LEGUME RESEARCH NETWORK PROJECT NEWSLETTER

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Issue No. 11 June 2004

ABOUT THIS ISSUE

The issue includes some interesting articles on collaborative work to evaluate green manure legumes for provision of food. Grass pea (*Lathyrus sativa*) is a legume suited to arid and semi arid conditions and it is being promoted as a food crop by International Centre for Agricultural Research in Dry Areas (ICARDA). The LRNP (Legume Research Network Project of Kenya) is collaborating with ICARDA to evaluate 15 entries of grass pea bred for low ODPA content, which is a neurotoxin. This collaborative work was initiated by Fr. Paul Leyden of Tangulbei Catholic Mission in his search for a viable grain legume crop suited to the dry environment of Tangulbei, Baringo District, Kenya. The area receives less than 500 mm of rainfall per annum. He has written a narrative article of how the work began. An article on performance of the grass pea entries in semi-arid environment at Matanya, a site located at Laikipia on the rain shadow side of Mt. Kenya is also reported. Still on food grain legumes, an article has been presented on the performance of promiscuous soybean varieties in Kitale and West Pokot sites. This is a collaborative project between the LRNP and TSBF – CIAT to evaluate promiscuous soybean accessions and develop soybean processing and utilization methods. While most of the previous newsletter articles are based on maize – legume intercrop, an article in this issue is about the use of GML for soil fertility improvement and weed control in potato – GML based intercrop system. Preliminary observations on the scaling up of GML technologies by RODI (Resource Oriented Development Initiative), an NGO working with ex-prisoners are given in this current issue. The network sincerely acknowledges the financial and technical support it has continued to receive from the Rockefeller Foundation since its inception and also Director KARI for the continued support.

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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 doing similar work in Kenya. This is a biannual newsletter and is published in June and December of each year. Your contribution and constructive comments are welcome and should be addressed to the Editors of LRNP Newsletter, CKK Gachene or LRNP Coordinator, JG Mureithi, *jmureithi@africaonline.co.ke*.

Grass pea (*Lathryrus sativa*); a potential grain and fodder legume for semi arid conditions of East Pokot, Kenya

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As a Catholic Missionary, I see food security as an integral part of evangelization. I live with the Pokots in East Pokot (north east Baringo District) who suffer from a chronic food insecurity problem. East Pokot is a semi-arid area. At the Mission, located in Tangulbei, we receive an average 660 mm per year of rain, most of if falling from the beginning of April and ending in August. We do not have a 'short rains' season here, during which time all is dry and barren. On average, people have been getting only one harvest of maize in every three years of planting. So, the poor rainfall received during the wet season in 2004, while disappointing, was by no means out of the ordinary. Local people almost expect no crop when they plant. This situation seems to me to be a lot of work for very little return, and yet each year around the beginning of April, as the clouds gather, the desire to try again manifests itself, and people get busy preparing and planting their small fields (1-2 acres). This situation has stunted their development and made them too dependant on food relief. As a Missionary I believe all that 'truly' promotes the 'human good' is in agreement with the Gospel, therefore, I know that working to solve the chronic hunger condition in these parts is very much fulfilling the dictates of the gospel.

The thought that was running through my mind was that we need plants that can survive the frequent dry spells in the wet seasons. Rather than hoping for or expecting more rain, we need crops which can produce food, or cash crops (besides their goats) which simply through their inherent hardness can produce a greater and more reliable return on their investment. A few years ago while listening to the B.B.C. World-service, I heard an item about a plant which could grow when almost nothing else could. I jotted down its name, grass pea, into my notebook. After a little surfing on the Internet, I came across an article called *'Detoxifying the Desert's Manna'*, by J. Raloff, in which the grass pea's history and future have been discussed and explained. I developed a keen interest in obtaining some of this seed for trial in Kenya. ICARDA's (International Centre for Agricultural Research for Dry Areas) name was mentioned a number of times in that article, and I eventually obtained their email address and made contact with Dr. Ali Abd El-Moneim, who kindly offered to send me a kit containing grass pea seed among others. It was recommended that I contact Dr. Joseph Mureithi of the Soil Management and Legume Research Network Projects, KARI. Right from the very start Dr. Mureithi displayed ardent interest and enthusiasm regarding the possibility of importing the grass pea kit and testing it in Kenya. Without going into all the details, let it suffice to say that Dr Mureithi and his colleagues succeeded in importing the desired kits.

Grass pea seeds

In 2004, two of the three kits were planted and it is safe to say that the year was a fair test for the seed varieties contained within the kit. The results of these two trials are being analyzed, but the interim impressions from those closely involved with the trials were positive, raising the hopes of plants capable of providing much needed food for our area. In 2005, the third kit will be planted at Tangulbei, in a terraced garden, that should also be a good test for these crops. It is my hope that upon evaluation of these trials, the successful plants will be bulked up and their seeds will find their way into the hands of local farmers.

I am not expecting the local people to abandon planting maize, but I would encourage them to extend their fields to include a section of these new hardy plants, so that if and when the maize fails, there will still be a chance of harvesting some food for their families from these new crops. It is also my hope that this would have the knock on effect of giving the Pokot the choice of bringing their goats to market during the dry season. At the moment, in most cases, there is no food stored in the homesteads prior to the start of the dry season, mainly because the crop failed. This means that in order to get maize flour and other needed items, the Pokot must bring their goats to market in order to convert them into cash. During the dry season the value of goats plummets because there are too many goats at market and not enough buyers. In order to get what you need, two goats have to be sold instead of one, which is great for the buyers (who come from outside East Pokot), but not so for the sellers, who see their assets leaving the region at bargain basement prices. If food was already in their homes, then I would hope that people would have the option not to bring their goat(s) to market, which would reduce the number of goats at market and hence keep the prices higher than would otherwise be. So the knock on effect of solving the food insecurity problem would be realizing a better price on their primary cash crop (goats) particularly during their most vulnerable time of the year.

Going hand in hand with this endeavor is the introduction of new techniques of rain-water harvesting. As mentioned above, the area receives 660 mm of rainfall per year, which is not too bad. At the moment no effort is made to harvest the run off, particularly after a couple of days of heavy rain. Just recently 10 people from 10 different families were selected to take part in a rainwater harvesting pilot project. The aim is to dig a three metre (width) by five metre (length) by one metre (depth) ditch in their fields at a place where surface water is seen to be flowing into their field. The ditch when full will hold 15,000 litres of water to be used on the crops when the rain has disappeared for a short time (two weeks) as it often does during the rainy season. It would be my hope that eventually a farmer might have 5 of these ditches in his or her field, connected together to form a network, and eventually dug to a depth of perhaps 3 metres. In this way, with a simple manual pump, or even just watering cans, a sizable section of a field could be salvaged from a dry patch during the wet season, where other fields without these water resources are wilting and dying. There are many other dry farming techniques which we will have to try, but it is my over- whelming conviction that there is as yet unrealized potential in this semi-arid area for the achievement of food security through the introduction of new and hardy crops as well as techniques of making the most of the water we are already receiving through precipitation.

Our work is still only in its infancy, but it is one we will continue to work at with the hope of one day relieving the Pokot from their chronic hunger as well as opening up new capacities for them to work for their own further development.

Evaluation of *Lathyrus sativa* (grass peas) accessions in Kenya. A collaborative program between International Centre for Agricultural Research in Dry Areas (ICARDA) and the Legume Research Network of Kenya (LRNP)

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Introduction

A major problem affecting food security in the arid and semi-arid areas of Kenya is lack of suitable legume cover crops for the regions which have potential to conserve the soil and provide food for humans and feed for livestock. Grass pea is a legume that has been grown for thousands of years in dry regions of the world from northwest China to Ethiopian highlands, India, Bangladesh, Pakistan and Nepal for feeding livestock and as a food crop (Raloff J., 2000; Campbell C.G., 1997). Grass pea seed is roasted for snack, cooked into a protein rich porridge/gravy, and even ground for baking into bread. Its hardy and penetrating root system is capable of tapping soil moisture and nutrients from deep soil layers making it tolerant to drought conditions. Compared to many other legumes, grass pea is tolerant to many pests and diseases. Surprisingly, it is know to tolerate high rainfall and flooding conditions as found in heavy clay soils and performs quite well.

A major draw back to its utilization is the presence of a neurotoxin known as beta-N-oxalyl-L-alpha-beta-diaminopropionic acid (ODAP) in its tissues which normally ranges between 1-2 % by weight (Raloff J, 200). Eating small quantities of the legume is usually harmless but when consumption exceeds 30% of daily calories intake and persist for several months a nervous system disease known as lythrism sets in. Plant breeders from ICARDA has over the years engaged in a breeding program to reduce ODAP content in the legume and have managed to develop materials that have as low as 0.04% ODAP content. ICARDA have initiated a germplasm evaluation program known as “Legume International Nurseries and Trials” and it collaborates with individuals and institutions interested in evaluating and introducing the leguminous materials they have bred in their environments.

In its efforts to identify suitable legume cover crops for the arid and semi-arid lands in Kenya, the LRNP is collaborating with ICARDA to evaluate a germplasm of low ODA grass pea materials in the regions. It is important to point out here that it is Father Paul Leyden of Tangulbei Catholic Mission who drew the attention of the LRNP to the value of grass pea as a food crop for the drought stricken areas of Kenya. He had already identified contacts in ICARDA who were requested to supply the grass pea evaluation kits. He is therefore an important collaborator in this evaluation work!

Materials and methods

Grass pea germplasm: Sixteen entries of grass pea were supplied by ICARDA in February 2004 in three kits. Each kit contained seed quantities enough for a plot area of 4.8 m^2 where the seed was planted at a spacing of 30 x 8 cm and for 3 replicates. For comparison purposes, chickpea (*Cicer arientinum*) and common bean (*Phaseolus vulgaris*) were also planted during the 2004 LR season. (April—August 2004).

Sites: The evaluation was done in Matanya in Laikipia that receive about 600 mm of rain annually and Chemongoch in Baringo that receive less than 700 mm of rain annually. The third site at Tangulbei catholic mission was not ready for the kit in 2004 but was to be included in 2005.

Establishment: The grass pea seed was planted in April 2004 and harvesting was done in August in both sites.

Data collection: Climatic data for each site was collected. Plant data collected included, seed germination, ground cover development, phenology, nodulation, grain yield and dry matter production.

Preliminary results

Rainfall received during the four month growth period was only 210 mm. Data collected from the two sites is being analyzed but some data from Matanya site is presented in Table 1.

There was no significant difference in percentage ground cover at 4 weeks which was on average about 45% for all the legume species. However, days to 50% flowering and podding were lowest for entry Sel 1304 while all the other grass pea entries, chick pea and common bean matured on average 12 days later. All the grass pea entries and the chick pea produced about 1 t ha^{-1} of grain. The common bean gave only a mere 0.34 t ha^{-1} of grain. There was hardly any difference in DM yield across all the legume species.

Conclusion

Preliminary conclusion is that the grass pea entries and the local check appear quite promising as grain legumes for human food and livestock feed. With only 210mm of rain they produced about a ton of grain and over 1.2 t ha^{-1} of legume residue.

Table 1. Performance of four best-bet grass pea entries compared with Chick pea (local check) and common beans at Matanya site; 2004 long rains (April—August 2004)

Species	% Ground cover at 4 weeks	50% flowering (days)	50% podding (days)	Grain yield T ha^{-1}	DM yield T ha^{-1}
Grass pea entries					
Sel 1321	46	47	53	1.09	1.37
Sel 1325	42	53	59	1.00	1.23
Sel 1326	41	48	60	0.91	1.25
Sel 1304	47	37	44	0.86	1.72
Chickpea	49	49	57	0.86	1.20
Common bean	-	48	51	0.34	1.34
F test	-	-	-	0.043	0.971
LSD	-	-	-	0.435	1.490
CV	-	-	-	29.08	62.801

Way forward
The evaluation will be repeated again during the short rains 2004 and long rains 2005 in the two sites. Analysis of data collected in LR 2004 will continue. An additional site in Tangulbei to be managed by the Catholic mission will be started in LR 2005.

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Screening of promiscuous soybean varieties in the North Rift Valley of Kenya

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Introduction
Soybean is becoming a very important grain legume in Kenya due to its recognized potential as food, livestock feed, for soil fertility improvement and income generation for small holder farmers. As human food, it is graded as one of the most important sources of high quality protein, edible oils and vitamins (GTZ, 1996). The cake, after oil extraction is used as a cheap and protein rich ingredient for the manufacture of livestock feeds. Increased production and utilization of soybean can therefore contribute to improved nutrition, health and the livelihoods of rural communities in Kenya.

Soybean varieties currently grown by farmers have very low soil improving potential unless inoculated with rhizobium bacteria to enhance their nodulation and nitrogen fixing ability. Most farmers do not have access to inoculants or lack the skills for proper handling. Promiscuous soybean varieties can play a more significant role in improving soil fertility because they nodulate freely with indigenous soil rhizobium and therefore do not require artificial inoculation (Sanginga *et al*, 2001). These varieties are reported to contribute appreciable amounts of nitrogen to the soil, which can benefit a subsequent cereal crop. They also produce large amounts of biomass that can contribute to the soil organic matter or can be fed to livestock to produce high quality manure.

Promiscuous soybean varieties bred in West Africa have been introduced and evaluated in Western Kenya by the TSBF – CIAT, and have shown good performance (The comminutor, 2003). There is need to test these varieties under different climatic conditions. In 2004, the LRNP, in collaboration with TSBF screened ten varieties with the main objective of identifying best bets for different agro-ecological zones. KARI Kitale was one of the LRNP site selected for screening the ten promiscuous soybean varieties.

Materials and methods
Screening of the soybean varieties was done at KARI Kitale in UM_4 agro-ecological zone and in the farmer's field in Kaplamai Division, Trans-Nzoia District. KARI Kitale is situated at an altitude of 1890 m.a.s.l and receives about 1200 mm of rainfall per annum. The soil type is Ferralsol. Koilel farm is at an altitude of 2000 m.a.s.l and receives slightly higher rainfall (average 1300 mm).

Seeds of the promiscuous soybean varieties (Table 1) were obtained from TSBF. Their performance was compared with a local variety, Duicker. Before planting, soil sampling was done at both sites to establish the soil fertility status. Planting was done on 30th April 2004 at the research center and on 5th May at Koilel farm. The seed was planted in drills spaced 75cm at a rate of 82 seeds per row. Each variety was planted with either 0 or 60 kg P_20_5 ha^{-1} applied as Triple Super Phosphate (TSP). Thinning was done one month after planting at a spacing of 3 cm between plants. All recommended cultural practices for growing soybean were followed. The trial was laid out in a split-plot design with the main plot (fertilizer rate) arranged in a Randomized Complete Block Design replicated 3 times. The varieties represented the sub-plot.

The data collected included; percent emergence at 4 weeks after planting, dry matter accumulation at 2 and 3 months, number of nodules and the nodule status (fixing or not fixing) at the onset of flowering, pest and disease incidences, plant height at 4 months, % ground cover at 2 and 3 months, days to onset of flowering and

50 % flowering, onset of pod formation, 50 % pod formation, days to maturity, total above ground biomass at harvesting, grain yield and a thousand grain weight. The data was subjected to analysis of variance using the SAS statistical package. The means were separated by the Least Significant Difference (LSD) at P = 0.05 level of significance.

Results and discussion

Crop emergence

Table 1 shows the % emergence of the varieties at 4 weeks after planting. Significant differences ($p < 0.05$) were observed between varieties and with fertilizer application at both sites. In the on station trial, higher germination was observed when P fertilizer was not applied than when it was applied. This could be attributed to the moisture stress immediately after planting which may have had a scorching effect on the seed. Some of the seedlings that germinated further dried up due to lack of rainfall for about 2 weeks after planting. The on-farm site received adequate rainfall after planting resulting in higher germination when P fertilizer was applied. Differences in the germination of the varieties may suggest differences in the seed longevity with some varieties maintaining their viability longer than others. Varieties that had over 70 % emergence were TGX 1869-31E, TGX 1889-12F, TGX 1740- 2F and TGX 1448-2E.

Plant height

Table 2 shows the plant height for the varieties at 4 months after planting with or without P fertilizer at the two sites. Significant differences were also observed between varieties and with fertilizer application at $p< 0.05$. Application of P increased plant height for all varieties only at the on farm site. Varieties TGX 1895-4F, TGX 1869-31E,TGX 1871-12E and 1895-6F were shorter than the local variety. All the varieties grew much taller at Koilel farm than on-station. No significant pest and disease attack was observed on the crop at both sites except for a very minor incidence of the web-worm at the on farm site, which caused no noticeable damage. No spraying was done to control the pest.

Table 1. Emergence (%) of soybean varieties at 4 weeks after planting with or without application of TSP at KARI-Kitale and Koilel farm in 2004

	KARI Kitale			Koilel farm		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	23.7	31.5	27.6 c,d	76.4	69.9	73.1 b,c
TGX 1893-10F	57.8	66.5	62.2 b,c	70.8	40.8	55.9 c
Local (Duicker)	49.2	49.9	49.6 c	77.1	73.2	75.2 a,b,c
TGX 1895-33F	19.1	29.5	24.3 c,d	62.6	68.8	65.7b,c
TGX 1869-31E	74.7	93.1	83.9 a	85.4	53.8	69.6 b,c
TGX 1889-12F	69.6	82.7	76.2 a,b	58.4	86.1	72.2 b,c
TGX 1740-2F	77.1	90.6	83.9 a	82.2	71.7	76.9 a,b
TGX 1448-2E	68.9	74.3	71.6 a,b	92.4	62.5	75.7 a,b
TGX 1830-20E	37.4	52.1	44.8 c	92.7	95.5	94.1 a
TGX 1871-12E	35.2	43.4	39.3 c	61.7	51.4	56.6 b,c
TGX 1895-6F	9.8	12.6	11.2 d	61.3	60.3	62.7 b,c
Mean	47.5 b	56.9 a	52.2	79.1 a	66.9 b	73.1
CV %	-	-	22.7	-	-	22.3
LSD(0.05)	-	-	19.2	-	-	19.5

Means in the same column or row followed by same letter were not significantly different at P=0.05

Table 2. Plant height (cm) for promiscuous soybean varieties at 4 months after planting with or without P fertilizer at KARI Kitale and Koilel farm in 2004

	KARI Kitale			Koilel Farm		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	43.4	57.8	50.6 c	82.2	85.0	83.6 a
TGX 1893-10F	58.5	59.2	58.9 a,b	75.0	86.0	80.5 b
Local (Duicker)	56.8	58.3	57.6 b	72.0	80.2	76.1 d
TGX 1895-33F	57.4	60.4	58.9 a,b	79.4	61.6	70.5 e
TGX 1869-31E	53.2	51.2	52.2 c	62.0	77.3	69.7 e
TGX 1889-12F	58.8	57.0	57.9 b	84.5	73.7	79.1 c
TGX 1740-2F	58.2	61.8	60.0 a	81.5	82.6	84.5 a
TGX 1448-2E	57.8	59.2	58.5 a,b	77.5	91.4	84.5 a
TGX 1830-20E	55.6	59.5	57.6 b	79.3	87.4	83.4 a
TGX 1871-12E	34.4	42.2	38.3 d	58.0	83.4	70.7 e
TGX 1895-6F	48.9	55.8	52.4 c	67.0	89.6	78.3 c
Mean	53.0 a	56.6 a	54.8	74.4 b	81.7 a	78.1
CV %	-	-	3.09	-	-	2.9
LSD(0.05)	-	-	2.03	-	-	1.9

Means in the same column or row followed by same letter were not significantly different at P=0.05

Table 3. Ground cover (%) at 2 and 3 months after planting at KARI-Kitale with or without fertilizer application

	2 months			3 months		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	45.3	37.5	41.4 g	66.4	61.6	64.0 g
TGX 1893-10F	46.9	42.1	44.5 f	71.4	68.8	70.1 e
Local (Duicker)	33.3	30.3	31.8 i	63.8	59.9	61.9 h
TGX 1895-33F	34.2	35.7	34.9 h	58.8	55.0	56.9 i
TGX 1869-31E	50.9	49.9	50.4 d	75.0	73.8	74.4 d
TGX 1889-12F	55.9	40.3	48.1 e	85.0	75.0	80.0 c
TGX 1740-2F	67.1	55.9	61.5 b	97.5	76.2	86.9 b
TGX 1448-2E	66.2	63.9	65.1 a	92.5	93.8	93.2 a
TGX 1830-20E	55.3	50.3	52.1 c	68.8	67.5	68.2 f
TGX 1871-12E	48.8	51.0	49.9 d,e	63.4	61.3	62.4 h
TGX 1895-6F	25.2	22.9	24.1 j	41.3	50.0	45.7 j
Mean	48.1 a	43.6 b	45.9	71.3 a	67.5 b	69.4
CV %	-	-	3.59	-	-	1.6
LSD(0.05)	-	-	1.97	-	-	1.4

Means in the same column or row followed by same letter were not significantly different at P=0.05

Ground cover

The ground cover at 2 and 3 months for the varieties in the on-station trial is shown in Table 3, Table 4 is for the on-farm site. There were significant differences at P <0.05 in ground cover for all the varieties at both sites. All the varieties had higher ground cover than the local variety except TGX 1895-6F at 2 months and TGX 1895-6F and TGX 1895-33F at 3 months. Varieties TGX 1448-2E and TGX 1740- 2F had the highest ground cover. The ground cover at Koilel farm at 3 months after planting was almost 100% for all varieties. The site received heavy rainfall during the growth period enhancing vigorous growth of the crop. In addition, the crop lodged and completely covered the ground. Application of P fertilizer significantly (P<0.05) increased ground cover at both sites.

Nodulation

Table 5 show the nodule numbers per plant and the nodule status of the varieties at the two sites with or without application of P fertilizer.

The data was collected at 4 months after planting when all the varieties had flowered. There were significant differences in nodule numbers between varieties at both sites. Application of P greatly increased the nodule numbers, size and their ability to fix nitrogen, although the varieties did not respond equally. Varieties TGX 1895-33F, TGX 1869-31E, TGX 1448-2E, TGX 1830-20E, had good nodulation ability. The varieties generally formed more nodules at the on farm site than on-station. The number of nodules varied greatly for different plants of the same variety. Some plants had high numbers of nodules, while others had very few or none at all. This may have contributed to the high coefficient of variation (CV %) as indicated in Table 5. The local variety did not form any nodules at both sites even with P application confirming the fact that the current varieties being grown by farmers require rhizobium inoculation to form nodules and fix nitrogen.

Flowering and podding

Data on onset of flowering and pod formation is presented in Table 6 from the on-station trial. It was not possible to accurately collect this information at the on-farm site because it required very frequent visits, which was not possible. The local variety flowered and formed pods earlier than all the promiscuous varieties. It took 70 days to start flowering and 135 days to mature. It was followed by TGX 1895-33F and TGX 1871-12 E, both of which took 84 days to flower and 153 days to mature as

Table 4. Ground cover (%) at 2 months after planting at Koilel farm with or without fertilizer application

Variety	+P	-P	Mean
TGX 1895-4F	72.5	57.2	68.9 [b]
TGX 1893-10F	72.4	62.5	67.5 [b]
Local (Duicker)	67.5	57.2	62.4 [b,c]
TGX 1895-33F	57.0	62.0	59.5 [c]
TGX 1869-31E	75.3	70.0	72.7 [a]
TGX 1889-12F	75.3	72.3	73.8 [a]
TGX 1740-2F	79.5	72.3	75.9 [a]
TGX 1448-2E	67.0	62.1	64.6[b,c]
TGX 1830-20E	62.5	57.2	59.9 [c]
TGX 1871-12E	62.5	62.3	62.4 [b,c]
TGX 1895-6F	42.5	43.9	43.2 [d]
Mean	66.7 [a]	62.5 [b]	64.6
CV %	-	-	2.9
LSD(0.05)	-	-	1.7

Means in the same column or row followed by same letter were not significantly different at P=0.05

Table 5. Nodule numbers per plant and the nodule N-fixing status of the varieties with or without application of P fertilizer at KARI Kitale and Koilel farm in 2004

Variety	KARI-Kitale			Koilel farm		
	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	4F	0	2 [b,c]	4 F	2	3 [d]
TGX 1893-10F	1F	0	1[c,d]	0	0	0 [d]
Local (Duicker)	0	0	0[e]	0	0	0 [d]
TGX 1895-33F	10F	0	5 [a]	50F	3 NF	27 [a]
TGX 1869-31E	5F	1 NF	3 [b]	44F	0	22 [a,b]
TGX 1889-12F	4F	0	2 [b,c]	24F	1NF	13 [c]
TGX 1740-2F	4F	0	2 [b,c]	17F	0	9 [c,d]
TGX 1448-2E	6F	0	3 [b]	14F	2NF	8 [c,d]
TGX 1830-20E	6F	0	3 [b]	27F	3NF	15 [b,c]
TGX 1871-12E	2F	0	1[c,d]	12F	0	7 [c,d]
TGX 1895-6F	2F	0	1[c,d]	5F	0	3 [d]
Mean	4[a]	0[b]	2	18 [a]	2 [b]	10
CV %	-	-	47.1	-	-	46.3
LSD(0.05)	-	-	1.89	-	-	8.9

Means in the same column or row followed by same letter were not significantly different at P=0.05
F = Fixing nitrogen, NF= Not fixing nitrogen

Table 6. Days to onset of flowering, pod-set, and maturity of promiscuous soybean varieties at KARI- Kitale in 2004

Variety	Onset of flowering	50 % flowering	Onset of pod formation	50 % pod formation	Maturity
TGX 1895-4F	88	94	91	113	166
TGX 1893-10F	87	95	93	100	166
Local (Duicker)	70	72	72	78	135
TGX 1895-33F	84	89	86	90	153
TGX 1869-31E	87	93	90	95	168
TGX 1889-12F	85	89	87	90	172
TGX 1740-2F	87	94	94	101	175
TGX 1448-2E	87	95	92	113	175
TGX 1830-20E	85	89	89	96	165
TGX 1871-12E	84	89	86	91	153
TGX 1895-6F	87	94	93	95	172

Dry matter production

Table 7 shows the dry matter accumulation at 2 and 3 months at the on station site. Significant differences were observed between varieties at P<0.05. However, there was no response to P application at both sites. Varieties with high dry matter accumulation were; TGX 1740-2F, TGX 1448-2E, TGX 1895-33F. These varieties also had the highest heights among the different varieties. The dry matter accumulation for the local variety at 3 months was high because it had already formed pods unlike the other varieties.

Total above ground biomass production

Table 8 shows the total above ground biomass production including grain for the varieties at the two sites. There were significant differences at P<0.05 between varieties but no significant differences for the fertilizer treatments. Varieties with high biomass production at both sites were; TGX 1889-12F, TGX 1740-2F, TGX 1448-2E and TGX 1895-4F. The biomass production at the on farm site was quite high compared to on station. Due to continued rainfall some varieties continued growing and forming pods but without filling with grain.

Grain yield

Table 9 shows the grain yield data at the two sites. There were significant differences between varieties and with or without P fertilizer application. At the on station site, variety TGX 1889-12F out yielded (1.9 t ha^{-1}) all the other varieties including the local check. It was followed by varieties TGX 1893 10F, TGX 1895-33F, TGX 1895-33F and TGX 1871-12E, whose yields were almost the same as the local variety. Variety TGX 1895-6F had the lowest mean yield. At the on farm site, the varieties had much lower seed yield compared to on station. Varieties TGX 1448-2E and TGX 1740-2F that had very high biomass production yielded less than 10 gm seed per plot and the seed was shriveled and not usable. Most of the pods did not form grain.

Table 10 shows a thousand grain weight for the seed harvested on station. Significant differences were observed between the varieties at P< 0.05, with the local variety having the highest weight. Among the promiscuous varieties, TGX 1895-4F, TGX 1895-4F, TGX 1895-33F, TGX 1889-12F and TGX 1895-6F had higher 1000 grain weights than the rest. Application of P fertilizer increased 1000 grain yield significantly at P<0.05.

Conclusion

From the above results, promiscuous soybean varieties can perform well in the UM_4 AEZ and can increase soil fertility through BNF without inoculation with rhizobium bacteria. Among the varieties tested the most promising were; TGX 1895-33F, TGX 1889-12F, TGX 1895-4F, TGX 1895-4F, TGX 1871-12E and TGX 1895-6F. These varieties had high biomass production, good nodulation and high seed yields. They would therefore be more suitable for farmers who prefer dual-purpose varieties. Application of P fertilizer significantly affected all the parameters measured except the dry matter accumulation and total above ground biomass production. It was evident that the varieties show their promiscuity only with application of P fertilizer.

The promiscuous varieties tested matured later than the local variety and took about 5 months from planting to maturity. It is therefore not possible for farmers in the UM_4 AEZ to grow a second crop under rain-fed conditions. Varieties with good seed longevity therefore need to be identified to ensure availability of viable seed for the following year’s crop.

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Table 7. Dry matter accumulation (t ha[-1]) at 2 and 3 months at KARI Kitale with or without application of P fertilizer

	2 months			3 months		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	1.1	1.4	1.2 [b]	2.2	2.3	2.3 [b,c]
TGX 1893-10F	1.6	1.3	1.4 [a,b]	3.2	2.5	1.9 [c]
Local (Duicker)	1.1	1.0	1.1 [b]	2.5	2.5	2.5 [b]
TGX 1895-33F	1.7	1.4	1.5 [a,b]	3.3	3.0	3.1 [a,b]
TGX 1869-31E	1.3	1.4	1.4 [a,b]	2.8	2.9	2.9 [b,c]
TGX 1889-12F	1.5	1.3	1.4 [a,b]	2.9	2.6	1.8 [c]
TGX 1740-2F	1.9	1.4	1.7 [a]	3.8	3.7	3.8 [a]
TGX 1448-2E	1.5	1.8	1.6 [a]	2.9	3.6	3.3 [a]
TGX 1830-20E	1.2	1.4	1.3 [b]	2.8	2.5	2.6 [b]
TGX 1871-12E	1.2	1.2	1.2 [b]	2.4	2.5	2.5 [b]
TGX 1895-6F	0.5	0.5	0.5 [c]	1.0	0.8	0.9 [d]
Mean	1.3 [a]	1.3 [a]	1.3	2.7 [a]	2.6 [a]	2.5 [b]
CV %	-	-	17.9	-	-	19.0
LSD(0.05)	-	-	0.3	-	-	0.5

Means in the same column or row followed by same letter were not significantly different at P=0.05

Table 8. Total above ground biomass (t ha[-1]) of the varieties with or without application of P fertilizer at KARI Kitale and Koilel farm in 2004

	KARI-Kitale			Koilel farm		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	3.6	4.4	4.0 [b,c,d]	5.5	7.1	6.3 [c]
TGX 1893-10F	4.0	3.9	3.9 [b,c,d,e]	5.4	7.0	6.2 [c]
Local (Duicker)	3.7	2.8	3.3 [e,f]	4.1	3.1	3.6 [d]
TGX 1895-33F	3.5	3.7	3.5 [e,f]	5.7	5.7	5.7 [c]
TGX 1869-31E	3.8	4.7	4.3 [b,c,d]	6.3	5.5	5.9 [c]
TGX 1889-12F	5.0	5.1	5.1 [a]	6.9	6.3	6.6 [b]
TGX 1740-2F	5.0	4.3	4.6 [b]	7.9	8.9	8.4 [a]
TGX 1448-2E	4.2	4.6	4.4 [b,c,d]	7.1	8.1	7.6 [a]
TGX 1830-20E	3.4	2.8	3.1 [f]	5.7	5.2	5.5 [c]
TGX 1871-12E	3.8	3.5	3.6 [c,d,e,f]	4.0	4.0	4.0 [d]
TGX 1895-6F	0.7	1.2	1.7 [g]	2.2	2.2	2.2 [e]
Mean	3.8 [a]	3.8 [a]	3.8	5.5 [a]	5.7 [a]	5.6
CV %	-	-	18.1	-	-	6.8
LSD(0.05)	-	-	0.8	-	-	0.6

Table 9. Grain yield (t ha^{-1}) of promiscuous soybean varieties with or without application of P fertilizer at KARI Kitale and Koilel farm in 2004

	KARI Kitale			Koilel farm		
Variety	+P	-P	Mean	+P	-P	Mean
TGX 1895-4F	1.2	1.5	1.4 [c]	0.1	0.1	0.1 [d]
TGX 1893-10F	1.7	1.3	1.5 [b,c]	0.1	0.07	0.08 [d]
Local (Duicker)	1.9	1.3	1.6 [b,c]	1.9	1.3	1.6 [a]
TGX 1895-33F	1.6	1.5	1.5 [b,c]	1.3	1.0	1.2 [a,b]
TGX 1869-31E	1.4	1.3	1.3 [c]	0.1	0.09	0.1 [d]
TGX 1889-12F	1.9	1.8	1.9 [a]	0.1	0.1	0.1 [d]
TGX 1740-2F	1.1	0.8	0.9 [e,d]	*	*	*
TGX 1448-2E	1.0	0.7	0.9 [e,d]	*	*	*
TGX 1830-20E	1.1	1.1	1.1 [d]	0.2	0.2	0.2 [d]
TGX 1871-12E	1.7	1.4	1.6 [b,c]	0.9	0.5	0.7 [b,c]
TGX 1895-6F	0.6	0.8	0.7 [d]	0.3	0.2	0.3 [c,d]
Mean	1.4 [a]	1.2 [b]	1.3	0.5	0.4	0.5
CV %	-	-	17.1	-	-	28.0
LSD(0.05)	-	-	0.3	-	-	0.5

Means in the same column or row followed by same letter were not significantly different at P=0.05
* Less than 10 gms of seed harvested.

Table 10. Thousand grain weight (gm) for promiscuous soybean varieties with or without P application at KARI- Kitale

Variety	+P	-P	Mean
TGX 1895-4F	145.0	136.3	140.5 [b]
TGX 1893-10F	139.7	123.5	131.6 [b]
Local (Duicker)	182.1	167.8	174.9 [a]
TGX 1895-33F	134.8	127.0	130.9 [b]
TGX 1869-31E	105.1	89.9	97.5 [c]
TGX 1889-12F	137.7	126.4	132.1 [b]
TGX 1740-2F	106.9	102.0	104.5 [c]
TGX 1448-2E	113.1	109.4	111.3 [c]
TGX 1830-20E	105.3	100.3	102.8 [c]
TGX 1871-12E	88.8	79.3	84.1 [d]
TGX 1895-6F	135.0	125.0	130.0 [b]
Mean	126.7 [a]	116.9 [b]	121.8
CV %	-	-	3.9
LSD(0.05)	-	-	9.2

Effect of rhizobia inoculation and urea application on nodulation and dry matter accumulation of green manure legumes at Katumani and Kabete sites, Kenya

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Introduction

Declining soil fertility is a major constraint to crop productivity on smallholder farms in Kenya. A cost-effective strategy to improve soil fertility is to integrate green manure cover crops into existing cropping systems. Velvet bean (*Mucuna pruriens*) and other green manure legumes have the potential to contribute to soil nitrogen and increase yields of subsequent or associated non-leguminous food crops through symbiotic nitrogen fixation (Mureithi et al., 2003). Velvet bean can derive as much as 70% of its nitrogen from the atmosphere and can fix 167 kg N per ha in 2 months under research station conditions. For green manure legumes to fully exploit their nitrogen fixing potential, the presence of sizeable compatible and effective populations of rhizobia in the soil is necessary. Rhizobia inoculation is necessary in absence of compatible indigenous rhizobia, when rhizobial populations are very low, when soil nitrate level is high and when indigenous rhizobia are ineffective. Studies conducted by the Legume Research Network Project (LRNP) in 10 sites showed that most legume cover crops did not respond to inoculation with rhizobia (Mureithi *et al.*, 1998; Mureithi *et. al.*, 2003). It was recommended that further systematic studies to determine the populations of indigenous rhizobia in the LRNP sites be conducted. As part of these studies, a two-season field experiment was conducted in two different sites to determine the response of velvet bean (M*ucuna pruriens*), hyacinth bean (*Lablab purpureus* cv. Rongai), Tanzania sunnhemp (*Crotolaria ochroleuca*), Jack bean (*Canavalia ensiformis*) and lima bean (*Phaseolus lunatus*) to rhizobia inoculation and 'starter' nitrogen application.

Materials and methods

Field experiments were conducted on a farmer's field in Katumani and at the University of Nairobi's Kabete Field Station for two seasons (shorts rains of 2003 and long rains of 2004) to establish the need for inoculation of legumes. Katumani site is situated at an elevation of 1600 m above sea level (a.s.l.) with a mean annual rainfall of 725 mm. The soils are chromic luvisols and low in organic matter content and nitrogen with neutral pH. The Kabete site is at an elevation of 1700 m a.s.l. with annual rainfall of 1000 mm. The soils are Humic Nitosols, deep and well drained with a pH of 6.

The treatments consisted of the following:

- Uninoculated legumes without N fertilizer
- Inoculated legumes without N fertilizer
- Uninoculated legumes but supplied with urea (30 kg/ha N) at planting.

The legume species used were velvet bean (M*ucuna pruriens*), hyacinth bean (*Lablab purpureus* cv. Rongai), Tanzania sunnhemp (*Crotolaria ochroleuca*), Jack bean (*Canavalia ensiformis*), and Lima bean (*Phaseolus lunatus*). The data collected, which included nodule number, nodule dry weight and aboveground dry matter, was subjected to analysis of variance (ANOVA). Means were separated by the least significant difference test (LSD) at the $p<0.05$ level of significance.

Results

Nodule numbers per plant

Inoculation and urea treatments had a significant effect ($P<0.05$) on nodule number and nodule dry matter at 8 weeks after planting in both sites and seasons (Tables 1-4). In addition, a significant interaction of inoculation with green manure legume (GM) species was observed in all the trials. Inoculation significantly increased nodule numbers/plant in Mucuna, crotalaria and lablab in 2003 short rains (SR) at Katumani and in both 2003 SR and 2004 long rains (LR) at Kabete (Tables 1, 2 and 4). In 2004 long rains at Kabete, inoculation significantly improved nodule number per plant only in Mucuna and lablab (Table 3). Inoculation did not improve nodule numbers in lima bean and canavalia in all the trials. In 2004 LR, urea application significantly reduced nodule numbers per plant relative to uninoculated treatments for all GM legumes except for lablab at Kabete. In contrast, in 2003 SR urea application improved nodulation relative to uninoculated treatments for Mucuna, crotalaria and lablab at Katumani and for lablab at Kabete. Canavalia plants did not form root nodules in 2003 SR in both sites, regardless of whether they were inoculated with rhizobia or not. Some nodules were observed only in 2004 LR in both Katumani (negligible numbers) and Kabete. On average across the sites, the number of nodules per plant varied in the order crotalaria>Mucuna>lablab>lima bean>canavalia. Within inoculated treatments, Mucuna had significantly the highest nodule numbers per plant in 2003 SR at Katumani and 2004 LR at Kabete. In contrast, crotalaria had the highest nodule numbers per plant in 2003 SR at Kabete and 2004 LR at Katumani.

Nodule dry matter per plant

Treatment effects on dry matter (DM) of nodules per plant, recorded in 2003 SR followed a trend similar to the one for nodule number per plant with a few exceptions (Tables 5 and 6). Among inoculated plants, lablab and Mucuna had significantly higher nodule DM than canavalia, lima bean and crotalaria. Nodule DM for Mucuna and lablab was statistically similar at Katumani, but the nodule DM for lablab was significantly superior at Kabete. Nodule DM for crotalaria and lima bean at both sites were not affected by inoculation. Urea application had no effect on nodule DM per plant for all GM legumes in both sites, but it significantly improved nodule DM for Mucuna at Kabete and crotalaria at Katumani.

Dry matter accumulation at 16 weeks after planting

Inoculation and urea treatments and their interaction with GML species had no significant effect on dry matter (DM) accumulation at 16 weeks after emergence at both sites (Tables 7 and 8). However, the GM legume species significantly influenced this attribute. At Kabete in 2003 SR, all GM legumes had significantly different DM yields. Lablab had significantly the highest DM whereas lima bean had significantly the lowest. At Kabete in 2004 LR, Mucuna accumulated significantly the most DM followed by crotalaria. Canavalia had similar DM with lablab whereas lima bean had the lowest DM. Inoculation and urea treatments had no significant effect on seed yield according to data recorded at Kabete in 2004 LR (data not shown).

Summary

Rhizobia nodulating GM legumes are present in both Kabete and Katumani sites which had no recent history

Table 1. Number of nodules per plant of green manure legumes (8 weeks after planting) grown at Katumani during the short rains in 2003

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	T Mean
Uninoculated	6.6	0.0	3.3	5.4	6.7	4.4
Inoculated	10.3	0.0	7.7	6.0	8.3	6.5
Nitrogen (Urea)	9.0	0.0	5.3	1.3	8.3	4.8
LS means	8.6	0.0	5.4	4.2	7.8	

$LSD_{0.05}$: T x LS means=1.5; T means=0.7; LS means=0.9
CV =18%

Table 2. Number of nodules per plant of green manure legumes (8 weeks after planting) grown at Kabete during the short rains in 2003

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	lablab	T Mean
Uninoculated	1.7	0.0	9.3	2.5	3.0	3.3
Inoculated	4.0	0.0	20.3	3.5	7.3	7.0
Nitrogen (Urea)	2.5	0.0	8.8	1.7	1.3	2.9
LS means	2.7	0.0	12..8	2.6	3.9	

$LSD_{0.05}$: T x LS means=1.4; T means=0.6; LS means=0.8
CV=19%

Table 3. Number of nodules per plant of green manure legumes (8 weeks after planting) grown at Katumani during the long rains in 2004

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	T Mean
Uninoculated	2.4	0	10.2	1.4	4.8	3.8
Inoculated	5.3	0	10.5	1.3	5.3	4.5
Nitrogen (Urea)	0.8	0	4.7	0	0.1	1.1
LS means	2.8	0	8.5	0.9	3.4	

$LSD_{0.05}$: T x LS means=1.5; T means=0.7; LS means=0.9
CV=27%

Table 4. Number of nodules per plant of green manure legumes grown at Kabete during the short rains in 2004

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	T Mean
Uninoculated	2.5	1.5	3.7	1.3	2.0	2.2
Inoculated	7.0	1.3	4.9	1.3	3.5	3.6
Nitrogen (Urea)	0.0	0.0	2.2	0.0	2.5	0.9
LS means	3.2	0.9	3.6	0.9	2.7	

$LSD_{0.05}$: T x LS means=1.1; T means=0.5; LS means=0.7
CV=30%

of GM legumes cultivation. Negligible nodulation was observed in canavalia plants even with inoculation, suggesting that rhizobial strains that form effective nodules with this species are in too small numbers or absent in the soils tested. In addition, the inoculants strain used may not be effective with canavalia. Inoculation improved nodulation for most species, but the increase in nodulation was not translated into improved dry matter yield. Urea application depressed nodule numbers but not nodule biomass. That application of urea did not improve dry matter may suggest that the GML species' N requirements can be made by soil sources and nitrogen fixation. Hence, there was no response to inoculation. Canavalia that was not well nodulated still performed well. Inoculation with rhizobia or urea application may not be necessary when the aim is to increase biomass of GML species for the area studied.

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Table 5. Nodule dry matter (mg) per plant of green manure legumes grown at Katumani during the short rains in 2003

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	Inoc Mean
Uninoculated	22.1	0	14.7	22.5	19.0	15.7
Inoculated	35.0	0	16.0	23.0	37.7	22.3
Nitrogen (Urea)	21.3	0	53.0	22.3	15.3	22.4
Species mean	26.1	0	27.9	22.6	24	

$LSD_{0.05}$: T x LS means=4.8; T means=2.1; LS means=2.7
CV=14%

Table 6. Nodule dry matter (mg) per plant of green manure legumes grown at Kabete during the short rains in 2003

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	Inoc. Mean
Uninoculated	30.0	0.0	23.7	20.0	49.0	24.5
Inoculated	197.0	0.0	29.0	18.0	463.3	141.4
Nitrogen (Urea)	217.0	0.0	32.0	12.0	20.0	56.2
LS means	148	0.0	28.2	16.7	177.3	

$LSD_{0.05}$: T x LS means=42.8; T means=19.1; LS means=24.7
CV=34%

Table 7. Total shoot dry weight (g/m²) of green manure legumes grown at Kabete during the short rains in 2003

	Legume species (Ls)					
Treatment (T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	Inoc. Mean
Uninoculated	162.5	207.6	242.7	126.4	294	206.6
Inoculated	179.6	200.2	293	133.4	396.8	240.6
Nitrogen (Urea)	195	268.1	288.6	145	278.1	235.0
Species mean	179.0	225.3	274.8	134.9	323.0	

$LSD_{0.05}$ LS means=46.5
CV=21%

Table 8. Total shoot dry weight (g/m[2]) of green manure legumes grown at Kabete during the long rains in 2004

	Legume species (Ls)					
Treatment(T)	Mucuna	Canavalia	Crotalaria	Limabean	Lablab	Inoc. Mean
Uninoculated	507.8	350.7	396.9	89.0	251.9	319.2
Inoculated	513.3	350.3	501.8	153.3	365.1	376.8
Nitrogen (Urea)	511.8	363.9	410.8	133.0	270.6	338.0
Species mean	511.0	355.03	436.4	125.1	295.9	

$LSD_{0.05}$: T x LS interaction mean = N.S.; T mean = N.S.; LS mean=87.3
CV=26%

Scaling up of green manure legume technologies: A project by Resources Oriented Development Initiatives (RODI) - an NGO working with prisoners, ex-prisoners and community groups

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This report gives a brief review of green manure legume activities, undertaken by RODI since April 2004. These activities were built on an on-going Prisoner Rehabilitation Programme (PREP) which seeks to cut the cycle of poverty, crime, imprisonment and re-offending, by training prisoners in sustainable agriculture and income generation, besides following them up after imprisonment. Through follow-ups, RODI is not only able to monitor ex-prisoner performance but it also reaches out to poor communities, who it encourages to learn from the former prisoners, and as much as possible, form Community Livelihood Improvement Groups (CLIGs). This arrangement helps speed up ex-prisoners acceptance by the communities and poverty reduction, a major cause of crime. CLIGs are in Central, Rift Valley, Nyanza and Western provinces.

The goal of this project is to enhance the use of green manure legumes among small-scale farmers, to improve soil fertility for increased food production and enhancing the sustainability of cropping systems. To pursue this goal each of the four RODI Project Officers is supposed to work with at least 5 groups of 20 members each.

The project got 11species of green manure legume seeds as follows:

Species	Amount (Kg)
Canavalia ensiformis (Jackbean)	25.6
Crotalaria juncea (Sunhemp)	2.5
Crotalaria ochroleuca (Tanzania Sunhemp)	3.0
Desmodium intortum (Silver leaf Desmodium)	3.0
Lablab purpureus (Hyacinth bean)	12.4
Mucuna pruriens (Velvet bean)	40.9
Phaseolus coccineus (Scarlet runner bean)	4.4
Phaseolus lunatus (Lima bean)	2.9

The seeds were received after the onset of long rains when farmers had already planted their farms. As a result we decided a trial run awaiting to do the real project later during the short rains. On the whole a total of 94.7Kg of seed were distributed to a total of 95 farmers in Central, Rift Valley and Nyanza provinces. Western region was covered later in the short rains as we had a staff gap. Surprisingly, performance in this region ended up being relatively better than in Nyanza and central regions.

Key project activities involving green manure legume work are:

- Green manure legume awareness creation and identification of farmers interested in the technology
- Basic training on the role of green manure legume crops
- Setting up of plots according to available space
- Training on management and use
- Monitoring performance
- Data collection

All these activities have been going on for the last ten months; during this period farmers planted, managed and harvested seed. Some went to the extent of establishing farmer niches that have further created interest among the neighbours. The germination rates across sites ranged from 50 and 80% depending on soil moisture availability. In Central Province, germination was very poor due to drought. But in North Rift the crops performed relatively well.

Observations in different regions

North Rift sites

The legumes in the North Rift did relatively well and observations showed that over 80% had performed above par. A total of 36 farmers in five CLIGs had been given seeds, but right now the number stands at 28.

Joseph Kibet Lagat, Nandi district-Rift valley province: Mucuna plot

Farmers in this area found solace in planting mucuna under upcoming tea plantations as a weed control measure and they saved seed for the following season.

Western Kenya site

Unlike farmers in other regions, farmers in this area did not plant during the long rains because RODI had not yet filled a staffing gap resulting from passing away of the area Project Office. Surprisingly, performance of the legumes ended up doing much better than those in Nyanza and Central provinces because of the short rains. However, this performance was not properly recorded because farmers harvested the legumes for vegetables and fodder. Lablab and crotalaria, already a delicacy in the area, were consumed before seeding, while mucuna and desmodium were fed to livestock.

Central Kenya sites

Farming in Central Kenya is characterised by relatively small land sizes on sloppy grounds. This makes over cultivation and soil erosion an obvious problem. Lack of adequate space for fodder and crop production is common. Legumes in central Kenya performed poorly because of various reasons, one being drought. However, this is one area where farmer niches were easier to establish, may be because of the many problems farmers face. For example, Njuguna's mother of Kiono Wendani CLIG inter-cropped jackbean and mucuna with napier grass and the results were encouraging including controlling of moles. Alice Wanja planted lablab, mucuna and sunhemp under coffee for lack of space. As expected, weed control was evident. In addition she planted mucuna and jackbean in between sweet potato vines.

Peter Kanyonyo planted lablab under tassling maize crop and ate the harvest.

Nyanza sites

A total of 22 farmers from four CLIGs participated in the onset of the project but right now only thirteen are active. Mucuna, sunnhemp, Desmodium, crotalaria, lablab (Rongai), lima bean and butter bean were distributed. Mucuna and desmodium had good organic matter and soil cover and good seed production. Lima bean, lablab and crotalaria nodulated relatively well. Desmodium and crotalaria flowered first and farmers harvested seed. Of all the legumes mucuna produced most seeds. Despite crotalaria being a delicacy in Nyanza, farmers feared to eat the vegetable because of its relatively big leaves. Lablab and butter bean performed poorly in germination.

Kamiti prison demonstration and multiplication

This is the biggest prison in Kenya in terms of inmates, officers and land size. Planting was done in plots measuring 15 by 30 ft. A total of 8 green manure legume species were planted in late April and early May on three different sites, the big Kamiti Prison Farm and on Kamiti youth Corrective Training Centre plot. Ruiru, where the prisons are located is a relatively dry area. The project was seriously affected by drought. However, it served a training purpose. A total of 46 inmates were trained in the principle and practice of green manure legumes.

Capacity Building

RODI field staff had been given literature and information on green manure legumes sourced from LRNP at the beginning of the project. All the field staff accompanied by the Executive Director attended a one day capacity building workshop at the National Agricultural Laboratories of KARI Nairobi, on 20 July 2004. The training covered; the work of LRNP, about green manure legumes, elements of experimentation, plot establishment, data collection and soya utilization.

RODI Staff during a visit in KARI Nairobi

Conclusion

On the whole our own observation and comments from farmers regarding usefulness and utilization of green manure legumes clearly show that the project has very high chances of scaling up in different areas and regions for different reasons, depending on varying farmers niches. Although the whole idea of green manure legumes was positively taken up by our farmers for various reasons it is important to mention that some species such as jackbean came in handy in solving a problem farmers had agonized with for along time; that is controlling of moles in tea, coffee, napier grass and sweet potatoes. Two to three trials need to be carried out to scale up use and general spread of green manure technology, encourage farmer niche establishment as well as correct mistakes noted in the first phase. While farmers were encouraged to keep seed for project continuity, which they did, the quantities were too small for successful continuation. More support will therefore be needed in terms of seed, training, logistical support and technical backstopping if the project goal is to be achieved.

Evaluation of Legumes as Cover Crops for Soil and Weed Management in Smallholder Coffee Cropping Systems in Central Kenya

Research Concept Note

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Introduction

Coffee is an important cash crop in Central Kenya and contributed 1.8 % to the gross domestic product in 1999 (Economic survey, 1999). It is grown in both large (> 20 ha on average) and smallholder farms (under 2 ha). Smallholder farms contribute about 76% of the total coffee and approximately 60% of the total national clean coffee. The average yields in the smallholder system are about 30% of those in the large-scale system (Coffee Board of Kenya) due to differences in the level of management. Low prices and high cost of inputs (fertilisers, pesticides and labour) have contributed to the downward coffee yield trend (Table 1). The unit cost of labour, fertiliser and fungicide costs increased by 430, 599 and 400%, respectively between 1986 and 1998; the labour, fertilizer and fungicide costs comprised 15, 11 and 16%, respectively of the production costs.

Coffee in Kenya is grown on gentle to steep slopes, making the soil vulnerable to erosion. Soil conservation structures are widespread in steep areas (Ngugi and Kabutha, 1989) but their maintenance is labour intensive and low coffee prices have resulted in their being neglected. Many farmers have resorted to intercropping the coffee with annual food crops to maximise land utilisation and have in some cases demolished terrace embankments to create space for food crop production. Some large-scale farms have uprooted coffee and converted land into more profitable enterprises while the smallholder farmers have intercropped coffee with food crops resulting in low yields.

Leguminous cover crops (LCC) can potentially play an important role in maintaining and replenishing soil fertility in coffee farms and in reducing soil erosion. A 40% cover in plots planted with LCC reduced soil loss by 80% compared with bare plots in Kabete, Kenya (Gachene and Haru, 1997). LCC incorporation and / or mulch increased organic matter and N inputs of

Table 1. Coffee production and yield trend in Kenya from 1961 to 2003 *

Year	Area (ha)	Production (Mt)	Yield (t ha^{-1})
1962	56,999	39,533	0.694
1965	83,391	45,867	0.550
1968	85,118	46,667	0.548
1971	86,155	59,949	0.696
1974	104,000	69,148	0.665
1977	119,055	88,618	0.744
1980	113,053	88,711	0.785
1983	138,542	97,333	0.703
1986	154,268	104,068	0.675
1989	154,167	116,500	0.756
1992	155,800	82,267	0.528
1995	165,533	91,092	0.550
1998	175,136	63,486	0.362
2001	170,000	66,800	0.393

Source: FAOSTAT
* Each value is mean of three years i.e. the year preceding and following the one indicated.

biologically fixed nitrogen (Sanginga *et al*., 1996) which would reduce external fertilizer inputs while conserving soil. LCC are also effective in controlling obnoxious weeds (Vissoh *et al*., 1998) which would be labour saving. The legumes are a source of food and fodder, an important attribute especially in the high population density areas with zero grazing dairy production system. Although legumes fed to animals may not directly contribute to coffee production, extra income generated from animal product sales can be ploughed into coffee production to offset input costs (fertilizer, labour or pesticides).

Legume cover crops have been used in soil management for plantations crops in Malaysia (Othman and Wan Sulaiman, 1992). They were initially used to provide cover against soil erosion in newly planted or replanted fields on steep terrain, and later to supply additional nitrogen. LCC reduce fertilizer requirements, but regular top dressing with phosphate fertilizer was required to establish and maintain the legume cover (Othman and Wan Sulaiman 1992). Phosphate fertilizer applied at 20 kg P ha^{-1} improves legume cover establishment in many Kenya soils (Mureithi *et al*., 2000).

Coffee - LCC and food legumes (dry beans, soy beans, dolichos) intercrops have been tested on-station at the Coffee Research Foundation (Ruiru) but have not been disseminated to the small holder farmers. Perennial legumes have been tested as cover crops but some have been found to compete for nitrogen and water with coffee. Leguminous food crops can be intercropped with coffee during establishment (Mwakha, 1980) or change of cycle to provide crop cover. Dual purpose annual cover crops like Dolichos (*Dolichos lablab/lablab purpureus*) and velvet bean (*Mucuna pruriens*) can be attractive to farmers who may want to grow food crops in rotation to cover crops under coffee. In highly infertile areas hardy legumes like *Canavalia ensiformis* (Jack bean) may be useful. Perennial cover crops like silver leaf Desmodium (*Desmodium uncinatum*) may be attractive to farmers who have large farms and are interested in fodder production without reseeding often. Multi-purpose LCC has high chances of adoption and integration in existing farming systems (Vissoh *et al*., 1998). Presentation of a range of LCC that are likely to meet a range of needs is likely to interest a wider range of farmers.

Project goal

The goal of the proposed research is to evaluate annual LCC performance under coffee and to incorporate the best-bets as cover crops into small holder coffee production systems mainly to conserve soil and water, improve soil fertility and reduce weeding labour in.

Specific objective 1: - Socio- Economic survey-: Investigate the critical socio-economic and agronomic factors associated with soil fertility and weed control in smallholder farms

To achieve the above the following activities will be done.

a) Stakeholders workshop
b) Initial Rapid Rural Appraisal (RRA)
c) Detailed Participatory Rural Appraisal (PRA) of the rural communities in the selected areas representing the smallholder coffee farming systems in the area.

Specific objective 2 - Setting of on-farm field trials/ demonstration sites.

The work will be carried out in Murang'a and Maragua district of Central Kenya. The project will be done in 3 sites representing UM1, UM2, UM3 agro-ecological zone. Each site will have five contact farmers selected during the PRA. Each farmer will be a replicate. The contact farmers will donate the land with the agreement that the site will be used as a learning demonstration sites. The legumes will be planted at the beginning of cropping system. Legume cover crops (LCC) to be used will include *Lablab purpureus, Mucuna pruriens, Crotalaria ochreleuca and Canavalia ensiformis*. Food legume crops will include *Glycine max, Vigna unguiculata and Phaseolus vulgaris.*

Outputs

- Linking up stakeholders (extension, researchers and farmers) and sharing information on the potential of LCC in small holder coffee cropping systems.
- Legume cover crops suitable for coffee cropping systems evaluated.
- Small holder coffee farmers sensitized in use of LCC for soil conservation, soil fertility and weed control.
- Up-scaling popular coffee-LCC-food production systems for soil conservation, soil fertility and weed control management
- Trained agricultural extension staff and farmers
- Information disseminated

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Green manure legume seed production: Efforts of the Legume Research Network Project (LRNP)

C.O. Nekesa, and J.G. Mureithi

Introduction

Many farmers face urgent problems of making sure there is enough food for their families for the whole year and earn sufficient income from the farm. Population growth and the increasing size of towns mean that the amount of land available to grow food for each family is decreasing. Yields are not always high, cost of artificial fertilizers and chemicals are high and feeds for livestock are becoming more expensive. Legume cover crop technologies can alleviate these problems. The LRNP has developed promising LCC technologies and demand for legume seed is on the increase.

LRNP members are bulking seed of legume species that have potential for seed production in their agro-ecological zones to meet the seed demand. At the LRNP sites, legumes are bulked in clean seed bed. They are planted in rows to ease operations like weeding and harvesting. Legumes that have a climbing habit are trellised to increase seed production and for ease of hand picking. Table 1 shows some of the GML species bulked by sites. The LRNP seed store is in one of KARI-NARL old labs that have been rehabilitated into an office, sorting area, seed testing lab and a store. All the seeds received at the store are handled as shown in figure 1.

Once the seed is received it is sorted out to get rid of foreign material and dirt. It is then weighed and dusted using actellic super to protect it from pest attack. The seed is currently kept in large polythene bags but advice on better storage bags is being sought from Gene Bank of Kenya. Before the seed is kept in the store its germination percentage is determined. Regular seed testing is done once every 2 months.

Table 1. Some of the GML species bulked

Scientific name	Common name	Scientific name	Common name
Canavalia ensiformis	jackbean	*Neontonia wightii*	glycine
Crotalaria juncea	sunnhemp	*Phaseolus coccineus*	butter bean
Crotalaria ochroleuca	Tanzanian sunnhemp	*Phaseolus lunatus*	lima bean
Clitoria ternatea (L.)	clitoria	*Phaseolus vulgaris*	common bean
Desmodium intortum	greenleaf desmodium	*Stylosanthes guianesis*	stylo
Desmodium uncinatum	silverleaf desmodium	*Vicia benghalensis*	purple vetch
Glycine max	soyabeans	*Vicia dasycarpa*	lana vetch
Lablab purpureus	dolichos rongai	*Vicia sativa*	common vetch
Lupinus luteus	sweet white lupine	*Vicia unguiculata*	cowpea
Macroptilium atropurpureum	siratro	*Vicia villosa*	hairy vetch
Mucuna pruriens	velvet bean	-	-

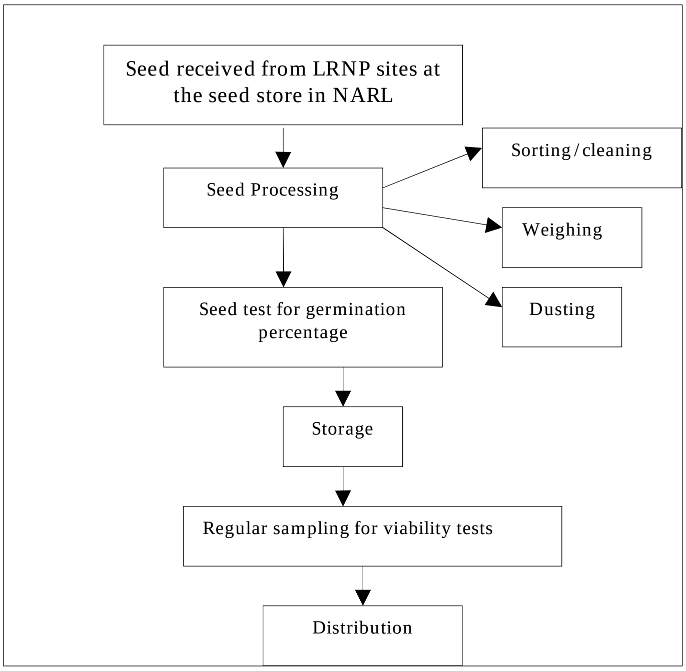

Figure 1. Steps in handling legume seeds at the seed store

Between 1999 and 2001, the total amount of seed received in store did not exceed one ton but in 2004 the amount of seed received was about 1700 kg (Figure 2).

Seed supply

The legume seed is supplied to network members, companies, NGOs, institutions and farmers. Non network members pay a small fee for quantities exceeding 5 kilos to KARI- NARL to cater for some of the production costs. The seeds are packed mostly in plastic bags labeled with information about the variety, quantity and accompaniment letter. The seed is usually requested for various uses which include, testing as cover crop for soil fertility improvement, soil erosion control, control of weed e.g. Striga, to plant for livestock feed, human food and in some cases to control pests like nematodes.

Way forward

Seed production is a continuous exercise and will continue in all LRNP sites to meet the high demand of the legume seed. The network is also encouraging sites with comparative advantage of bulking certain legume species to bulk. Some legume seeds are reported to have very low germination percentage in the field despite having good laboratory germination percentage. A study to investigate soil pathogens likely to cause the low germination and identify any seed borne pathogen is proposed. When the viability of the seed in the store falls below 40 percentage the seed is planted (i.e. rejuvenated) and fresh seeds are placed in the store.

Legume seed status at the LRNP seed store
The amount of seed received, issued out and in storage by June 2004 are in table 2.

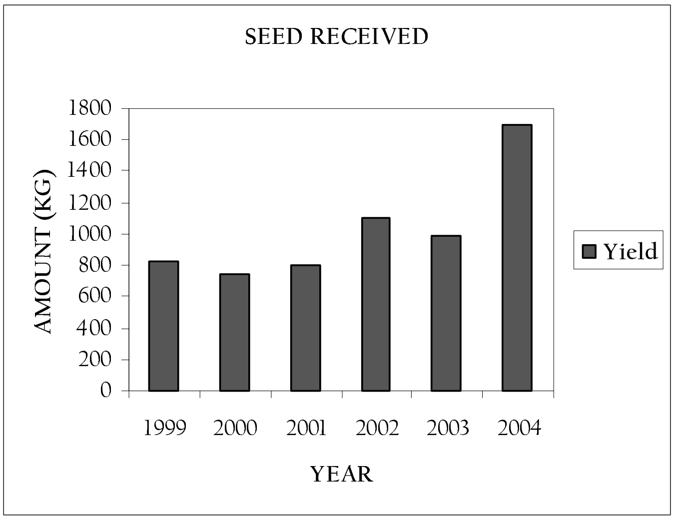

Figure 2. Seeds received from sites for the last 6 years

Table 2. The amount of seed received, issued out and in storage by 31st December 2004

Species	Amount of seed from sites (kg)	Amount of seed issued out (kg)	Amount of seed in store (kg)
Canavalia ensiformis	587	377	210
Crotalaria juncea	20.5	16.8	3.7
Crotalaria ochroleuca	277.5	247.5	30
Desmodium unicinatum	19.7	15	4.7
Desmodium intortum	17.6	11.3	6.3
Glycine max	64.6	1.8	62.8
Lablab purpureus (Brown	474	365	109
(Black)	51.2	51.1	0.1
Phaseoulus lunatus	77	69.3	7.7
Macroptilium atropurpurem	88.1	84.1	4.0
Mucuna pruriens (White)	1591.4	1351.4	240
(Black)	456.5	453.4	3.1
(Mottled)	13	2.0	11.0
Stylosanthanes	19.3	10.8	8.5
Neontonia wightii	75.3	69.3	6
Vigna unguiculata: (Cowpea K80)	20.5	19	1.5
(Cowpea M66)	34	30.4	3.6
Vicia villosa	11.8	11.7	0.1
Phaseolus coccineus (Black)	38.2	35.2	3.0
V (White)	29.3	28.3	1.0
Vicia benghalensis	27	18.5	8.5
Vicia dasycarpa	5.7	4.8	0.9

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NAIROBI, KENYA.