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 #

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ABOUT THE NEWSLETTER

This second issue focuses on the introduction of legume green manure technologies to the small-holder farming systems in Kenya. Farmer's participation in the testing of the technologies and their perceptions of the technologies are reported in articles from four Network sites, Kakamega, Kitale, Gatanga and Embu. The inaugural issue highlighted the activities of the Legume Research Network Project (LRNP). Copies were circulated widely to local and international institutions and the newsletter was well received. The Network received congratulatory messages for initiating the newsletter and many thought it had lots of exciting information. A few requested that we broaden the Network's activities to include research on grain legumes and quantify effects of P, K and Mo on nodulation, biomass and grain yield of green manure and grain legumes. We take this opportunity to 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. All those who contributed articles in this issue are indeed thanked.

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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 legume 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.

INTRODUCTION OF GREEN MANURE TECHNOLOGIES TO SMALL-HOLDER FARMING SYSTEMS IN KENYA

Creating Green Manure Awareness among Small-holder Farmers in Western Kenya *John Ojiem and Elizabeth Okwuosa, KARI, RRC-Kakamega, P.O. Box 169 Kakamega*

Introduction

Efforts have been made by the LRNP to popularize green manure technology in western Kenya over the last two years. Soils in western Kenya are generally low in fertility. High population pressure on land has led to continuous cultivation and mining of essential nutrients. Due to low incomes, small-holder farmers are unable to purchase most of the required farm inputs, particularly inorganic fertilizers while availability of animal manure is limited. Surveys in western Kenya indicate that more than 50% of small-holders do not own livestock and only a small fraction of those who own livestock can generate sufficient quantities of manure for soil fertility improvement. After several years of legume research, the LRNP has identified several green manure legume species that have the potential of making a significant contribution to soil fertility and food production improvement in small-holder farms.

The LRNP, with the support of the Rockefeller Foundation, initiated the Integrated Nutrient Management (INM) project in western Kenya and other parts of the country. The aim of this project is to develop integrated and sustainable soil fertility management options combining animal manure, inorganic fertilizers and legume green manure for maize production. However, green manuring is not a common practice among small-holders and appropriate species are often unavailable. Farmers must therefore be sensitized and the seed of the potential legume species made available, before legume green manure can be used. For this reason, the INM project initiated a farmer sensitization exercise in September 1997. Sensitization was done through workshops, field days and demonstration plots.

Sensitization workshop

A farmer sensitization workshop was organized in Kabras Division, Kakamega District, the principal site for the INM project. Thirty farmers, twelve extension officers and several researchers from KARI- Regional Research Centre, Kakamega attended the workshop. During the workshop, soil fertility problems were discussed as well as options available for addressing them. Farmers were introduced to the basic principles of INM and the potential resources that can be integrated in this management. The idea of incorporating a variety of legume species into the farming system to be used as green manure, fodder and human food, generated a lot of interest among farmers.

Seed bulking

After the workshop, seven farmers were selected and provided with small quantities of sunnhemp (Crotolaria ochreleuca), Dolichos (Lablab purpureus), soyabean (Glycine max), calopo (Calopgonium muconoides) and velvet bean (Mucuna pruriens) seeds, to bulk for their own use and to pass on to the neighbours. This was one way of ensuring that these potential green manure species become part of the small-holder farming system. The farmers are being monitored yearly to determine how the process of seed bulking and sharing is proceeding. By the end of 1999, 15 farmers had benefited from the seed bulked by the original (pioneer) farmers. In addition, 11 women group leaders had received sunnhemp and dolichos seeds from the pioneer farmers. This positive response by farmers is very encouraging. The entry of the women group leaders in the seed multiplication and distribution is particularly welcome since this a more effective way of reaching a greater number of farmers quickly.

A similar farmer sensitization exercise was conducted in Yala Division, Siaya District. Members of Tate women's group shared the responsibility of bulking sunnhemp, dolichos and velvet bean, for distribution to other members. Sunnhemp and dolichos are dual purpose (green manure and food) and were selected for this reason.

Farmers' experience with legume green manuring

Four members of Tate women's group evaluated the effect of sunnhemp green manure on maize grain yield. These trials were carried out from September 1997 to August

1999. The green manure was produced during the short rain season and incorporated just before the start of the long rain season and maize planted. Majority of farmers in Yala do not use fertilizer and maize yields is low (0.8 t ha^{-1}). By using sunnhemp green manure, Tate Womenís Group members were able to increase their maize yields by over 200%, from 0.8 to 2.6 t ha^{-1}. Greatly impressed by these results, the women are now exploring ways of addressing the high labour requirement associated with green manure practice, so as to expand the area under green manure. One of the options they are thinking of is using oxen to incorporate green manure in the soil.

A Legume Green Manure System Developed for Small-holder Maize Production in Trans Nzoia District

B.A.M. Kirungu, P. Shiundu, S. Kamwana, J. Kasiti, E. Wamalwa, S. Nderitu, and M. Mukongo, Environment Action Team, P.O. Box 2065 Kitale

Introduction

Environmental Action Team (EAT), an NGO based in Kitale, Kenya, began conducting research with farmers in 1995 with the aim of developing a legume-based green manure system for the small-holder maize crop. Maize is the main cash crop and subsistence food in Trans Nzoia district. Farmers grow late-maturing hybrid maize varieties that are well adapted to the region's long growing season and potential maize yields in the district are among the highest in the country, at 7 t ha^{-1}. Small-scale farmers in the area practice continuous maize/bean intercropping on deep, well-drained Ferralsols of low fertility. Crop residues are routinely burnt and the soils are low in organic matter and prone to crusting and run-off. Previously, farmers maintained high yields by using increasing amounts of inorganic fertilizers. However, fertilizers have become too expensive for small-scale farmers and yields have declined to about 0.8 t ha^{-1}. This has resulted in food insecurity and poverty.

EAT trains farmers to increase soil and crop productivity by managing and utilizing organic resources. For example, farmers involved in EAT's on-farm work are able to harvest 3.3 t ha^{-1} of maize using approximately 12 t ha^{-1} of well-managed FYM or compost at planting. These yields can be increased even further, up to 6.2 t ha^{-1}, by mixing the FYM or compost with reduced amounts of inorganic fertilizer (28 kg N/ha vs. the recommended 60 kg N/ha). However, FYM, compost and inorganic fertilizers are always in short supply. When EAT joined the LRNP in 1994, research was begun to identify legumes that could occupy the land during the dry season and be used as a green manure for maize planted at the onset of the next rainy season. As part of the Network activities, EAT carried out systematic testing of more than 25 different legume species. After 2 years of screening, a number of potential species, which produced large quantities of biomass and survived the dry season, were identified. Mucuna pruriens and Lablab purpureus, both long lived annual legumes, were selected as the most promising species to take to farmers for on-farm testing.

Technology generation (1995-1998)

EAT wanted farmers' criteria to guide the direction of the research. Thus, in 1995, evaluation of the legume's green manure potential and the possibilities for incorporating them into small-holders' existing cropping systems began with a group of 20 farmers drawn from 5 different parts of the district. Between 1995 and 1998, these farmers experimented with different legume planting times, legume pure stands vs. legumes relayed into maize and ways of managing the legume residues (incorporating them into the soil vs. leaving them as a surface mulch). By the end of three research cycles, EAT and the farmers had developed a potential system. Lablab or mucuna is relayed into an existing maize crop (or planted on its own) sometime between August and mid-September. Once the maize is harvested, the legume is left to grow until the onset of the next rainy season, when it's incorporated into the soil. Maize is planted 7 days after incorporation.

Technology verification and fine tuning (1997-1999)

More farmers, drawn from two new areas, became involved in testing and fine-tuning this system in 1997. EAT added another two areas in 1999. Currently, 122 farmers, drawn from the 4 study areas, are involved in the research. These farmers are now experimenting with incorporating the residues mechanically.

Farmers' reactions to the technology

Farmer collaborators who have had successful results with their experimental plots have started to plant their own larger scale plots of lablab green manure (independent of the research plots they are having with EAT). Most have started growing their own lablab seed; a few have purchased the seed from the market. It seems quite probable that, if the year 2000 lablab mechanical incorporation trial is successful, the technology will be more widely adopted and may even begin to spread spontaneously within the four research communities.

Farmers have been impressed with the dramatic maize yield increases they have been able to achieve using the green manure legumes plus maize stover. On-farm experimental maize yields with the technology have been in the region of 4.4-6.7 t ha^{-1}. Although the legumes require labour to establish (land preparation plus two weedings), farmers feel that growing the green manure *in situ* is less labour intensive than making, managing and applying compost or FYM. Farmers have also commented on the legume's ability to reduce the incidence of annual weeds in the subsequent maize crop and the improvement in soil physical properties especially soil tilth.

Food security is a major concern for small-scale farmers in the area and our collaborators have overwhelmingly preferred lablab to mucuna. Mucuna seeds contain toxins that require elaborate processing to remove if they are to be eaten, while lablab grain and leaves are edible with no processing. Farmers are trying to strike a balance between using the legumes as food versus fertilizer. They are trying to evaluate how harvesting various amounts of seed for consumption will affect the subsequent maize crop.

Farmers have preferred incorporating residues versus mulching them. They feel that incorporated residues produce higher maize yields and don't encourage rat damage they observed when the legume/stover residues were left as mulch on the soil surface. But, they feel that the technology will be of limited usefulness on

a field scale if the legumes can't be mechanically incorporated, since incorporating the residues by hand would be too labour intensive. Another reason why farmers have preferred lablab to mucuna is that they feel that mucuna's rope-like vines will become easily entangled with the plow.

They have also noted some risks involved in the technology, especially with regards to the window of opportunity for establishing a successful lablab stand. On one hand, there is lablab's sensitivity to very wet conditions during the establishment phase; on the other hand, delaying planting too long may mean that there is insufficient rain to ensure the lablab's survival. The risk of losing the stand to uncontrolled grazing is also quite high in areas where farms are not fenced and livestock are left to roam free during the dry season.

When EAT asked its collaborators, "Which farmers are most likely to benefit from this technology?" They answered, "In order to benefit from this technology, you must be hard working and understand the importance of organic matter management."

Introduction of Green Manure Legumes to Small-holders in Gatanga Division, Thika District

Mureithi J.G., Mwaura P. and Kamande T. KARI, NARL, P.O. Box 14733, Nairobi

Introduction

Gatanga division is characterized by hilly terrain and high population density. The land sizes are small, ranging from 0.1 to 2.0 ha. A major constraint to farming in the area is decline in soil fertility as a result of continuous cultivation and soil erosion. Most farmers use farmyard manure to maintain soil fertility and a few use inorganic fertilizers. Introduction of green manure legumes as an alternative method of improving soil fertility began in 1996 when a legume screening trial was conducted to identify the most suitable green manure legume species for the area. *Crotalaria ochreleuca and Mucuna pruriens* were selected as the most promising on the basis of quick establishment and producing higher biomass yield. During the 1997 short rains, a legume residue management study was initiated in

farmers' fields to identify the best practice of managing the legume biomass in a legume/maize intercrop system. Treatments evaluated were: incorporation of legume biomass into the soil, slashing and leaving the biomass on the surface as mulch and removing the harvested biomass from the plot. Before the study commenced, several workshops were held to

train farmers on the procedures of conducting research and benefits of green manuring technology in improving soil fertility. During the workshops, farmers interested in participating in the study volunteered themselves. Responsibilities for implementing the study were shared during the workshops. It was agreed that participating farmers would provide land and labour for land preparation, planting and weeding. The project would provide legume and maize seeds, and fertilizers. In addition, the project would hire field assistants to supervise implementation of the trial. Farmers and the field assistants would participate in harvesting the trial and evaluating the results. Nineteen farmers were involved in the study.

During routine field visits, it was noted that some farmers participated actively in the implementation of the study while others participated halfheartedly; a few even dropped out. To understand why this was so, an informal study was conducted in April/May 1999 to identify attributes/factors that made some farmers more active and others less active. Also, the study assessed perceptions of farmers to the green manure technologies.

Methodology

The methods used in the study were informal visits and semi-structured interviews. Two field assistants based in the area visited farmers and held informal discussions. Discussions were held as the farmers worked to avoid interfering with their activities for the day. Key issues discussed included, methods used to maintain soil fertility, characteristics of suitable green manure legumes, possible niches for green manure legumes technologies and past involvement in on-farm research work. Farmers were also asked to indicate the treatment most preferred in the legume residue study and why. Twenty farmers were visited; they included 17 who were participating in the legume

residue management trial and 3 dropouts. During the visits, field assistants recorded their impressions on how well individual farms were managed.

Results and discussions

Farmer participation

Two major categories of farmers were identified; interested farmers who comprised 65% of the farmers visited and the rest (35%) of the farmers, who were categorized as less interested. The latter category also included the dropouts. Table 1 summarizes the major attributes of each category. Most of the interested farmers had participated in on-farm research work before and were generally better farmers. They had good understanding of factors causing soil fertility decline and appreciated green manuring as one method of maintaining soil fertility. They participated actively in trial evaluation and always gave useful comments on how the study should progress. The less interested farmers and dropouts were after immediate and tangible results from the study. They required constant encouragement by fellow farmers and field assistants to continue with the work. Some of them expected to be provided with free inputs as some projects had done in the past.

Characteristics of suitable green manure legume species

Five major characteristics were identified; these were:

a) *Biomass production* - For soil fertility improvement, farmers preferred a legume that produces a lot of biomass because the more the biomass produced the more is available for incorporation in the maize plots. They indicated that among the legumes they were using, mucuna gave the highest biomass.

b) *Ground cover* - Farmers explained that a legume with ability to cover the ground quickly was favoured because it would be more effective in soil erosion control and weed suppression.

c) *Twining* - About 75% of the farmers recommended the twining legumes because although they entwined on maize and required additional labour to untwine, they grew faster than the upright ones. They also added that the twining legumes produced more biomass than the upright legumes.

d)*Alternative uses* - Farmers expressed interest in legumes that had other uses apart from soil fertility improvement. They singled out value as human food and livestock feed as important characters because of food security and limited livestock feeds.

e) *Ease of incorporation* - A legume that had hard stems like crotalaria was not preferred because it was difficult to chop the stems during incorporation. On this account, mucuna was favoured because it has soft stems and can be cut into pieces easily.

Legume residue study; treatment most preferred

About 90 % of farmers preferred the treatment of incorporating the legume biomass into the soil. They explained that maize grown where the legume is incorporated always looks healthier and in case of water stress the maize takes longer to wilt. They also said that soil in that treatment is light compared to others and it is easier to till.

Possible legume green manure niches

Farmers identified five niches for green manure technologies; these were:

a) *Under the coffee trees* - This was identified by about five farmers. They said they did not always have enough farmyard manure to apply to the coffee fields and green manure legumes could be used as an alternative. Mucuna was preferred because of its quick establishment.

b) *Intercropping with vegetables* - Some farmers indicated that legumes could be intercropped with vegetables like kales. Crotalaria was most preferred for this pur-pose because it grows upright and does not coil on the kale plants.

(c) *On steep land* - Farmers explained that green manure legumes, especially mucuna could be planted on the steep land because of its ability to cover the ground quickly. This can help control the soil erosion in the area.

d) *Intercropping with maize* - Farmers in the study area have intercropped maize with legumes for some seasons and they find it to be a good way of improving soil fertility.

(e)*Under the avocado trees* - Some farmers are already planting legumes such as desmodium under avocado trees. The legumes are used as a measure of soil erosion control and also as a fodder for live-stock.

Table 1. Participation of farmers in on-farm green manure study at Gatanga

Active and interested farmers (65%): key attributes	Less interested farmers and drop outs(35%): key attributes
♦ Most have participated in on-farm research work before.	♦ Few have participated in on-farm research work before.
♦ Appreciate green manure technologies as one way of improving soil fertility.	♦ Were after immediate responses from the green manure treatments. Some had very poor soils and could not see evidence of tangible benefits from the green manures
♦ Always prepare land and plant on time, weed whenever necessary, keen during harvesting and trial evaluation.	♦ Could not cope with labour demand of green manure technologies.
♦ Give useful comments regarding the way forward.	♦ Some had very small pieces of land and preferred to plant cash generating cash crops like passion fruits.
♦ Generally better managers of their farms. Most manage their farm yard manure well; they regularly remove it from the shed, keep it under shade, turn it regularly and use it in the farm when well decomposed	♦ Expected material gains. ♦ Some lost interest because of pressure from their spouses

Conclusion

Although this study was informal, several conclusions can be drawn from the results. First, farmers' active participation in on-farm research can be influenced to a large extent by past exposure in on-farm research and a clear understanding of the benefits accruing from the technology being tested. This underscores

the importance of farmers understanding the subject matter of the research they are undertaking before the research commences. This is why a training workshop was held for Gatanga farmers on soil fertility in general and processes that led to soil formation and soil degradation. Secondly, farmers demonstrated good understanding of green manure technologies and the role legumes play in the farming systems. They identified suitable niches for green manure technologies and explained why they were suitable. They also highlighted desirable characteristics for suitable green manure legume species. For example, green manure legumes with food and feed value would appeal more to farmers. Lastly, badly degraded soils may require a combination of measures to improve soil fertility as green manure legumes alone may not be adequate.

Farmer Evaluation of Green Manure Legumes in Embu and Mbere Districts

Njiru Gitari, Simon Karumba, Mary Gichovi and Kennedy Mwaniki KARI, RRC-Embu, P.O. Box 27 Embu

Introduction

The agro-ecological zones UM2, UM3, LM3 and LM4 form the grain basket of the densely populated part of southern and eastern slopes of Mt. Kenya region. Due to continuous planting of cereals, the soils have considerably declined in fertility and maize yields are generally low. However, majority of the small-holder farmers are resource poor and cannot afford inorganic fertilizers. Most households keep 1-3 head of cattle, which cannot provide enough supply of manures. A study on the use of green manure to improve soil fertility and maize production was initiated at Embu, RRC in 1995.

In the first phase, 25 legume species and accessions were screened for climatic and soil adaptation and ability to produce large amounts of biomass. Two legumes, velvet bean and sunnhemp were identified as some of the most promising legumes for green manure production and were advanced in the next stage for on-farm evaluation.

Farmers' participation

Farmer participatory green manuring work started in October 1997 under the LRNP at two sites, namely Karurina and Gachoka in Embu and Mbere districts, respectively. The main aim is to test the effectiveness of different combinations of legume green manure, organic (farmyard manure) and inorganic nitrogen on maize yield. A total of 20 farmers, 10 from each site were recruited for the exercise. The criteria for farmer selection were based on land availability, accessibility of the farm and willingness of the farmer to participate in the trials. The researchers together with local extension staff recruited farmers. Majority of the farmers interviewed said that the concept of enhancing soil fertility using green manures was relatively new to them. They were however excited and willing to try this new technology since the traditional methods of combating soil infertility had many shortcomings.

During the initial season, maize was planted using farmer practice and the legumes were relayed 2 weeks after emergence of maize. In the subsequent seasons, a range of treatments using inorganic fertilizer, farmyard manure and green manure from the legume at different combination rates were applied. A farmer practice treatment was also included in each farm.

A participatory farmer evaluation of some of the treatments was conducted at the grain filling stage of the maize. Farmer-based criteria for judging the best treatment were first generated through a general consensus amongst the farmers present. The criteria included plant height, greenness of leaves, soil colour and ear size. During evaluations conducted at the Gachoka site in July 1998, farmers recorded their perceptions about green manuring and soil fertility in general. They also gave indicators of soil fertility, which included soil colour, and the types of plants growing in an area. Red-coloured soils were regarded as infertile whereas dark-coloured soils were regarded as fertile. Certain weed species such as poverty

Table 2: Maize grain yields at Karurina and Gachoka

Treatment	Maize Grain Yield (t ha^{-1})	
	Karurina	Gachoka
Legume residue	6.5	3.1
Farm yard manure	5.1	2.7
Inorganic fertilizer	4.7	3.1
Farmers practice	3.5	2.7

grass, locally known as 'Muguku' were associated with infertile soils while *Lantana camara* indicated fertile soils. Maize yields obtained from three of the best treatments: inorganic fertilizer at 50kg ha^{-1} N and P_2O_5, farm yard manure at 5.0 t ha^{-1} and incorporation of velvet bean residue were compared alongside the yield obtained from farmer practice. The treatment where mucuna residue was incorporated gave the highest score in terms of plant height, greenness of leaves and ear size. Farmer practice where low quantities of farmyard manure and inorganic fertilizers were used scored the lowest using those criteria. The mucuna treatment gave the highest maize yields, which were 87 and 14% higher than the farmer practice in Karurina and Gachoka, respectively (Table 2).

PARTICIPATORY COWPEA VARIETAL SCREENING TRIAL IN COASTAL KENYA

M.B. Muli, C.Chiro and Ramadhan KARI, RRC-Mtwapa, P.O. Box 16 Mtwapa

Introduction

Cowpea *(Vigna unguiculata)* is the most important pulse crop in coastal Kenya. However, farmers realize low grain yields (100-300 kg ha^{-1}) attributed to insect pest damage, lack of high yielding varieties and poor crop husbandry. The International Institute for Tropical Agriculture (IITA) has developed day-neutral cultivars, which have some degree of tolerance to many of the major pests affecting the cowpea. The Mtwapa team of LRNP secured some of these cowpea cultivars from IITA and started a screening programme for climatic and soil adaptation, yields and insect pest tolerance. A total of 52 varieties were evaluated for leaf and grain yields, and maturation period. After the initial screening, it was realized that the local varieties had greater biomass of edible leaves than the IITA varieties. Therefore further screening of the varieties focused on grain yield and pest tolerance. Out of the initial 52 varieties, 8 were selected for further evaluation on-station and 7 screened on-farm under farmers' management.

Trial Implementation

Eight varieties coded as: 611 (IT95K-1380), 612 (IT93K-273-2-1), 63 (IT95K-1156-3), 613 (IT93K-2046-2), 610 (IT93K-734), 66 (IT93K-2045-29) and 64 (IT90K-284-2) and a local check K80 were evaluated on-station at RRC- Mtwapa and Msabaha sub-centre (IITA codes in brackets). They were planted in May 1999 after the on-set of the long rains in plots of 4 by 2.5 m at a spacing of 50 by 20 cm. The treatments were replicated four times in a randomized complete block design. Insecticides were applied to control insect pests.The on-farm trial was implemented in three clusters, one in Samburu Division of Kwale District and two in Kaloleni and Kikambala Divisions of Kilifi District. The trial evaluated all the eight varieties except variety 66, which was replaced by a local variety, coded number 62. A total of 42 farmers, 14 at each cluster, participated in the trial. Planting began in late May 1999 and continued until mid June. Each plot comprised four rows each four metres long. Farmers were provided with seed and insecticides. In return, they provided land and labour for crop management.

Results

Grain yield for on-station trial ranged from 1.6 to 2.8 t ha^{-1} and 1.7 to 2.7 t ha^{-1} for Mtwapa and Msabaha respectively (Table 3). Variety 66 recorded the highest yield at Mtwapa while variety 613 yielded the lowest. At Msabaha variety 63 had the highest grain yield. Variety 623 had the lowest yield at Msabaha but it ranked third at Mtwapa.

Table 3: Grain yield (t ha^{-1}) of 8 cowpea varieties at RRC, Mtwapa and Msabaha, sub-Centre, Coastal Kenya.

Variety	Site	
	RRC-Mtwapa	Msabaha sub-Centre
66	2.8	2.3
63	2.4	2.4
623	2.2	1.7
64	2.2	2.3
611	2.1	2.1
612	2.1	1.9
610	2.0	2.1
613	1.6	2.0
Mean	2.2	2.1

The average grain yields from Kikambala, Kaloleni and Samburu sites ranged from 0.3 t ha^{-1} for the variety 613 to 1.3 t ha^{-1} for variety

623 (Table 4). Variety 623 performed relatively better than all the others in all the clusters. Except for variety 613, all the other varieties performed better in Kikambala than in Kaloleni and Samburu.

Table 4. Mean grain yield (t ha^{-1}) of 8 cowpea varieties for 3 clusters in coastal Kenya.

Variety	Cluster		
	Kikambala	Kaloleni	Samburu
623	1.3	0.73	0.87
64	0.98	0.36	0.50
63	0.94	0.60	0.48
62	0.91	0.45	0.53
611	0.74	0.53	0.37
610	0.71	0.56	0.58
612	0.64	0.35	0.30
613	0.51	0.69	0.47
Mean	0.84	0.53	0.51

The way forward

The study has identified some promising cowpea varieties suitable for coastal Kenya but it will continue for 2 more seasons to establish superiority of the introduced cowpea varieties over the locally available ones. The promising varieties will be bulked and seeds issued to more farmers in the region for testing. Additional methods of utilizing cowpeas as food and for soil conservation will be explored to enhance the value of the crop in the region.

EVALUATION OF SELECTED FORAGE LEGUMES AS SUPPLEMENTARY FEEDS FOR DUAL PURPOSE GOATS IN SEMI-ARID REGION OF EASTERN KENYA

Njarui D.M.G and Wandera, F.P KARI NDFRC-Katumani, P.O. Box 340 Machakos and Muinga R.W KARI RRC-Mtwapa, P.O. Box 16 Mtwapa

Introduction

A number of forage legumes, which are well adapted to climate and soils of the semi-arid region of eastern Kenya and produce high biomass, have been identified. Some of these legumes include stylos (*Stylosanthes guianesis*), velvet bean (*Mucuna pruriens*), lablab (*Lablab purpureus*), siratro (*Macropitilium atropurpureum*) and glycine (*Neonotonia wightii* cv. Cooper). These legumes can provide important supplementary feeds to livestock especially during the dry seasons. Furthermore, manure collected from animals fed on these legumes is likely to be of higher quality. However, the adoption of these legumes in the local farming system has been low primarily due to lack of seed and information on their utilisation.

The objective of this experiment was to study the live weight changes of Kenya Dual Purpose Goats (KDPG) when supplemented with two forage legumes; siratro and glycine.

Materials and methods

Sixteen bucklings of Kenya Dual-Purpose goat (KDPG) were used for the study. These were stratified according to live weight into four groups of four goats each. An adaptation period was allowed before the experiment began. The treatments were as follows: the first group was supplemented with siratro, the second group with glycine, the third with leucaena leaf meal and the fourth group was a control, fed on grass alone. Leucaena was included in the study for

comparison with other legumes since information is available about its nutritive and feeding quality. The feed supplements were given at 30% of the daily dry matter requirement of an individual buckling. The total daily dry matter requirement for individual goat was taken as 3.5% of its body weight. The goats were weighed weekly for 12 weeks. All the goats had free access to mineral block licks and water was provided ad-libitum.
The goats were fed with natural pasture grass and chopped Napier grass as the basal diet. Napier grass was cut with a hand chopper and put in troughs while the other grasses from a natural pasture were hang with a string. The bucklings were dewormed at the start of the experiment to control endoparasites and dipped once a week to control ectoparasites.

Live weight changes in bucklings were calculated as the difference between the starting weekly weight and the end weekly weight and averaged for bucklings in each group. At the end of the experiment, daily weight gain/loss was subjected to an analysis of variance and means were separated by LSD.

Results and discussion

Growth performance
The progressive weight change for the bucklings during the experimental period is given in Figure 1. Goats supplemented with siratro maintained their initial weight up to week 4 after which weight decreased to a lowest level in week 7; thereafter it continued to increase up to the end of the experiment. Those supplemented with glycine also maintained their weight up to week 5 but had a slight weight loss in weeks 6 and 7. From week 8 this group continued to register increase in weight. The reason for loss in weight is not clear; all the goats developed pneumonia during this period but they were treated. The control group (fed on grass alone) lost weight throughout the experimental period, an indication that the diet did not meet the nutrition requirement of the goats. Goats fed leucaena-based diet maintained weight during the first half of the experimental period and thereafter continued to increase in weight.

Overall, goats supplemented with siratro had marginal weight gain but this was not significantly different from that of the control. A daily weight gain of 16.37 g attained from supplementing with glycine was not significantly different from that with siratro supplement but was better than the control. The goats that were not given any supplementary forage (control) lost weight and the weight change was negative. However, the standard supplement, leucaena resulted in the highest gain but this was not significantly different from that due to the other two supplements.

Conclusion and way forward

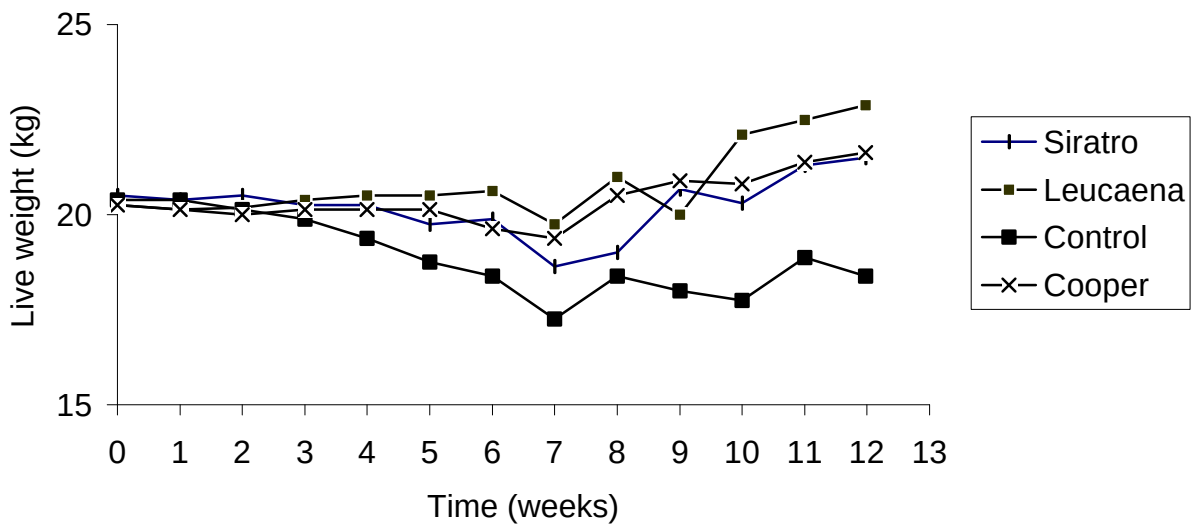

Figure 1: Response of KDPG when supplemented with forage legumes

Before the goats were selected for the experiment, they were grazing on natural pastures and could selectively browse on nutritious forage including leguminous shrubs.
This was not possible during the experiments and some diets made animals loose weight. However, all the diets except the control resulted in weight gains and farmers should be encouraged to grow them for livestock.

FARMERS' TRAINING WORKSHOPS ON SCIENCE OF SOILS AND MAINTENANCE OF SOIL FERTILITY

The LRNP has been organizing training workshops for farmers and other stakeholders on soil formation and processes that lead to soil degradation. Green manure technologies have also been taught as alternatives of maintaining soil fertility to inorganic fertilizers and animal manure. The workshops normally take one day and the facilitator/trainer has been a soil scientist with a wide experience in soil fertility and plant nutrition. The topics covered in the workshop include soil genesis, types of soils, soil fertility, soil degradation, diagnosis of soil fertility status and the practical options of maintaining soil fertility. Also included in the training is the biological process of nitrogen fixation that enables the legumes to utilize atmospheric nitrogen. This arouses a lot of farmer's interest and they start appreciating the role of nodules found on legume roots. Advantages of cultural practices such as crop rotation and leaving land fallow are presented as effective alternatives to continuous cropping or monocropping. Soil erosion is singled out as a big threat to soil fertility while planting of deep rooted crops is highlighted as a means of pumping up the nutrients leached beyond root zones. The workshops usually spare time to discuss various types of chemical fertilizers and the need to choose wisely depending on the required nutrient(s) and cost per active ingredient. Emphasis is given to the advantages associated with combining of organic and inorganic fertilizers in crop production.

Training venue is chosen within farmers' locality (e.g. a school, church) and participants include farmers participating in on-farm research work of the LRNP and local extension staff. The sitting arrangement is the round table and every participant is encouraged to contribute to the issue under discussion. The training programme is made flexible to prevent the participants from getting bored. The language of instruction is the local language and an effort is made to explain difficult technical terms. Where problems arise in direct translations, the meaning is debated with the extension staff, researchers and the more learned farmers.
Farmers have shown a lot of interest in these training sessions. They have shown deep understanding of the

factors that contribute to decline in soil fertility. Farmers in Gatanga and Embu sites have been trained and the same programme is to be offered to farmers in other sites. Site Co-ordinators are requested to organize farmers for the training and bring to the attention of Co-ordinator any subject matter that might require to be included in the workshop's training programme.

PHD RESEARCH PROGRAMMES: SUMMARIES OF RESEARCH WORK

Three Ph.D. students affiliated to the LRNP will conduct their research work on green manure cover crops in the country. The studies, which will mainly be conducted on-station, will generate results that will complement the on-farm research the Network is undertaking. These students are:

Mr. Michael N. Njunie of KARI, RRC-Mtwapa is a student of North Carolina State University and is currently in the country and has begun his research work at Mtwapa. The title of his research is, ***Evaluation of herbaceous legumes for soil fertility improvement in maize / cassava production systems in the coastal lowlands of Kenya.***

Mr. Elkana M. Nyambati of KARI, NARC- Kitale is a student of the University of Florida; he is also in the country and is conducting his research work in Kitale. His work is entitled, ***Management and nutritive evaluation of* Mucuna pruriens-*Maize and* Lablab purpureus-*maize intercrops in Northwestern Kenya.***

Mr. David Mbugua of KARI, RRC-Kisii is a student of Cornell University and will come later in the year for his research work that is to be conducted in Kisii. The title of his work is ***Utilization of forage legumes for enhanced nutrient cycling in the small-holder farms in the Kisii highland.***

In this issue, a summary of Njunie's and Nyambati's research work will be presented. A summary of David's proposal will appear in the next issue.

Evaluation of herbaceous legumes for soil fertility improvement in maize / cassava production systems in the coastal lowlands of Kenya

(Michael N. Njunie)

Crop yields in coastal Kenya are limited by poor soils and erratic rainfall. Legumes have potential to improve land productivity through nitrogen fixation and incorporation of forage green manure. The overall objective of the Ph.D. research is to study the effects of harvest frequency and stage of development of annual and perennial forage legumes on:

- biomass and nutrient accumulation of legume residue;
- rate of nutrient release from legume residue;
- availability of residue-derived nutrients to maize and/or cassava;
- supply of legume forage and nutrient quality; and soil water availability during the cropping season.

This study is being conducted at the Kenya Agricultural Research Institute Regional Research Centre in Mtwapa. The Centre is within the coconut/cassava agro-ecological zone (semi-humid with bimodal annual rainfall of 1050-1230 mm). The dominant soils are Orthic Ferralsols, which are well-drained, sandy loam to sandy clay loam and low in organic matter and plant nutrients. Two experiments are being carried out concurrently. The first experiment is evaluating a perennial forage legume, *Clitoria ternatea* in monoculture or intercropped with cassava and /or maize. Its foliage is harvested and applied on the ground as surface mulch and after mineralization it is expected to release nutrients to maize or cassava plants. The second experiment is similar to the first but evaluates an annual legume, *Lablab purpureus*. The two experiments were established in April 1999 at the on-set of long rains. Two control treatments were included: application of recommended rate of commercial fertilizer and use of no inputs. The design for first experiment is a split-plot where the main plots were seven production systems of legume (i.e. systems of growing legumes together with maize, cassava and mixture of cassava and maize. Sole stands of maize and cassava were also considered as production systems); the subplots were the harvesting frequency of forage legumes (at every six or ten weeks). The design of the second

experiment is similar to that of the first, but differs in type of legume used and legume harvesting frequency, which were harvesting after 2 and 4 months after planting.

Data collected include crop and legume biomass yield (maize, cassava and legume), nutrient removed by the crops and legumes (N, P, K, Ca and Mg), mineralization of legume biomass and ground cover. Soil data include pH, time sequence of inorganic N (NH4 and NO3), P, K, organic C, soil moisture and soil physical characteristics. It is anticipated that this research will contribute to sustained maize and cassava yields with reduced use of commercial fertilizer.

Management and nutritive evaluation of *Mucuna pruriens*-Maize and *Lablab purpureus*-maize intercrops in Northwestern Kenya

(Elkana M. Nyambati)

Declining soil fertility and inadequate livestock feeds, particularly lack of protein during the dry season are the major production constraints in small-holder mixed farms in northwestern Kenya. The broad objective of this study is to determine the effect of removing high quality upper canopy of green manure legume for dry season livestock feed and incorporating the remaining intermediate stubble into the soil for fertility improvement. Two experiments will be conducted at the National Agricultural Research Center (NARC) - Kitale and on farmers' fields 50 km North of Kitale Town during 1999, 2000, and 2001. The first experiment will evaluate the effect of alternative cropping systems (green manure/ legume relay cropping) on grain yield of current and subsequent maize crops, and on legume fodder production. There will be 15 treatments arising from 3 controls and a 2x3x2 factorial that includes two cropping systems, three crop sequences, and two legume defoliation treatments. Measurements will be made on nitrogen mineralization, crop N uptake, grain and stover/straw DM yields of maize and beans, and on herbage yield and chemical composition. The second experiment will focus on nutritive evaluation of legume fodder hay as a supplement to basal diet of Napier grass for lactating cows at NARC, Kitale. The treatments will be: 1) Basal diet fed alone (BDA), 2) BDA supplemented with mucuna hay (MH), 3) BDA supplemented with lablab hay (LH), 4) BDA supplemented with commercial dairy meal (DM). Measurement will be made on, 1) chemical composition of feeds and fecaes (total N, NDF-N, soluble N, NDF, ADF, lignin, polyphenol, Ca, and P), 2) IVOMD of feeds, 3) intake (kg DM/$W^{.75}$), 4) average daily gain (kg d^{-1}) and body condition changes, and 5) milk yield (kg d^{-1}) and composition (total solids, butter fat, C P). Experiment one was started in 1999 and will continue in 2000 and 2001. The second experiment will start in February 2000.

LRNP MONITORING TOUR TO THE SITES EAST OF THE RIFT VALLEY; 26TH - 30TH JULY 1999

This tour was arranged to familiarize members with research activities and farming systems of the sites east of rift valley. These sites were Embu, Machakos, Kabete, Gatanga and Mtwapa. The tour was to include all the 11 LRNP sites but due to logistical reasons this was not possible. About twelve Network members participated in the tour and spent a day visiting activities of each site. The main activities visited were:

a) **The integrated nutrient management study:** That is evaluating the effectiveness inorganic fertilizers, farmyard manure and their combinations, on maize performance. This study is being imple-mented nationally by three sites but only two sites, Embu and Mtwapa were visited during the tour. The work is conducted both on-station and on-farm. Embu has two on-farm sites; Karurina and Gachoka, which have 10 farmers each. Mtwapa also has two on-farm sites at Kaloleni in Kilifi District and Mavirivirini in Kwale District.

b) **The legume residue management study:** That is assessing three methods of managing the legume residue. These methods are incorporating the legume residue into the soil, slashing and leaving it on the surface as mulch and removing the slashed legume biomass from the plot leaving behind the leaf drop and root biomass. The study is being implemented nationally at five sites. Three of the sites; Machakos, Kabete and Gatanga were visited during the tour.

c) Livestock feeding studies: These studies are being implemented at KARI's Dryland Farming Research Centre in Katumani and at KARI's Regional Research Centre at Mtwapa. The study at Katumani involves feeding of dual-purpose goat with lablab and mucuna forage as supplements and assessing their effects on daily live weight changes. In Mtwapa, lablab, mucuna and clitoria forage were fed to jersey cows as supplements to Napier grass basal diet. Milk yield and live weight changes were monitored. During the visit both studies were in progress.

d) Cowpea variety trial: This work is imple-mented in Mtwapa at both on-station and on-farm sites. Fifty-two cowpea varieties obtained from IITA were screened on-sta- tion in 1998 and nine lines were selected for on-farm testing. During the tour a few farmers involved in the study were visited. The on-station work was also visited; the work included a study evaluating the effect of spraying cowpeas against insect pests.

e) Legume seed bulking: All the sites are bulking seeds of the best-bet legume species. Most of the bulking is done on-station. In addition to on-station bulking, Embu site is also bulking in farmers' fields and Gatanga is bulking in primary school farms.

Highlights of the tours

a) Mucuna performed generally better than the other green manure species (e.g. crotalaria and lablab) in terms of establishment, ground cover and biomass yield in all the sites visited. In Machakos, which is a dry site, Lima bean performed as well as mucuna.

b) Variability of mucuna in terms of flower and seed colour was observed in a number of sites. The Network noted that it is important to genetically characterize the mucuna germplasm, which is in use in all the sites.

c) A drawback associated with green manure legume technologies is the additional labour required for the management of the legume residue. During the tour farmers indicated they had no problem in spending more labour in the management of the legumes so long as they were to get good returns from the farm.

d) Farmer to farmer extension was evident in a number of sites. In the Karurina site Veronica Mutave gave crotalaria seeds to neigbours to bulk in their farms. At Gachoka, Agatha Njuki distributed mucuna seeds to three farmers and according to the local extension worker mucuna in those farms was doing well.

e) The many treatments of the INM study (eight) were confusing to some farmers. It was suggested that to avoid confusion, the treatments be reduced to only three promising ones. Farmers from the

Network members visit on-farm work at Machakos site

two Embu sites preferred the three-way combination, i.e., legume combined with reduced levels of inorganic fertilizer and farmyard manure.

f) The treatment effects of legume residue management study were variable depending on the sites. Farmers in Gatanga, which is a wet site, indicated that incorporation of the legume residue into the soil gave higher maize yields while in Machakos, a less wet site, mulching with legume residue gave a better maize response. This was attributed to the to the ability of the mulch to conserve soil moisture. However, a farmer in Gatanga made an interesting choice of the treatments. She preferred the treatment where legume residue was removed from the plot. She explained that the forage removed can have multiple benefits such as fodder for livestock, enriches the manure in the cattle boma, and can be used to fertilize the less fertile portions of her farm.

g) Farmer training: Farmers in most sites requested to have workshops on agriculture-related subjects particularly on soil fertility and management of the legumes in maize-based production systems.

LRNP COORDINATION OFFICE STRENGTHENED

Technical assistant deployed to coordination office, The coordination Office is happy to report that Ms. Clotilda Nekesa is now a permanent employee of KARI. She was employed on 06 July 1999 as Technical Assistant I and was officially deployed to the Network to support the coordination Office. She joined the Network in 1995 and worked as a casual till her employment. She graduated from Sangalo College of Agriculture in 1993 with a certificate in Agriculture. Since she joined the Network, she has learnt a lot of skills and techniques that made her most suited to her job. Some of these skills include management of field experiments and seed bulking plots, management of the legume seed store and conducting routine germination tests to assess the quality of legume seeds. She is well acquainted with the following computer programmes; MSWord 97, MS Excel and MS Access.

Internet facility

The coordination Office is now connected to the Internet services and is served by Net2000.
The facility has been fitted in the computer placed at the TA's office. Members of the Network can always surf the Net with prior arrangement with Ms Nekesa. The coordination Office is maintaining a list of interesting websites which include,
<http://www.agriculture.com>
<http://www.rockfound.org>
<http://www.cgiar.org>
and <http://www.kenyaweb.com/kenyagov/agricult/agricult.html>.

LEGUME SEED BULKING

Table 5 below shows amounts of seed received from sites, amounts issued out and amounts available in store by December 1999.

OTHER IMPORTANT NETWORK ACTIVITIES UNDETAKEN DURING THE LAST HALF OF 1999

LRNP team visit RRC- Mtwapa and on-farm research sites

The team arrived at the centre on 29th July 1999. After a brief summary on the programs and research activities carried out by the centre, the team visited a cowpea varietal screening trial at Mtepeni (Kilifi District). The crop was at an early vegetative stage and

Table 5: mounts of seed received from sites, issued out and amounts available in store by December 1999

SPECIES	Amounts of seed received from sites	Amounts of seed issued out (kg)	Amounts of seed in store (kg)
Canavalia ensiformis	333	211	122
Crotalaria juncea	8	0.5	7
Crotalaria ochroleuca	70	53	17
Desmodium uncinatum	3	3	-
Lablab purpureus: brown	66	43	23
black	13	3	10
Phaseolus lunatus	10	6	4
Macroptilium atropurpureum	47	17	30
Mucuna pruriens: white	445	275	170
Black	10	5	5
Neontonia wightii	36	3	32
Vigna unguiculata: cowpea K80	19	15	4
cowpea M66	8	7	1
Vicia villosa	9	4	6

little difference could be observed except for leaf quantity and quality. The local check and K80 were observed to be superior to the others in leaf number and size. From Mtepeni, the team travelled to Mavirivirini in Kwale District where they also visited work on screening of cowpea varieties and the INM trial.

Science writing, editing and oral presentation course: Four network members attended this course which took two weeks. It was held at the Kenya Forestry Research Institute (KEFRI), Muguga from 2nd to 13th August 1999 and it was offered by **SCIDCOM INTERNATIONAL LTD.** The Network met the costs of their training.

Mtepeni and Mavirivirini farmers visit on-station LRNP site at RRC-Mtwapa

The participating farmers on cowpea varietal screening from Mtepeni were invited to the Centre to evaluate the cowpea varieties on 5th August1999. The farmers used their criteria to evaluate the varieties; the criteria included grain yield, leaf yield, number of pods per plant, pod size, growth habit, seed size and seed coat colour. On 12th August 1999, six cowpea and INM trial farmers from Mavirivirini visited the centre on their own initiative. These farmers were able to compare the research plots with theirs and this generated a lot of discussion. They also visited other research activities at the centre.

In-depth case studies for the Global GMCC exploration Project

Three case studies each from the three eastern African countries were documented by Network members between July and October 1999 for the GMCC Project. They were,

1. **Farmers Experience on Marejea *(Crotalaria ochroleuca)* Cultivation in Peramiho, Ruvuma Region, Tanzania.** C.K.K. Gachene.
2. **Farmers Evaluation of Green Manure Cover Crops in Ikulwe Village, Iganga District, Uganda.** C.K.K. Gachene.

3. **Forage production systems for dairy production in coastal lowland Kenya.** Donald M.G. Njarui and Joseph G. Mureithi

Visit by Dr. Michael Wagger, a Professor of soil science in North Carolina State University. LRNP site at the coast region was honoured with a visit by Dr Wagger who is Mr. M.N. Njunieís Ph.D supervisor. He came on 30th November 1999 mainly to see the pro-gress Mr. Njunie had made on his research work at Mtwapa. He also visited farmer's field to familiarize with farming systems of the region. He had an opportunity to interact with research scientists at the RRC-Mtwapa during a seminar presented by Mr. Njunie on the progress of his research work. The Network Coordinator attended the seminar.

Participation in ASA meeting; 31st October - 4th November 1999

Dr C.K.K.Gachene and Dr. J.G. Mureithi attended the ASA meeting held in Salt Lake City
U.S.A. Dr. Gachene presented a paper entitled "Influence of green manure cover crops on maize yields in central Kenya highlands." Dr. Mureithi presented a poster entitled, "Incor-

porating green manure cover crops in small-holder agriculture in central Kenya"

ANNOUNCEMENTS

The second conference of the Soil Management Project (SMP) and the legume Research Network Project (LRNP) is planned to be held from 26th to 30th June 2000 and the tentative venue is Mombasa, Kenya. For more information contact Dr. J.G. Mureithi, P.O. Box 14733 Nairobi, e-mail address <jmureithi@net2000ke.com>

The Soil Science Society of East Africa is planning to hold the 18th Conference and end of millenium celebrations from 27th Nov. to 1st Dec. 2000 at a venue in Mombasa. For further information contact Dr. Daniel Mugendi, Kenyatta University at <dmugendi@yahoo.com>or Dr. J.G. Mureithi at the above address.

Animal Production Society of Kenya is planning to hold a Symposium from 20th to 23rd March 2000 at KARI Headquarters. For more information please contact Dr. E.A Mukisira
P.O. Box 58711 Nairobi, e-mail address <mukisira@arcc.or.ke>

An international symposium on balanced nutrient management systems for the moist savanna and humid forest zones of Africa. Cotonou, Republic of Benin, October 9 - 12, 2000. Contact persons Drs. N Sanginga/B. Vanlauwe. e-mail addresses <N.Sanginga@cgiar.org> <B.Vanlauwe@cgiar.org>

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. <o.sft@nontri.ku.ac.th>
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