particularly after the maize harvest. The rate of infestation differed from one farm to another.

During the April to May rains, dolichos crop was initially under water stress in most farms but later recovered, established a good canopy and resulted in high yields. In some farms, the canopy (Oct season) was too dense that, even spraying to control the insects was a problem. The canopy continued to develop till December 2002. Direct planting of maize in September into the mulched plots was carried out in some of the farms. In such farms, the soil was loose and friable. It took one hour compared to one-days work with farmers practice to prepare planting holes for the October rains in the mulched plots. The biomass was sufficient in controlling weeds and soil workability was good in plots where mulch

Photo 1: Good ground cover provided by dolichos, Kalama, Machakos disrict

had been applied.

Ten farmers harvested dolichos seeds which they shared with other members of their group, friends and neighbours. One lady gave all members of her group each half a kilogram of seed and gave the Kenya Conservation Tillage Initiative (KCTI) project 20 kgs of seed. The farmers indicated that dolichos had the advantage of controlling weed and that there was some saving in labour. Weeding was only necessary before canopy establishment of the dolichos. Afterwards canopy cover adequately suppressed all the weeds. Maize yields in mulched plots were on average 2.4 t ha^{-1} compared to 1.0 t ha^{-1} obtained in conventional tilled plots. The high maize yield achieved in dolichos mulched plots was attributed to soil moisture conservation and less weed infestation. The herbicide treatment gave promosing results of suppressing weeds but it was dropped because of high costs.

Dissemination

Two field days were held for each area where about 120 farmers attended. They were shown the benefits of CA using cover crops. Participants during field days included staff from the Ministry of Agriculture, Kenya Agricultural Research Institute, University of Nairobi, Kenya Draught Animals Technologies, local administrators, Africa Conservation Tillage and Regional Land Management Unit.

Way forward

Further trials on direct planting into mulch need to be carried out. Matraca planter (hand) or the Marfrense 1 mulch planter (animal drawn), both available at the National Agricultural Research Laboratories (NARL) can be used for direct planting into mulch. There is need for further studies on the control of pests which severely affected dolichos, particularly use of natural products such as neem. Farmers are now bulking their own seeds while others are requesting to be provided with dolichos seeds. Work on the use of other cover crops for CA, especially mucuna, needs to be carried out.

Acknowledgement

This work was conducted under the KCTI collaborative programme and I am grateful to the support provided. I am truly thankful to the farmers who participated in this activity. They were cooperative, hardworking and contributed to the success of this work. KARI Director is thanked for providing enabling environment for conducting this research.

An Investigation of Suitable Cover Crops for Soil Fertility Improvement in Sisal Plantation at DWA Sisal Estate

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Introduction

DWA Estate is located in Makueni District of Eastern Province and falls in agro-ecological zone LM5. The average annual rainfall is 600 mm. Sisal variety 11648, which is a high yielding hybrid is grown in the Estate. The hybrid has high demand for soil nutrients due to its high yielding ability. Good farming practices are therefore important to enable the soil retain nutrient for successful cycles of the crop. In view of this, the Estate is looking for a suitable cover crop(s) to supplement inorganic fertilizers which are currently used to improve yields. The Legume Research Network Project was approached for advice on suitable legume species which can be grown to replenish soil fertility in the sisal estate. Three types of legume species were recommended for trial and some seeds were given by the LRNP.

The legumes were:- Mucuna *(Mucuna pruriens)*, Neotonia *(Neotonia wightii)* and Siratro *(Macroptilium atropurpureum)*. These species were selected based on the following criteria:

(a) Easy to establish and regeneration through seed or perennial character.
(b) Nitrogen fixation expectation (100–300 kg N ha^{-1}).
(c) Easy to control and fit readily onto the normal sisal maintenance and harvesting practices.
(d) Not compete unfavourably with the main crop for moisture or restrict in growth.

(e) Good root structure to penetrate any hard soil areas

At the onset of the 2001 short rains (October – December), the three species were planted in a young sisal field for observation

Photo: Mucuna in sisal field

Observations:

Mucuna pruriens: Easy to establish and very vigorous in growth covering the interrow spaces quickly and prolific in seed production. Mucuna died back after seed production leaving an abundant mulch cover. The seeds collected were planted out in the field for multiplication and further observation.

Macroptilium atropurpureum: Established easily, moderate growth vigour, perennial in character with a good root system. Seed collection was still going on and they were to be planted out in the field for observation and multiplication.

Neontonia wightii: Establishment was patchy and poor in growth. No seed collected. Regeneration was being observed and if successful, seeds were to be collected.

Initial observations indicated that *Mucuna pruriens* (Mucuna) and *Macroptilium atropurpureum* (siratro) were promising.

Legume Utilization Day: Legumes as an Alternative Source of Food in Matanya

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Introduction

Matanya site lies in the rain shadow of Mt. Kenya and Aberdares ranges. The rainfall pattern is bimodal averaging 600 mm per year and poorly distributed in the two rainy seasons. The temperatures are extremely low in the night and high during the day. Due to harsh weather conditions, most of the well-known Kenyan traditional food crops perform very poorly in the area. The farm sizes are small ranging from 0.8 – 2.0 ha per household. During the legume screening work conducted by the Legume Research Network Project, farmers realized that some of the legumes grown for soil improvement can also be an alternative source of food. The farmers therefore decided to hold a utilization day to test the cookability, palatability and taste of some the green manure legumes.

Field activities

The utilization day was held on 12/2/03. A total of 25 people attended, which included 19 farmers and 4 extension staffs from the Ministry of Agriculture. To familiarize the participants with the legumes, they were first taken to the legume plots so that they could compare with what they had in their farms and see how the legumes performed in the field. The group actively participated by asking questions on utilization and performance of each of the legumes. The species were *Mucuna pruriens* (velvet bean), *Neotonia wightii*, *Crotalaria ochroleuca* (Tanzanian sunnhemp), *Vicia benghalensis* (purple vetch), *Phaseolus coccineus* (butter bean, white and coloured type), *Lablab purpureus* (dolichos), *Glycine max* (soyabean), and *Phaseolus lunatus* (lima bean). The importance and the roles (for instance, moisture conservation, soil fertility improvement, as feed for animals and food for humans) that each legume has in the existing farming systems were explained by the site coordinator.

Participants' observations

- Some of the participants wanted to know the advantages of intercropping legumes with potatoes and maize. The participants were told that trials conducted at the Matanya LRNP site indicated that potatoes intercropped with vetch had more tubers compared to the control plots where potatoes were intercropped with maize, the latter being the common practice in the area.

- On whether the legumes can substitute farmyard manure and the inorganic fertilizers, the participants were informed on the importance of integrating legumes in the farming systems and they should not completely ignore the use of inorganic fertilizer and farm yard manure.
- Farmers were explained on the potential of lima bean as an alternative to the tradition beans grown in the area. The participants noted that lima bean is high yielding and does not twine on maize. They were eager to know the price of seeds which they can use for planting. The participants were informed that there was no price set for the legume seeds and that few quantities could be obtained from the coordination office store.

Recipes

Five main recipes were prepared during the utilization day, namely, Sunnhemp vegetables, butter bean-githeri (a mixture of boiled butter beans and maize), lima bean-githeri, soya milk and fried soya-githeri. The legume seeds used were harvested during the previous season.

1. Sunnhemp (*Crotalaria ochroleuca*) vegetables

The recipe was mainly prepared for consumption with Ugali (a local maize meal dish prepared by boiling water and mixing it with maize flour). The expert for this recipe was one of the Network farmers who come from a region where crotolaria is commonly used as vegetable before she got married in Matanya. She explained and demonstrated to the participants the best time and the part of legume to be picked for use as vegetable. The best time to start picking the vegetables is when the shoots are about 30 cm from the ground. She explained that this will allow more shoots to sprout thus giving more leaves for vegetables and seeds. The farmer further informed the participants that one can continue picking the leaves upto the time when the plant has fully podded and when there are no more young and tender leaves. The fresh vegetables were boiled for 15 minutes with magadi soda (Trona or sodium bicarbonate) to make them smooth and tender before frying. The participants were informed that, bean stalk ash can be used when magadi is not available. After 15 minutes, the water was squeezed out of the vegetables ready for frying. Milk was added into the vegetable as it neutralizes any remaining traces of magadi. After boiling the vegetables with milk for about 5 minutes, cooking fat and onions were added (although it is not a must if they are not available). The recipe was then ready for consumption. Ugali was prepared by one of male farmer who surprised the other participants with his expertise of preparing ugali. This was served with the vegetables.

2. Butter bean (*Phaseolus coccineus*)

Ingredients for this recipe included dry white and coloured butter beans, green maize, potatoes and pumpkin leaves. Both coloured and white butter beans were boiled using charcoal cookers separately for some time and later, green maize was added into the pots in the ratio of 1:3. The mixture was allowed to boil for about two to three hours. The potatoes and pumpkins leaves were added into the bean-maize mixture when the latter were almost completely cooked and allowed to boil for thirty minutes. The mixture was then mashed ready to be served. The farmers ranked first the coloured butter bean in taste and time for it to cook properly compared with the white variety.

The participants were impressed by its performance in terms of seed yield in the LRNP demonstration plots. Most of the participants had at least tasted butter bean dishes before, although they complained that seeds are hard to get.

3. Lima bean (*Phaseolus lunatus*)

The ingredients and preparation of this dish were the same as those of butter beans. The beans were consumed without being mixed with any other foods. The participants noted that lima bean took two hours to cook fully which was the shortest time taken compared to the other dishes. The taste and the colour of the dish was acceptable to all participants and farmers were of the opinion that lima bean can be used as an alternative source of food for the area.

4. Soya bean *(Glycine max)*

The soya bean was mixed with green maize in a ratio of 1: 3 and cooked for $1^1/_2$ hrs. The mixture was fried with potatoes, tomatoes and other food seasonings. The farmers were taught how to blanch and dehull the beans using hot water treatment and cooking for 25 – 50 minutes.

Soya bean blanching procedure *(Heat treatment)*

Water was boiled in the ratio of 1:5 soya bean to water, respectively. The soya bean seeds were put in the boiling water in small amounts until all seeds were soaked in the water. They were boiled for 30 minutes in readiness for dehulling.

Dehulling

Dehulling is the process of seed coat removal. The soya beans were boiled for 30 minutes; then water was decanted and some lukewarm water added. This was to enhance seed coat removal by lowering the water temperature. Seeds were rubbed against each other to peel off seed coat which floated on water. Water used in dehulling and seed coats was decanted leaving the seeds in the pot. This was repeated twice to make sure all seed coats were removed. Dehulled seeds were sun dried for 2 days to reduce moisture to about 13% ready for either Githeri fry or milling for flour in the local posho mill for preparation of soya milk.

5. Soya milk

Dried dehulled soyabeans were taken to a local posho mill and ground to make flour. The flour was added to boiling water in the ratio of 1:5 . The mixture was boiled and like cow milk, it bubbled and tended to overflow. This surprised farmers very much. The boiled milk was sieved and put into another container. Farmers tasted it and they nicknamed it ‘matiba’. This name was given in reminisce to some kind of porridge made from green maize used in the old days.

6. Soya *githeri*

The ingredients were: dehulled soya seeds, maize, potatoes, cabbages, onions, tomatoes and water. The ratio of soya bean to maize was 1:3. Water was added to fully cover the mixture and cooked for $2^1/_2$ hrs. Chopped onions were fried in cooking fat until they turned brown. Peeled chopped tomatoes were then added and allowed to cook for 5 minutes. Potatoes, cabbages and maize-soya mixture was cooked for an hour and served to the participants.

Farmers’ reactions

- Farmers requested seeds for the soya beans
- They requested to be taught dehulling method as this was the most important stage in preparing soya bean recipes.
- Farmers were impressed by the soya-githeri dish as they had initially thought that soya can never be fully cooked.

Conclusion

The participants learnt that legumes can play a very important role in supplementing the already existing sources of food which were limited due to the harsh weather conditions prevailing in the area. Farmers resolved to organize another utilization day which should involve more participants from the area. The participants pointed out lack of seeds as the main obstacles that hindered wider integration of legumes into the existing farming systems. Lima bean was ranked first due to its higher yield and adaptability in the area compared to the other species. The participants noted that lima bean required a shorter time to cook compared to the rest. Coloured butter bean was ranked second.

Seed Production of Dolichos (*Lablab purpureus* cv Rongai) in Trans Nzoia and West Pokot Districts, North Rift Kenya

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Introduction

The realization of the potential use of Dolichos lablab as a green manure crop in addition to being a grain legume has resulted in increased demand for its seed that has often been in short supply. A proposal by EAT to the LRNP to produce lablab seed to address this rising demand was supported for the 2002 cropping season. A total of three acres (1.2 ha) at on-farm sites in Trans Nzoia and West Pokot districts were used for the seed production. The sites were acquired through lease agreements for a period of one year. The first season crop was grown from May to September 2002 while the second season was grown from September to January. A total of two and a quarter acres (0.95 ha) of land previously used for maize production were planted in the first season while for the second season only three quarters of an acre (0.3 ha) was used for seed production.

Materials and methods

For the first season crop, tractor drawn disc plough was used to prepare the land at the sites and an ox-drawn plough was used to make ridges for seed placement. For the second season crop, the land was prepared by hand. Two seeds were placed per hole at a spacing of 45 by 30 cm giving a plant population of about 148,148 plants ha^{-1} with seed requirements of about 35 kg ha^{-1}. Phosphorus fertilizer was applied at planting in form of triple super phosphate (TSP) at a rate of 50 kg P_2O_5 ha^{-1} to ensure adequate supply of phosphorus to the crop. The seeds and fertilizer were covered by soil using hand hoes.

The fields were kept weed free through hand weeding. Two hand weedings were done, two weeks after germination and the second just before flowering. Pest and disease surveillance was done on the crop during its growth for any necessary control measures to be taken. Mature dry pods were picked from the field by hand, dried, and then threshed. The seed was air dried to approximately 12% moisture content, dusted with actellic powder and then packaged into bags for storage.

Observations

Incidences of insect pests and diseases occurrence on the crop were minimal in both seasons. However, the first season crop appeared to have been more damaged by pod sucking insects slightly lowering the quality of seed. The yields obtained for the different sites are shown in Table 1. The main factor that appeared to have strongly influenced seed production at the different sites during the two seasons was rainfall. In the first season, there was less than normal amount of rainfall which was poorly distributed and resulted in reduced yields. The very low yield per unit land area at the West

Table 1. **Lablab seed production at three sites in Trans Nzoia and West Pokot districts during 2002 cropping seasons.**

Site/District	Season	Actual area (ha)	Grain yield (kg)	Grain yield (kg ha^{-1})
Wehoya (Trans Nzoia)	1	0.5	438.6	877.2
KARI (Trans Nzoia)	2	0.3	350.0	1166.7
Chepareria (West Pokot)	1	0.4	133.1	332.8
Total		1.2	921.7*	

*Actual seed harvested

Pokot site underscores the effects of low rainfall amounts. The poor rains experienced during the year resulted in relatively high costs of production per unit quantity of seed.

SUMMARY REPORTS OF THREE COMPLETED PH.D STUDIES

Introduction

Three KARI scientists affiliated to the LRNP , namely Drs. M.N. Njunie, E.M. Nyambati and D. Mbugua successfully finished their Ph.D studies which were based on green manure cover crop legumes. The three undertook their studies at North Carolina State University, University of Florida and Cornell University, respectively. In Issue No. 2 of the LRNP, we included proposal summaries of these studies. The following is the summary reports of their research work.

Evaluation of Forage Legumes for Soil Fertility Improvement in Maize/ cassava Production Systems

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Abstract

Soil fertility decline is a major factor limiting crop production in smallholder farms in sub-Saharan Africa. Coastal Kenya farmers are aware of the problem of declining soil fertility caused by continuous cropping without returning nutrients, soil erosion, burning of plant residues, and short fallow intervals in food crops production. This research examined intercropping of forage legumes as potential nutrient sources in maize and cassava production systems. The overall objective was to study the effects of harvest frequency and developmental stage at harvest of an annual (dolichos) and perennial (clitoria) forage legume on: i) biomass and nutrient accumulation ii) rate of nutrient release from the respective legume residues, and iii) availability of residue derived nutrients to maize and/ or cassava. The design for the experiment was a split-plot with five replications, consisting of cropping system (main plot) and harvest management (subplot) factors. Main plot treatments were clitoria or dolichos grown as monocultures or as an intercrops with two tropical food crops (cassava and maize). Clitoria was first cut at 2 months after planting, and subsequently every 6 or 10 weeks after the first cut, while dolichos was cut at 2 and 4 months after planting the legume. The harvested foliage was applied as surface mulch. A third experiment monitored the decomposition and nutrient release from clitoria and dolichos residues. Following each legume harvest, three replicates of nylon mesh bags containing legume residue as intact plants were placed on the ground surface within their respective cropping system and legume management plots, and then retrieved at 0, 1, 2, 4, 8 and 16 weeks in the field. Nonlinear regression equations for percentage of original dry weight, N, P, K, Ca, and Mg remaining at each retrieval date were determined by

Maize dolichos intercrop

cropping system and legume cutting strategy and data was fit to single, double, and asymptotic models of NLIN procedure. Results from the maize/cassava production experiments revealed that the legumes accumulated nutrients (2-year average) ranging from 50 to 101kg N ha^{-1}, 4 to 8 kg P ha^{-1}, 33 to 83 kg K ha^{-1}, 7 to 32 kg Ca ha^{-1}, and 5 to 7 kg Mg ha^{-1} during the long rain season, with dolichos producing greater values. Unlike the long rain season, nutrient contents of clitoria were greater than dolichos during the short rain season, with values ranging from 36 to 54 kg N ha^{-1}, 3 to 5 kg P ha^{-1}, 26 to 40 kg K ha^{-1}, 5 to 8 kg Ca ha^{-1}, and 5 to 7 kg Mg ha^{-1}. Intercropping reduced nutrient contents of the legumes to < 80% of the monoculture, and was most pronounced for clitoria intercropped with cassava. Delayed harvest of dolichos from two to four months after planting

Cassava inercropped with clitoria

increased dolichos nutrient accumulation between two and fourfold, but harvest management was not significant for clitoria nutrient accumulation.
As expected, fertilizer inputs increased maize and stover yields by 70% over maize grown without fertilizer inputs.
Intercropping maize with clitoria increased grain and stover nutrient accumulation by values ranging from 50 to 80%, compared to maize monoculture without fertilizer inputs, while intercropping maize with dolichos yielded less grain and stover.
Cassava monoculture resulted in the greatest tuber yields (9 Mg ha^{-1}), while intercropping of cassava with a legume reduced tuber yield by an average of 21%.
Overall, positive nutrient balance results occurred for maize monoculture systems supplied with fertilizer, and maize/legume intercropping systems with maize stover returned to the system and P supplied to the legume as inorganic fertilizer.
Generally, the presence of cassava in a cropping system resulted in negative N and K balances, supporting the need to review N and K replenishment recommendations for maize and/or cassava cropping systems in the region.

Results of the decomposition and nutrient release study revealed that an asymptotic model best described clitoria and dolichos dry matter disappearance across different harvest management strategies, while legume residue decomposition rates were unaffected by cropping system. The rate coefficients for dry matter disappearance of clitoria and dolichos residues were 0.2 and 0.5 wk^{-1}, respectively. Similarly, nutrient release from clitoria and dolichos residues best fit an asymptotic model. The *k*-values obtained for dolichos showed the greatest variation (0.2 to 2.5 wk^{-1}) compared to those obtained for clitoria (0.3 to1.0 wk^{-1}). Nitrogen release was generally slowest in clitoria and in dolichos cut at 4 months. Across harvest management strategies, the general order of nutrient release was K > P > Mg > N, while that of dolichos cut at 2 months was K>Mg> N>P and K>N>P>Mg for dolichos cut at 4 months.

Calculations of the area by time equivalent ratios (ATER) based on totals of long and short rain seasons' yields of maize, legume, and cassava revealed that intercropping of clitoria or dolichos with maize or cassava resulted in the most efficient way of utilizing land area and time, with the longer cutting intervals of legume indicating a more efficient use of space and time. The ATER for clitoria intercropping with maize and/or cassava ranged from 1.2 to 1.6, while that of dolichos ranged from 1.1 to 2.0. Generally, greater values of ATER were observed where the basis for the comparisons was the no fertilizer input control, implying that advantages of intercropping would be noticeable in situations where fertilizer inputs are a constraint, as is the case in coastal Kenya.

These results demonstrated the legumes potential to supply nutrients for maize grain and cassava tuber production, and indicated that biological efficiency may be improved by intercropping maize with legumes. The need to develop N and K replenishment recommendations for cropping systems with cassava is suggested. Further research aimed at reducing nutrient losses by synchronizing nutrient release with principal crop demand is recommended.

Management and Nutritive Evaluation of *Mucuna pruriens* and *Lablab purpureus*-Maize Intercrops in the Sub-Humid Highlands of Northwestern Kenya

EM Nyambati, KARI, NARC - Kitale, P. O. Box 450, Kitale

Abstract

Declining soil fertility and inadequate and low quality feed resources limit smallholder crop yields and dairy production in Kenya. Herbaceous legumes can provide an alternative to the use of commercial N sources for cereal crops and livestock production in these low external-input farming systems. The overall objectives of this study were 1) to assess the productivity of relay-cropped mucuna [*Mucuna pruriens* (L.) DC. Var. utilis (Wright) Bruck] and lablab [*Lablab purpureus* (L.) Sweet cv. Rongai] and their effect on maize (*Zea may* L.) - bean (*Phaseolus vulgaris* L.) intercrop performance, 2) to gain greater understanding of the N-release from soil-incorporated legume residue and its uptake by succeeding maize, 3) and to determine the effect of harvesting top canopy biomass of legumes as fodder for livestock on their contributions to soil enhancement and livestock nutrition. To realize the above objectives, the following experiments were carried out:

(i) Experiment 1 evaluated the N contribution of relay-cropped mucuna and lablab to the succeeding maize-bean intercrop when part of the legume biomass was harvested for fodder.
(ii) In experiment 2, the effect of legume cropping system, defoliation regime, and cropping sequence (number of years of residue application) on subsequent maize and beans were evaluated on the research station.
(iii) The third experiment evaluated the productivity of relay-cropped mucuna and lablab on low soil fertility, in smallholder farms.
(iv) The objective of the feeding experiment which was the last part of this study was to evaluate the effects of feeding mucuna and lablab hay as supplements to lactating dairy cows fed a basal diet

of napier grass on dry matter intake and digestibility, body condition and body weight gain, and on the quantity and quality of milk and manure produced.

Based on the results from the above experiments, the following recommendations can be drawn. Relay cropping mucuna or lablab in the current maize-common bean intercrop has potential to increase grain yields of subsequent maize and beans when P is not limiting. The impact of defoliating upper canopy herbage of legumes as fodder on yields of subsequent maize and beans depends on the legume growth morphology. Defoliation of lablab, which has upright growth habit, decreases grain yields of subsequent maize, but it does not eliminate its longer-term residual effects on soil fertility. Defoliation of mucuna enhances the synchrony of N release with maize demand for the current crop, and appears to increase the longer-term residual effects on soil fertility. There is no apparent advantage of incorporating undefoliated mucuna residue for two consecutive years compared to one year, but application of lablab residue for two consecutive years has cumulative residual effects. Farmers can skip one year of residue application and still realize some residual benefit of residue applied the previous year. Feeding part of mucuna or lablab herbage as dry season protein supplement to lactating cows has potential to increase milk yield and cattle manure output. The fodder quality of mucuna is comparable to that of lablab, therefore harvesting the top-canopy biomass of either mucuna or lablab as fodder can improve the productivity of smallholder low-external input mixed crop-livestock systems by providing benefits in addition to soil fertility improvement, such as increased milk and manure yields. This could increase the adoption of the green manure technology.

Future research should focus on the efficiency of N uptake and recovery in relation to different times of residue application in relation to onset of rains and planting of maize. Also on-farm evaluation of mucuna and lablab as supplements for dairy cows feeding on low quality feeds such as maize stover and napier grass should be undertaken to elucidate the potential of these legumes in providing additional benefits to the smallholder farmers.

The Effects of Anti-Nutritive Compounds in Tropical Legumes on Ruminant Nutrient Utilization, Excretion and Decomposition of Manure in the Soil

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Many smallholder farmers in sub-Saharan Africa are using herbaceous and shrub legumes for livestock feeding and as green manures. Besides their beneficial high nitrogen contents, these legumes also contain a variety of anti-nutritive compounds, such as tannins, alkaloids and saponins. The objectives of this study were: i) to investigate the roles of anti-nutritive plant compounds in tropical forage legumes on nutrient utilization by ruminants and the consequences of their interactions, ii) to explore the effects of tannins and alkaloids and their interactions on decomposition and mineralization patterns of animal and compost manures in acidic tropical soils, and iii) to investigate the role of micro- and meso-fauna on decomposition of soil amendments containing tannins and alkaloids. *In vitro*, purified condensed tannins (CT) and sparteine (quinolizidine alkaloid) significantly ($P < 0.05$) depressed neutral detergent fiber degradability. However, only CT significantly reduced cumulative gas volume and the rate of gas production. A significant negative interaction ($P < 0.01$) between tannins and alkaloids on rate of gas production was observed. Simulations with the Cornell Net Carbohydrate and Protein System (CNCPS) showed that reduction of the degradation rate of the B2 carbohydrate fraction (digestible fiber) by CT reduced energy allowable milk by 1.0 kg^{-1} when the rate changed from 0.067 h^{-1} to 0.051 h^{-1}. Microbial protein synthesis from fermentation of forages with alkaloids and tannins was responsive to the level and quality of available energy in a feed and the inhibitory effects of the secondary compounds were most evident under conditions of limited nutrient availability. Tannins, but not alkaloids, reduced N digestibility by animals, but there were no significant effects on intake and dry matter digestibility. Faeces from animals fed legumes containing tannins and alkaloids and compost from these same plants decomposed significantly faster ($P < 0.05$) than feeds when incubated in the soil. Decomposition and release of nutrients from soil amendments placed in 2000 m pore size litterbags were higher ($P < 0.001$) than those placed in 53 m mesh size bags. These studies indicate that presence of anti-nutritive compounds in ruminant feeds, especially tannins, can reduce nutrient availability but may not necessarily affect animal performance. These studies also suggest that presence of meso-fauna is critical in litter and manure decomposition in the soil.

Farmers' Knowledge on Local Soil Fertility Indicators and the Role of Plant Residues in Soil Productivity in Embu District, Kenya.

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Introduction

Indigenous inhabitants in certain rural areas of world's poorer nations possess assets in form of indigenous knowledge of their ecosystems and changes that occur therein. They act as invaluable source of information that could be used to assess, monitor and evaluate changes that occur in land resources (Brokensha, *et al.*; 1980; Pieri *et al.*, 1995). Pawluk *et al.*, (1992) and Zimmeerer (1994) examined the relationship between local soil knowledge and science and concluded that the local knowledge is relatively accurate and an inexpensive means of monitoring soil conditions in a given environment. The local inhabitants are able to identify plant life and relate the vegetation with the rest of the ecosystem where they grow and also to give a detailed information of soil types and properties in the specific environment where they occur (Brokensha, *et al*., 1980; Steiner, 1998). A study was conducted to document farmers ITK in soil management in Embu district. The objectives of this on-going study are:

(i) To assess the soil fertility status of the smallholder farms as experienced by farmers.
(ii) To identify the major soil quality limitations affecting crop and livestock productivity in the study area.
(iii) To give an insight into the farmers' perception of soil fertility and the mechanisms they have put in place to alleviate the problem.
(iv) To identify the main soil fertility indicators that farmers use to judge the soil fertility status in their local environments.

Methodology

The study was conducted across an altitudinal gradient of the farming area of Embu district on July 3 to19, 2002. The survey area consisted of a transect commencing at the Mount Kenya forest edge, cutting across all the five major agro-ecological zones of the district. The survey route covered about 30 km passing through the Lower Highland (LH 1) 1, Upper Midland (UM) 1, UM 2, UM 3 and Lower Midland (LM) 3 agro-ecological zones. A stratified random sample of 134 farmers (approximately 27 from each zone) were interviewed. Data collection was done by administering a standard questionnaire to individual farmers. There was a farm visit during each of the interviews to different parts of the farm to observe the general characteristics of the farm, crops grown, livestock kept as well as different types of weeds and crops occurring in the farm. Information was sought on soil fertility indicators and on the role that plant residues play in solving soil fertility problems. The questionnaire was processed and analysed using Statistical Package for Social Scientists (SPSS) computer software. The analysis was done for farmer characteristics, farm character, institutional factors and technological attributes.

Results highlights

Socio-economic characteristics of the study area: Farm sizes, age and education of farm decision-makers

The results showed that farm sizes ranged from 0.3 to 10.0 ha in different agro-ecological zones and the mean farm size per household was about 3.0 ha. Majority of farm decision makers (95%) were between 31 to 60 years old. The highest number of the decision makers (30%) were 41-50 years old. About half of the decision-makers had attained primary level education while a quarter had attained secondary or tertiary education.

Crop and livestock enterprises

Maize, beans, tea and coffee were the predominant crops in the study area. Tea was the predominant crop in the LH 1 agro-ecological zone (AEZ) where the crop occupied nearly all the area of the entire farm. Farmers in this zone were therefore net food importers since most of the farm was devoted to the cultivation of tea. In AEZ UM 1, tea occupied 60 per cent of the total farm area. Unlike tea, coffee was found throughout the entire transect area of the study area. The crop was, however, more prominent in the middle section of the transect which consisted mainly of the UM 2 and UM 3 AEZ. Survey results also indicated that average maize yield for the entire district was about 1.9 t ha^{-1}. Other prominent crops in most of the farms in the district included bananas and napier grass.

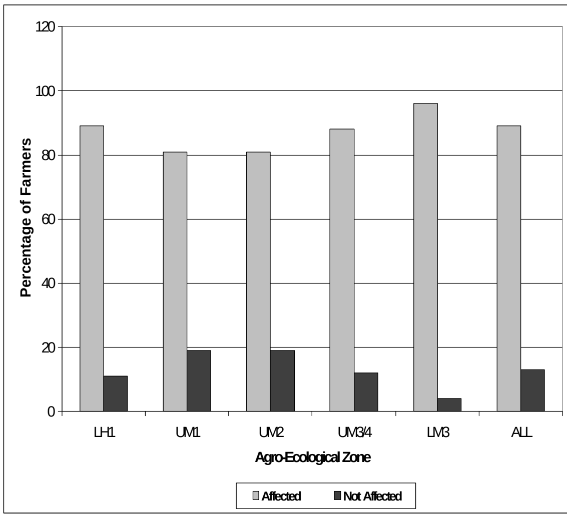
Livestock farming was an important farming enterprise in all the five agro-ecological zones of the district. The types of livestock kept by farmers include cattle, goats, sheep, and poultry. On average, farmers owned two herds of cattle and one goat. Sheep were more common in the warmer agro-ecological zones of UM 4 and LM 3 while poultry keeping was a widespread occupation in the entire district. The mean number of chicken per household was about thirteeen.

Soil Fertility Management

Causes of low soil fertility in farmers' fields

Farmers in all the five agro-ecological zones were affected by low soil fertility. On average, 87 per cent of all the farmers in the district were affected by the problems of low soil fertility in their farms (Figure 1). Within the farm fields,

Figure 1. Proportion (%) of farmers in Embu District that are affected by low soil fertility.



different parts of the farm were affected differently by soil fertility problem. The proportion of land with different farm niches that had an infertile soil were located away from the homestead (34%) when compared to those located nearer to the homestead. Farm niches that lie at the steep slopes also accounted for about 20% of all the infertile sections of the respective farms. The reasons that farmers gave as the main causes of low soil fertility, in order of importance, were: soil type (31%), little or no use of amendments (19%), soil erosion (16%), over-cultivation (13%) and wrong tree species (5%). The remaining causes of soil infertility were attributed to factors not known to the farmers.

Soil Fertility Indicators

Weed species as indicators of soil fertility

In all the five agro-ecological zones, farmers listed weed species that they use as indicators for high soil fertility in their farms (Table 1).

Table 1. Frequency of prevalence in occurrence of weed species indicating high soil fertility status in different Agro-ecological zones of Embu District.

Weed species	Mean frequency (n=82)
Commelina benghalensis	16 (1.3)*
Bidens pilosa	15 (1.3)
Galinsoga parviflora	16 (1.3)
Amaranthus spp.	5 (1.3)
Commelina diffusa	16 (3.1)
Solanum nigrum	4 (2.1)
Rottboellia cochinchinensis	8 (3.1)
Ageratum conyzoides	2 (2.1)

** Figures in brackets are standard errors of the respective means.*

Farmers also listed several weed species that they use as indicators of low soil fertility status. The red top grass (*Rhynchelytrum repens*) was the most prevalent weed species in all the five agro-ecological zones, which farmers use to denote the occurrence of an impoverished soil. Other low fertility indicator weeds are shown in Table 2.

Table 2. Frequency of prevalence in occurrence of weed species indicating low soil fertility status in different Agro-ecological zones of Embu District.

Weed species	Mean frequency (n=52)
Rhynchelytrum repens	13 (1.2)*
Richardia scabra	7 (1.2)
Pteridium equilinum	7 (1.6)
Digitaria velutina	3 (3.6)
Alternanthera philoxeroides	9 (1.6)
Acanthospernum hispidum	13 (2.9)

** Figures in brackets are standard errors of the respective means.*

The Role of Plant Residues in Soil Fertility

Soil improving plant residues:

There were three main sources of plant residues whose presence in the soil was beneficial. These sources included crops, trees as well as weeds. The LH 1 agro-ecological zone had very few sources of plant residues. The main residue source in this zone was either tea bushes (*Camellina sinensis)* or *Grevillea robusta* trees. The rest of the agro-ecological zones had several alternative sources of plant residues. *Grevillea robusta* was a main source of plant residues for soil fertility improvement in all the five agro-ecological zones. The various sources of plant residues for soil fertility improvement are shown in Table 3.

Table 3. Frequency of prevalence in occurrence of soil fertility improving plant residues in different Agro-ecological zones of Embu District.

Plant residue source	Mean Frequency (n=56)
Zea mays	18 (2.4)*
Grevillea robusta	8 (1.9)
Phaseolus vulgaris	9 (2.4)
Persea americana	4 (2.3)
Vitex keniensis	2 (3.3)
Camellina sinensis	4 (3.4)
Ficus sycomorus	5 (2.7)
Cordia africana	3 (3.3)
Tithonia diversifollia	3 (3.3)

** Figures in brackets are standard errors of the respective means.*

Soil impoverishing plant residues

The frequency of prevalence in the occurrence of *Macadamia* spp., *Cupressus lusitanica* and *Eucalyptus saligna* as soil impoverishing residues were higher than all the other plant residue sources across all the five agro-eclogical zones. In the cooler agro-ecological zones of LH 1 and UM 1, *Acacia mearnsii* was listed as a tree species whose residues are not associated with any soil fertility enhancing attributes. In the warmer areas of UM 4 and LM 3 zones, farmers identified *Croton megalocarpus* and *Sorghum bicolour* residues as sources of soil impoverishing residues. The crop/tree residues listed as soil impoverishing are listed in Table 4.

Table 4. Frequency of prevalence in occurrence of soil impoverishing plant residues in different Agro-ecological zones of Embu District.

Plant residue source	Mean frequency (n=27)
Macadamia integrifolia /Tetraphylla spp.	9 (1.6)*
Eucalyptus saligna	6 (1.4)
Acacia mearnsii	2 (1.9)
Mangifera indica	3 (1.9)
Croton megalocarpus	3 (1.9)
Sorghum bicolour	4 (3.4)

** Figures in brackets are standard errors of the respective means.*

Conclusions and Way forward

This survey clearly shows that most farmers in Embu district (which to a larger extent represents smallholder farming systems of the central highlands of Kenya) are aware of the problem of soil fertility and its negative consequences on land productivity in the area. The farmers have over the years acquired some indigenous technical knowledge on parameters useful in determining soil fertility as it affects crop yields and the general land productivity. This study has revealed a need for the researchers and other community-based workers to tap some of this farmers' knowledge as a useful tool in helping to understand the factors limiting agricultural output in these complex farming systems typical of the central highlands of Kenyan region. However, interventions of addressing soil fertility problems should also be looked into. A major component of this on-going research project involves the use of green manure for improving soil fertility.

References

Brokensha, D. D.M. Warren, O. Werner. 1980. Indigenous knowledge systems and development. University Press of America. New York, U.S.A. Pp. 460.

Pawluk, R.R., A.J. Sandor and J.A. Tabor. 1992. The role of indigenous soil knowledge in agricultural development. *Journal of Soil and water Conservation* 47: 298-302.

Pieri, C., J. Dumanski, A. Hamblin and A. Young. 1995. Land quality indicators. World bank discussion Papers 315. IBRD/The World bank, Washington, D.C.

Steiner, K.G., 1998. Using farmers knowledge of soil in making research results more relevant to field practice: Experiences from Rwanda. *Agriculture, Environment and Ecosystems* 69: 191-200.

Zimmerer K.S. 1994. Local Soil Knowledge: Answering basic questions in highland Bolivia. *Journal of Soil and Water Conservation* 49: 29-34.

LEGUME SEED STORAGE

Amounts of seed in store by 30th December 2002 are shown in Table 1.

Table 1. Amounts of legume seed in store by 30th December 2002.

Species	Seed (kg)
Canavalia ensiformis	228.9
Crotalaria juncea	3.2
Crotalaria ochroleuca	50.9
Desmodium unicinatum Silver	2.5
Lablab purpureus (Brown	1.6
(Black)	27.7
Phaseoulus lunatus	54
Macroptilium atropurpurem	5.1
Mucuna pruriens (White)	604.4
(Black)	183
Stylosanthanes	4.9
Neontonia wightii	0.55
Vigna unguiculata: (Cowpea K80)	-
(Cowpea M66)	1.2
Vicia villosa	0.08
Phaseolus coccineus (Black)	18.4
(White)	9.9
Vicia benghalensis	19
Vicia dasycarpa	1.1
Vicia sativa	1.2

ANNOUNCEMENT

a) The proceedings of the International Workshop on Increasing Mucuna's Potential as Food and Feed Crop held in Mombasa, Kenya (Sept. 23-26, 2002.
The papers presented in the workshop are published in a Special Issue of the Tropical and Subtropical Agroecosystems journal, Vol, No. 2-3, 2003. The full citation is: Eilitta M, Muinga R, Mureithi J, Castro CS and Szabo N. (Eds.) 2003. Increasing Mucuna's Potential as a Food and Feed Crop. Tropical and Subtropical Agroecosystems Journal, Special Issue, Vol I, No. 2-3. The Journal is available at the following website: **http://www.uady.mx/sitios/veterina**.

b) Publication
Evaluation of four forage legumes as supplementary feed for Kenya Dual-Purpose goat in the semi-arid region of eastern Kenya, 2003. D. M. G. Njarui, J. G. Mureithi, F. P. Wandera and R. W. Muinga. Tropical and Subtropical Agro-ecosystems 3 (2003): 65-71.

The paper is available at the following web site: **http://www.uady.mx/sitios/veterina/servicios/journal/2003-2/indice-2(2).html**.

c) OSSREA's Research Grant Awards Scheme
The Organization for Social Science Research in Eastern and Southern Africa (OSSREA) was established in 1980. It focuses on social sciences, research, training in research methodologies, and disseminating research outputs. Membership to the organization is open to individuals, organizations and government agencies interested or engaged in social science research.
Its major objectives are;

1. promoting the development of an African research tradition
2. enhancing policy/research interface
3. building research capacity through training
4. undertaking collaborative research and creating facilities for the exchange of scholarly ideas
5. disseminating research outputs
6. promoting cooperation between social scientists in Eastern and Southern Africa and African development institutions
7. facilitating dialogue, cooperation and collaboration between social science researchers, other scholars and policy makers in Eastern and Southern Africa

A major activity of OSSREA is to run a competitive Research Grant Awards scheme as part of OSSREA's capacity building programme. The research proposals submitted are screened by juries of reputed scholars and the winners are awarded the grants to do research in one year and then submit the results. The research outputs are evaluated and disseminated through publication.

For more information contact: The Executive Secretary, P.O. Box 31971, Addis Ababa, Ethiopia. Email: **ossrea@telecom.net.et**, website: http:/www.ossrea.net

Dr. Regina G.M. Karega, Bureau of Training and Consultancy, Kenyatta University, P.O. Box 43844, Nairobi, Kenya. Email: kubtc@avu.org

d) Conference/Meeting/Workshop
Dairy 2003 Conference. Theme: Modern technology options for milk farmers, April 10, 2003, Silver Springs Hotel. For more information, contact; Kenya Agricultural Mart, P. O. Box 210, Ngong Hills 00208 Tel. +254-45-40661. Conference Secretary, Sarah Kajuju Mobile +254-722-288023 or

Conference Coordinator, Richard K. Ephanto Mobile +254-722-386893. Email: dairy@eposta.co.ke.

Regional Sugar Stakeholders' conference to be held in Kisumu, Kenya from 22nd – 27th June, 2003. The purpose of the conference is to bring together sugar players and other stakeholders to discuss the transitions taking place in the sector and chart the way forward. For more information please contact Dr. Eusebius J. Mukhwana, the Secretary Organizing Committee, Regional Sugar Stakeholders' Conference c/o SACRED-Africa, P.O. Box 2248, Bungoma, Kenya. Email: Sacred@africaonline.co.ke

The 7th International Rangeland Congress, Durban, South Africa, 26th July - 1st August 2003. For more information, contact: International Rangeland Congress c/o Sue Bumpsteed Conferences, Private Bag X37, Greyville, 4023, Duban, South Africa. Tel. +27 31 303 2480, Fax: +27 31 312 9441. Email: delegates@sbconferences.co.za

The ninth regional conference of the Southern and Eastern African Association for Farming Systems Research-Extension (SEAAFSRE) will be hosted jointly by Makerere University, the National Agricultural Research Organisation (NARO) of Uganda, Uganda National Agricultural Advisory Services (NAADS) and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) on 29 September – 3 October, 2003. The conference theme is: Moving beyond doing good research and extension to making a difference to the lives of resource-constrained farmers and the rural poor. For further information, contact: Dr Fina Opio, Chairperson, 9th SEAAFSRE Conference Organizing Committee, Namulonge Agricultural and Animal Production Institute, P.O. Box 7084, Kampala, Uganda. Tel: 256-(0)77-423907, email: fopio@naro-ug.org

The Egerton University/KARI – NPBRC 3rd Annual Symposium will be held from 20th - 21st November 2003 at ARC, Egerton University. The Theme is: Technology for sustainable agricultural and national development. For more information, contact:
Egerton University /KARI – NPBRC Symposium Secretariat
Attn:
Dr J. N. Nanua, Dairy & Food Science Dept. P. O. Box536 Njoro.
Email:nnanua@yahoo.com **OR** Dr. A. W. Wangai
Email:rvkepawae@africaonline.co.ke
Phone:051-62278 ext 3204, 051-62039/62437

The 6th Conference of the African Crop Science Society, Nairobi, Kenya; 12 - 17 October 2003. The theme is: 'Harnessing crop technologies to alleviate hunger and poverty in Africa'. For more information, contact: The 6th ACSS Organizing Committee, Department of Crop Protection, University of Nairobi, P. O. Box 30197, Nairobi, Kenya. Fax: 254-2-226673/632121/631957 Email: mwangombe@kenyaweb.com

The Soil Science Society of East Africa will hold the 21st Conference from 1st – 5th Dec. 2003 in Eldoret, Kenya. The theme of the conference is *Capacity Building for Land Resource Management to Meet the Challenges of Food Security in Africa*. For more information write to; Chairman SSSEA, Kenyatta University, P.O. Box 43844, Nairobi. Email: dmugendi@yahoo.com or dmugendi@avu.org, Tel No. 254-0733-601635 **OR** Secretary General, SSSEA, University of Nairobi, Department of Soil Science, P.O. Box 29053, Nairobi Email:ckkgachene@africaonline.co.ke Attn Dr. G. Kirochi,
Tel. No.254 2631643/631634 Nairobi