ISSN 0856-3128

Tanzania Agricultural

Research & Training Newsletter

VOL. XIX, Nos. 1-4 **DECEMBER 2004**

Published by the Ministry of Agriculture Food Security and Cooperatives
Department of Research & Training P.O.Box 2066 Dar es Salaam, Tanzania

CONTENTS

COVER PHOTO

Pigeon peans is among important grain legume crop as a source of protein and income. In the above photo (left) a scientist demonstrates how to use a hand operated machine which was designed for processing pegion peans. Right photo shows one of the improved varieties of pigeon peas.

P*hoto by the Courtesy of Mr. Salvatory Kundi, Principal Agricultural Research Officer, Agricultural Research Institute Ilonga, Tanzania*

The Tanzania Agricultural Research & Training Newsletter is published qauarterly by the Department of Research & Training, Ministry of Agriculture Food security & Cooperatives. The newsletter is a means of enhancing communication among Tanzania agricultural scientists, and disseminating scientific information especially recent research findings to relevant users. It is also used for publication-exchange programme with other scientific institutions within and outside Tanzania.

We invite contributions from the agricultural scientists and those of the allied sectors in Tanzania. Such contributions should be in form of short articles (800 - 3000 words), workshop/conference reports, illustration materials and news items that will help agricultural development in Tanzania. The articles should be original and authentic research findings or progress reports about on going projects.

Please send contributions or any enquiries to:

The Director of reseach& Training or the Editor, Research & Training Newsletter
P.O. Box 2066 Dar es Salaam, Tanzania
Tel: +255-22-2860326
Fax: +255-22-2865312
email: drt@kilimo.go.tz
Website URL: http://www.drd.mafs.go.tz

• • • • • • • • • • • • • • •

Editor: Richard Y. Kasuga
Typesetting & Layout: Richard Y. Kasuga

ISSN 0856-3128

Message from the Director of Research and Training

As 2004 came to a close, it is prudent to make a recap of important issues that transpired during the year which in one way or another have had impact on our research activities. Admittedly, the year was the most difficult financially because the Tanzania Agricultural Research Project (TARP II) which has been funding research over the last six years came to an end. This happened at the time when the Government was not fully prepared to absorb the financial gap that was caused by TARP II culmination. As a result the Department decided not to initiate new research activities but use the small funds available to maintain on going research projects.

Dr. J.M. Haki

However, there were many research projects whose funding was through collaborative arrangement which were not affected. Such projects included those under ASARECA networks and TARP II SUA.

It is commendable that despite financial difficulties the volume of activities that were undertaken was not affected because many research projects write ups were prepared by scientists which enabled them solicit funds from other sources. This provided scientists with opportunity to interact with other scientists abroad which created avenues for sharing experiences to a larger extent to improve knowledge pool in the department.

Despite these efforts, particularly the spirit that has developed amongst scientists, to find alternative sources of funds, to some extent the funds cannot be used to address problems that are unique to our country. This shows the importance to have funds from our budget that can be used to address national priorities. That is why; the government has seen this dilemma and reached a decision of increasing the budget allocation to research in the coming years.

It is also true that, the government budget alone can not be enough to finance big research investments such as infrastructures like those that were implemented under TARP II. In recognition of TARP II achievements, follow up activities under Agricultural Sector Development Programme (ASDP) is planned to carry out research in a wider scope.

Let me once again point out the importance of publishing research findings, by taking advantage the various existing national, regional and international publications such as journals, newsletters and conference proceedings. I would also like to assure you that the number of publications published will be among criteria for selecting the best scientists who will be rewarded.

In making sure that our research output are widely disseminated, in the coming years some funds will be set aside to facilitate scientist's participation in national, regional and international conferences for presentation of research papers. On the same weight, I take this opportunity to remind every scientist to contribute articles to the R & T Newsletter. In addition my department will continue to facilitate and meet the costs of printing all documents authored by our scientists. Any manuscripts for books, booklets should be forwarded to my office for possible scrutiny and consideration for printing support.

In winding up my message, let me convey my sincere appreciations to all scientists and technicians who will have reached retirement age in the coming year. It was a great hour and privilege working with you and for that matter the contributions you have made through out your service in the public office is a treasure to all of us behind and we shall be following on your footsteps. I wish you every success in your life outside the public service.

And for those scientists who have just joined the research system I take this opportunity to welcome you all and will do our best to make your stay enjoyable. I understand there could be some difficulties as your begin your new career, but with commitment and patience, I am certain we will all move together in our endeavour to revolutionalise agriculture through research.

With that note, I wish all of you every success in your research agendas.

Dr. Jeremiah.M. Haki, PhD
Director, DRT

New Released Crop Varieties of Cassava, Beans, Maize and Wheat

New varieties of cassava, common beans, maize and wheat were in December 2004 officially released for production in farmer's fields. This was as a result of a thorough evaluation of their performance in on-station and on-farm experiments. Normally a variety qualifies for release when it has shown outstanding performance for at least three years of on-station and one-year in on-farm trials.

During on-farm experimentation, in addition to yield, disease and pest data, the variety must undergo farmers' preference tests, which are considered necessary for acceptability and adoption. It is also mandatory to collect information on Distinctness, Uniformity and Stability (DUS), a test that is performed by the Tanzania Official Seed Certification Institute (TOSCI). Any variety to quality for release it must be proven beyond doubts that it is Distinct, Uniform and Stable.

The release of new crop varieties is the responsibility of the National Variety Release and Seed Certification Committee, which meets annually. Below is a synopsis of the characteristics of the newly released varieties.

Cassava

Two cassava varieties namely, Kiroba and Hombolo 95 were released as a result of an intensive breeding scheme of the Sugarcane Research Institute, Kibaha and Agricultural Research Centre, Hombolo. The aim of the breeding programme was to obtain cassava varieties, which produce high yields with resistance to pests and diseases, especially those caused by virus. Other important aspect was to have varieties which have acceptable agronomic factors and that can be grown in wide range of environments.

Variety Kiroba

Major distinguishing characteristics of variety Kiroba are:

- tolerance to cassava mosaic disease (CMD),cassava brown streak disease (CBSD) and cassava green mite (CGM)
- it has high dry matter content
- it has medium maturity period of 8-10 months
- it has long ground storability of 8-12 months
- Its root biodegradation starts 7 days after harvesting

The variety is acceptable by consumers and farmers, producing yield as high as 27t/ha of fresh roots under optimum condition. It is recommended in lowlands with warm humid and sub-humid areas with an altitude range of 10-1000 m.a.s.l.

Variety Hombolo 95

The variety's major distinguishing characteristics are:

- tolerance to cassava mosaic disease (CMD), cassava brown streak diseases (CBSD) and cassava green mites (CGM)
- moderately drought resistance
- long in ground storability of 12-15 months
- high ability of leaf retention
- High dry matter content (29%)
- matures at 10-12 months
- Root biodegradation of 4 days after harvesting.

The variety is highly acceptable to consumers with yield potential of 18t/ha of fresh roots. The variety is recommended in highlands warm semi arid areas of Tanzania with altitudes above 1000 m.a.s.l.

Phaseolus bean varieties

Phaseolus bean varieties; *Uyole 04* and *BILFA 16* were developed at Uyole Agricultural Research Institute. The varieties are the result of efforts of the bean improvement program that has for many years emphasized on developing varieties with high yields and agronomic characteristics that are acceptable to farmers and consumers. The two varieties were released due to acceptable seeds type, palatability qualities and tolerance to some major bean diseases.

The ***Uyole 04*** is a semi climber with medium to large cream coloured seeds. It is tolerant to major diseases beans such as rust and anthracnose. The line cooks very fast and it is very palatable.

The recommended sowing dates would depend on the start and cessation of rains. For example in areas where rains end in April/May the recommended planting time would be early to mid March. In dry areas where irrigation is possible the recommended planting date is between April and July.

The recommended seed rate is 70-80kg/ha to attain a plant population of 200,000 plants/ha. The

variety is expected to attain maturity at105 days.

Uyole 04 has the potential to produce yield of 2.2 to 3.0 t/ha and between 1.5 to 1.8 t/ha in farmers' fields. It is recommended in the Southern Highlands zone (SHZ) with altitude range of 800-2000 m.a.s.l.

The variety BILFA has a red mottle colour, medium size plum seed that is tolerant to major diseases. green slightly small and abundant leaves; erect stem with 4-5 branches. Flowers are pink with white to cream pods at maturity. Seedlings are green whereas seeds have red kidney of medium size of 31-32g/100 seeds.

The recommended sowing dates are similar to Uyole 03. The variety has seed rate of 70-80 kg/ha, which is lower than Uyole 03 for the same plant population of 200,000 plants/ha. Urafiki matures at 80-84 days that is almost comparable to Uyole 03.

This variety is recommended in the Southern Highlands zone in areas with altitude range of 1000-19000 m.a.s.l. The potential yield of the variety ranges from 2.0 to 2.5 t/ha and between 1.2 – 1.5 t/ha under farmers management.

Maize

Variety UH6303: was released as a result of the Southern Highlands Maize Improvement Programme (SHMIP) efforts to ensure continued supply of genetically superior maize varieties in order to take advantage of the favourable agro-climatic conditions of the SH, for the benefit of maize growers in the zone.

The maize variety UH6303 was the second in a series of maize hybrids to be released to farmers in the Southern Highlands in areas where GLS is now an endemic problem.

On-station evaluation of UH6303 in several locations of SHZ vividly showed its superiority over a number of commercial maize hybrids currently on the market. The points of merit of the hybrid include the following:

- High grain yield potential and stability across varying environmental conditions
- High level of tolerance to Grey Leaf Spot disease.
- Good level of tolerance to Turcicum leaf blight.
- Semi-flint grain texture and therefore, good pounding ability.
- High consumer acceptability as demonstrated from farmer assessment during on-farm demonstrations.

The variety's distinguishing characteristics include white grain colour with semi-flint texture, a white cob, light pink of the silk, white tassels. The yield potential of UH6303 is 9-10 t/ha at recommended plant population of 45,000 plants/ha**.**

UH 6303

Wheat

Variety SIFA was developed by the Wheat Improvement programme of ARI- Uyole. The variety was accepted for release after demonstrating many superior qualities such as high yields and tolerance to diseases.

The variety has a potential of producing grain yields ranging from 4.5-5 tons/Ha and takes approximately 100 days to reach maturity. As far as diseases are concerned, the variety is tolerant to stripe and stem rust and *Septoria blotch*. The seeds are distinctively white and large, with good backing quality.

The variety is recommended to be grown in the Southern Highlands and Northern Zone within altitude of 1700-2300 m.a.s.l

VARIETY SIFA

Efficacy of botanical insecticides on *Sitophillus spp* on Maize in the Southern Highlands of Tanzania[1]

Mkoga, Z.J.; Shetto, R.M.; Mkomwa, S.; Mwakimbwala, R.; Kabungo, D.A. and Ndegeulaya, D.

Abstract

Locally prepared powders from leaves of Neem (Azadirachta indica),* Artemisia afra, Targetes minuta, Vernonia amygdalina, *and pods of* Pilliostigma thoningii, *tubers of* Neuratanenia mitis *and roots of* Zanha africana *were tested against free and natural infestation of storage insects of maize grain. The efficacy of the plant materials was compared to* Actellic *Super Dust, pyrethrum gist, pyrethrum marc and no insecticide treatments. The test materials were admixed with maize grains at a rate of 900g per 100kg of maize. The laboratory and on-farm experiments showed that all the materials had high potency against* Sitophillus spp. *The potency against* Sitophillus spp *infestation varied between 86.3 and 97.7 per cent. On-farm experiments showed inconsistent results whereby only* Zanha africana *maintained the efficacy against the common storage pests up to six months in storage. Other materials controlled insects for up to three months of storage after which they deteriorated beyond threshold limits. The experiments have indicated the potential of the materials as natural* protectants *against storage pests. However, further research on active ingredients,suitable formulation,appropriate extraction and procedures is needed to be able to make conclusions.

Introduction

Surveys conducted in the Southern Highlands of Tanzania indicate that between 42-80% of farmers use industrial insecticides for grain storage (Ashimogo1995; Nyangali *et al*., 1986; Mkoga and Shetto, 1995). However, many farmers do not use the insecticides at the recommended doses and formulation. Recent studies have revealed a declining use of the industrial insecticides in grain storage amongst farmers in the Southern Highlands. This could be attributed to among other things, the poor distribution systems, high prices and increasing availability of substandard storage insecticides in the market. Consequently some farmers have resorted to the use of natural plant materials in protecting their crops.

Plant materials, such as neem and pyrethrum extracts have been tested in other countries and found to be effective in protecting crops against some pests (Stoll.1996; Grainge and Ahmed, 1988; Van Huis, 1991; Raman *et al.,* 1987). In developed countries, research is based on transferring the valuable plant materials in laboratories for perfection and for industrial processing (Makokha, 1994).

Current efforts in Tanzania aim at exploring natural plant materials establishing safe methods and effective rates of application. Fourteen plant species with insecticidal properties have been identified as a result of a series of surveys in the Southern Highland of Tanzania (Mkoga *et al*., 1999). Laboratory and on-farm experiments were conducted in Southern Highlands to assess the efficacy of the plant materials based on farmers' formulations and practices. This paper presents results of this work and gives recommendations for further research.

Materials and Methods

Screening experiment

In the screening experiment, storage pests *Sitophillus spp* were used as test insects. Twenty insects were introduced in each set of treatment in Petri dishes with a mixture of 5g of plant materials and maize grain. The experiment was then set up in the laboratory at room temperature of about 26^0C in Randomized Complete Block Design with three replicates. Counts of dead and live *Sitophillus spp*. insects were recorded after 36 hours.

On-Station storage experiment

Fresh mature leaves or flowers were harvested, dried under shade and ground into fine powder. Tubers and roots were chopped, dried and ground. Pyrethrum marc was applied in the form in which it was collected. In each treatment, 5kg of maize admixed with plant materials were put in a small gunny bag. The plant materials were applied at a rate of 900g per 100kg of grain maize whereas Actellic super dust was applied at 100g per 100kg of grain maize. The trial was set and exposed to natural infestation in the laboratory and assessment done at 6, 8, 9 and 11 months. At each assessment, about 150-200 grains of maize were sampled and analysed for damage at the same time recording the number of live *Sitophillus*.

On- farm Experiment

A total of eleven on-farm experiments were conducted to assess the efficacy of some selected insecticidal plant materials in 22 villages in the Southern Highlands of Tanzania. The villages were sampled from Iringa, Mufindi, Njombe, Songea, Sumbawanga and Chunya districts. The type of treatments in each village was determined by the use and availability of

[1] Uyole Agricultural Research Institute, P.O. Box 400 Mbeya, Tanzania

plant materials in the locality. Fifteen locally prepared botanical insecticides were tested. *N. mitis* was the main plant material tested in which ten out of fifteen materials were made from tubers of *N. mitis.* The tubers were dug chopped, smashed, dried and then ground into fine powder.

The fresh leaves of neem and *Targetes minuta* were sun dried and ground to fine powder. In case of "Msegese" (*Pilliostigunia thorningii*) fresh pods were smashed, dried and ground to fine powder. Root Bark Powder of 'Livangavanga' (*Zanha africana*) was also used as one of the test materials. The efficacy of the plant materials was compared to Actellic super dust and insecticide free treatments. A total of 134 farmers were involved in on farm experiments. The treatments were put in 3kg packets of gunny bags at a convenient place in the farmer's field under natural infestation. Assessments were made every 3 months of the storage period.

Data Analysis

Means of the efficacy of materials in different locations were determined. The proportion of damaged grains and counts of dead and live insects were subjected to Arcsine and Square Root Transformation to normalize the variances. Data were subjected to analysis of variance (ANOVA) and mean separation was also done using Duncaris multiple range test.

Results and Discussion

The laboratory screening indicates that all the plant materials killed the storage pest, *Sitophillus spp.* The materials that performed well were neem (97.7%), *N. mitis* (Ng'andangolo), (92.3%), (Nyongwe) (90.7%), *V. amygdalina* ('Isogoyo) (80.7%) and pyrethrum marc (86.3%). However, "Likumbanguluwe" whose taxonomic identity is not yet known had the poorest performance (39.7%) Most plant materials were less effective in controlling *Sitophillus spp* in the on-farm experiments. The plant materials controlled grain damage and insect infestation only up to three months in storage. However, grain damage and insect infestation was low even in the insecticide free treatment.

Treatment consisting of *Zanha africana* powder maintained its effectiveness and controlled grain damage of *Sitophilus spp* up to sixth month in storage. There was generally no significant difference ($P<0.05$) in grain damage and live infestation of plant materials tested on-farm.

There were differences in effectiveness of botanical insecticides in controlling maize weevils between on-farm and on-station experiments. Results of most materials were promising in the on-station compared to on-farm trials. This may be due to better controlled conditions available on-station as opposed to the on-farm set-up.

For example materials used in on-station experiments were well ground and sieved. Whereas materials used in on-farm experiments were prepared by farmers using local facilities and may not have been finely ground. On the other hand the efficacy of *N. mitis* extracts varied widely in the on-farm experiments. Different strains of plant species, time and place of harvest may have influenced the variation in the efficacy of the materials. This is because the concentration of active ingredients in most botanical materials differs with climate, time and stage of growth (Verd Court and Citrump, 1969). The other reasons may include improper preparations and over due shelf life.

Neem leaves powder performed poorly probably because they contain less Azadirachtins than neem seeds (Tierto Niber et al. 1992). Cobbinah and Appiah – Kwarteng (1989), reported that neem leaf is a poor protectant of maize against maize weevils (*S. zeamais*).Similar results were reported in the control of *Plutella xylostella* in cabbage (Przybyszewski,

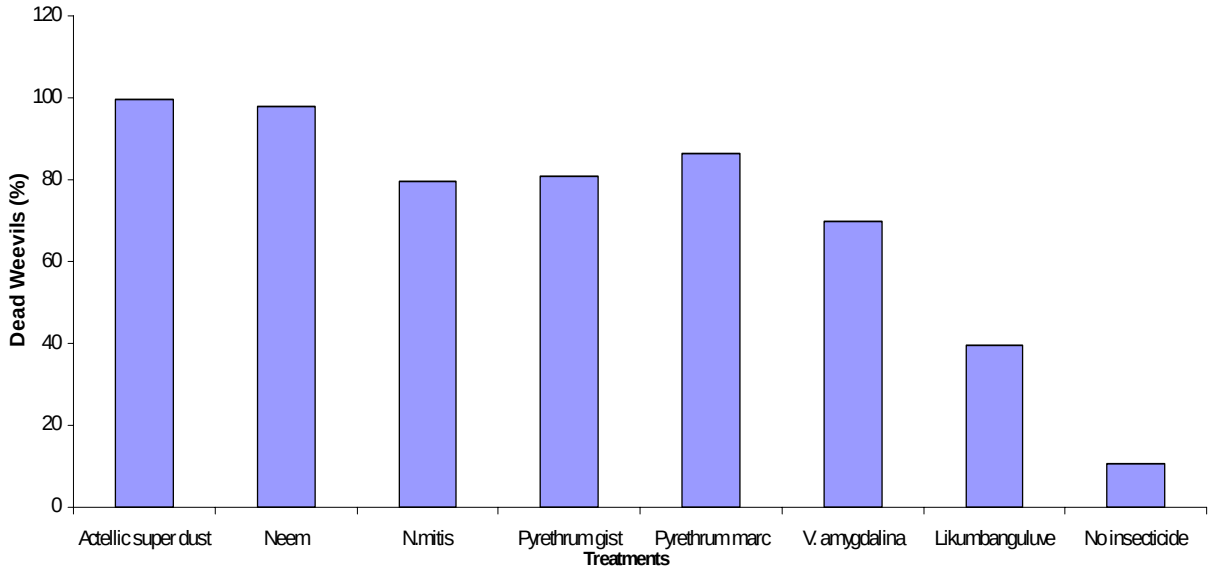

Fig. 1 Percentage of dead weevils in the screening laboratory experiment

1993) and other vegetable.Powders made from root barks of *Z. africana* was highly efficacious. However, use of this material is limited because extraction of roots entails killing of the plants, which take many years to establish. In that case several plants may need to be cut down to produce enough powder to protect a few bags of grain.

Conclusions and Recommendations

This study has confirmed the potential of botanical insecticides in the control of storage pests. However at this point there is no concrete conclusion that can be given because there is still a lot to be done to answer the pertinent questions on the materials. This work has only provided indicative results on the effectiveness of the materials, identified potential materials and issues for further research. Further investigation is required to get convincing results on the use of *P.thorningii* in grain storage. Further experiments on the use of neem in grain storage need to emphasize on neem seed extracts as they have proved to be relatively more effective. Among the questions needing further investigation include: At what stage of growth is most appropriate to harvest the active part of plant? What are the most active modes, rates and application methods? What could be the safest preparation and application procedures? Above all studies are required on the quantities and qualities of active ingredients including toxicology, health hazards, safety to human beings and environmental impacts.

Acknowledgements

We are indebted to the International Development Research Centre IDRC, Nairobi office, International Fund for Agricultural Development-Southern Highlands Extension Research and Financial Services Project (IFAD – SHERFSP) and Tanzania Agricultural Research Project Phase II (TARP II) for their financial support. Gratitude are also due to D. Ndegeulaya, W. Tegambwage, L. Mwabenga for their role in data collection. Last but not least, we would like to extend our appreciations to the farmers and every one who in one way or another contributed to the success of the study.

References

Ashimogo G. 1995. Peasant grain storage and marketing in Tanzania: A case study of Maize in Sumbawanga District. Ph.D. Thesis, Berhin University, German. pp. 369.

Cobbinah J.R. and **Appiah-Kwarteng J.** 1989. Effects of some neem products on stored maize weevil, *Stophilus zeamais* (Motsch). Insect Science Applications 10: 89 - 92.

Grainge M. and **Ahmed S.** 1988. Hand book of plants with pest-control properties. John Wiley & Sons, New York, N.Y., 1 – 470

Makokha F. 1994. West's "Bio-Pirates" are costing Africa millions in lost species revenue. In: The East African, Regional News, December 5 – 11, 1994, pp. 6.

Mkoga Z. J. and **Shetto R. M.** 1995. Post harvest grain systems project (Tanzania). Centre File: 3-p-88-0305. Final report submitted to IDRC, Nairobi, pp. 41.

Mkoga Z. J., Shetto R. M., Kabungo D.A. and **Ndegeulaya D.** 1999. An inventory of insecticidal plants for field crops and grain storage protection in the Southern Highlands of Tanzania.

Nyangali E. E., Wandema F. S. and N**gonyani H. K.** 1986. Evaluation of food storage at household level in Rukwa Region. Tanzania Food and Nutrition Centre (TFNC) Report No. 1035. Dar es salaam.

Przybyszewski, J. 1993. The use of neem seed and leaf extracts to control lepidoptera pests of cabbage in Kaedi Mauritania, West Africa. Tropical Science 33: 217 – 225.

Raman K. V., Booth R. H. and **Palacios M.** 1987. Control of potato tuber moth *Phthorimaea operculella* (Zeller) in rosticpotatostores. Trop. Sci. 27: 275-194.

Stoll G. 1996. Natural crop protection in the tropics. Margraf Verlug, Weikersheim, Germany. pp.188.

Tierto Niber B., Helenivs J. and **Varis A.L.** 1992. Toxicity of plant extracts to three storage beetles (*Coleoptera*). Journal of Applied Entomology, 113: 202 - 208.

Van Huis A. 1991. Biological methods of bruchid control in the tropics: A review. Insect Science Applic. Vol 12.No. 1/2/3: p.87 – 102.

Verd Court B. and **Citrump E.** 1969. Common poisonous plants of East Africa. Collins. St. James Place. London.

Effects of Storage Period on Seed Viability and Germination Capacity of Rice Cultivars in Tanzania

Z.L. Kanyeka[1]

Abstract

The aim of the study was to investigate the effects of storage period on the seed viability and germination capacity of landraces and improved rice cultivars. Four landrace namely "Kihogo", "Afaa Kikanganga", "Shingo ya Mwali" and "India Rangi"; four improved cultivars namely Line 88, TXD 85, Jaribu 220 and Supa were used in the study. The viability and germination capacity of the rice cultivars was monitored at an interval of 1-2 months, for the storage period of 3 - 12 months after harvesting (3-12MAH). Significant differences (0<0.001) among cultivars were revealed for germination capacity over the storage periods. Combined Analysis of variance of four storage periods (3, 6, 7 and 8MAH) showed statistical differences (P<0.05) among cultivars, storage periods and their interactions (P<0.001). The mean germination capacity of 6, 7 and 8MAH storage periods were statistically higher than that of 3MAH. The trends of germination capacity of improved cultivars over storage periods were more diverse than the landraces. Cultivar Supa had maximum and constant maximum germination capacity whereas Jaribu 220-1-3-3-1 had the poorest germination capacity, loosing its viability within 5 months in storage. The landraces maintained their maximum germination capacity even under longer storage period (5-11month) than the improved cultivars (5-9months).

Introduction

Cultivating an estimated 0.5 million ha of rice area, Tanzania is the major producer and consumer of rice in the continental Eastern, Central and Southern African (ECSA) region (FAO, 2001). Smallholder farmers cultivate over 90% of the rice area, largely in rain fed lowland (74%) and upland (20%) ecosystems . After harvesting, the rice crop is normally stored under normal storage conditions for at least 6-8 months.

The duration of seed viability of domestic crops is a function of genotypes, dormancy mechanisms and storage conditions. The conditions under which the seeds are stored always influence their viability and germination capacity (Campbell et al 1997, Gardner et al., 1985). In case of grain legumes, seed viability is lost rapidly when stored in humid air temperatures of 35^{o}C and above (Salisbury and Ross 1992).

Rice seed induces dormancy in the process of seed formation which takes some time before it is ready for germination. After maturity the dormancy period differs greatly according to cultivars and strains. These differences in the speed of seed germination are hereditary and the factors responsible for that vary with aging of the seeds (Takahashi, 1997). For the newly harvested rice crop, the difference in germination is attributed mainly to the embryo and the seed coat (hull) (Sheshu and Sorrells, 1986). However, in storage, the difference in germination is only caused by the seed coat (hull) factors (Takahashi 1962; Tomar, 1984; Das 1985).

This study is part of the on-going research on the diversity and genetic variability of rice germplasm available in Tanzania. It was undertaken to provide a clear understanding of the effects of storage periods on viability and germination capacity of the rice cultivars.

Materials and Methods

Germination capacity and viability of eight rice cultivars comprising of two groups were monitored for the period of twelve months in storage starting with three months after harvesting (3MAH). The first group comprised of four landraces; "Kihogo Red", "Shingo ya mwali", "Afaa kikanganga" and "India Rangi". The second group consisted of four improved cultivars, which are Line 88, TXD 85 Jaribu 220 and Supa.

The experiment was conducted in the laboratory of the Department of Botany of the University of Dar es Salaam from September 2000 to October 2001. In the laboratory, the cultivars seed lots were stored at the normal storage conditions with temperatures ranging from 24-28^{0}C. The germination capacity of the cultivars was monitored at 1 - 2 months-intervals for 12 months.

The cultivars were seeded in petri dishes lined with mesh cloth. For each cultivar, twenty-five seeds arranged in five lines were sown in each petri dish. The experiment was conducted in a Completely Randomized Block Design (RCBD) with three replicates. Seeds were watered twice a day with distilled water until the seventh day after germination. At the 4th and 7th day after seeding, the numbers of germinated and un-germinated seeds were recorded in each petri dish and the data was used to determine the germination percentage of the cultivars: using a

[1] Department of Botany, University of Dar Es Salaam P.O. Box 35060, Dar Es Salaam Tanzania.
E-mail: *zkanyeka@yahoo.com or kanyeka@botany.udsm.ac.tz*

caliper, length of radicles and plumules of five randomly selected germinated seeds in each Petri dish was also measured. These were recorded at 4MAH and 7MAH storage periods.

Analysis of Variance of germination capacity (percentage) of the cultivars for the data recorded at 7 days after seeding was separately carried out for each storage period. A Combined Analysis of Variance of germination capacity for four storage periods (3, 5, 7 and 8 MAH) was also done.

Means of germination capacity (percentage), length of radicles and plumules were compared using Duncan Multiple Range Test (Gomez and Gomez 1987).

Results

The effect of storage periods on germination capacity was highly significant ($P<0.001$) among the rice cultivars. Results for the combined analysis of variance of four storage periods (i.e. 3, 6, 7 and 8 MAH) revealed significant differences ($p<0.05$) among cultivars and highly significant statistical differences ($p<0.001$) among the storage periods and their interactions. These results indicate that germination capacity of both the landraces and improved rice cultivars were influenced by rice genotypes and storage periods. The dependence of germination capacity of cultivars on storage periods is also reflected in the mean germination percent of the cultivars in the four storage periods (3, 6, 7 and 8 MAH). The mean germination capacity of the cultivars showed no significant differences among the long storage periods of 6, 7 and 8 months against the short storage period of 3 months after harvesting.

Trends of germination capacity of the rice cultivars across storage periods

Figures 1a, 1b, 2a and 2b show the germination trends of the two groups of rice cultivars as compared with the storage periods. Irrespective of whether the germination data was recorded at 4 or 7 days after seeding the two groups of rice cultivars had different patterns of germination capacity across storage periods.

Improved rice cultivars

Germination capacity of all the improved cultivars except Jaribu 220 increased with increasing storage periods. At 7 days after sowing (7DAS), the germination capacity of the cultivar Supa had the lowest rate. The germination capacity of the cultivar increased from 80 per cent at 3MAH to a maximum of 98 per cent at the 11th month of storage. In this case cultivar Supa had a constant germination capacity across the storage period which is advantageous to rice farmers who for various reasons delay sowing of the crop.

Of the three progenies derived from crosses involving variety Supa as one of the parents, Line 88 had the highest rate of germination, increasing from 36 to 100 per cent in six months (Fig.2a). For both germination data recorded at 4 and 7DAS, the germination capacity of Jaribu 220 decreased drastically at three months (3MAH) in storage and completely lost its viability at six months of storage period (Fig. 2a & b). This drastic loss of germination capacity may possibly be due to high moisture content at harvesting and poor storage condition of the seeds.

Germination data recorded at 7DAS (Fig. 2b) revealed that improved cultivars except Jaribu 220 attained their maximum germination capacity between 5-9 months of storage. This period coincides with rice-planting period that starts in December and ends in February.

Landraces

Landraces had similar trends of germination capacity over the storage periods for data recorded at 4 and 7DAS (Fig. 1a & b). Germination data recorded at 4DAS, germination capacities of all landraces were increasing from 3MAH to 11MAH. (Fig1b).

The trend changed for germination data recorded at 7 DAS (Fig 1a). At 3 months of storage (i.e. 3MAH), landraces had statistically different germination capacity whereby "India Rangi" and "Afaa Kikanganga" recorded the highest and lowest capacities respectively. From the 5^{th} to 11^{th} months in storage, the germination capacity of all landraces leveled and subsequently decreased at varying degrees. "Shingo ya Mwali" and "Afaa Kikanganga" recorded the lowest germination capacities at 12MAH (Fig1a).

Discussion

Comparing the two groups of cultivars, the improved cultivars showed more variable germination capacity than the landraces, which can possibly be attributed to the selection advantage and adaptation in the country's rice ecosystems. Additionally, the landraces retained their maximum germination capacity for a longer storage period (i.e. 5-11 months) compared to the improved cultivars (5-9 months).

Such characteristics have allowed farmers to sow the landraces late in the season without affecting germination and crop establishment of direct-seeded rice in rain fed lowland ecosystems. In the rain fed lowland rice ecosystems, farmers usually direct seed. The above characteristic of the landraces has enabled late sowing without affecting germination or crop establishment.

Optimum seed germination and seedling establishment of the rice crop also depend on seed quality and moisture content of seeds in storage. The period of storing rice seeds of 6-7 months seems to coincide with the maximum germination capacity of most landraces and some improved cultivars grown by farmers.

Conclusion

Generally, depending on the seed quality at harvesting and seed moisture content at storage, farmers sow their rice seeds 6-7 months of storage after harvesting. This storage period seems to coincide with the maximum germination capacity of all the landraces and the improved cultivars, except Jaribu 220.

There is also a need to confirm the results obtained for an elite line Jaribu 220 in this study. It is also appropriate to monitor the germination capacity of these groups of rice cultivars beginning soon after harvesting so as to determine the degree of dormancy of the cultivars.

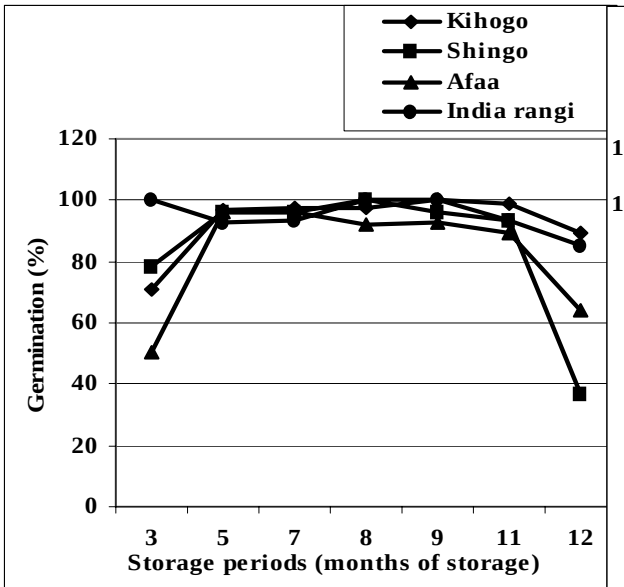

Figure 1a. Germination capacity of landraces over storage periods (7DAS)

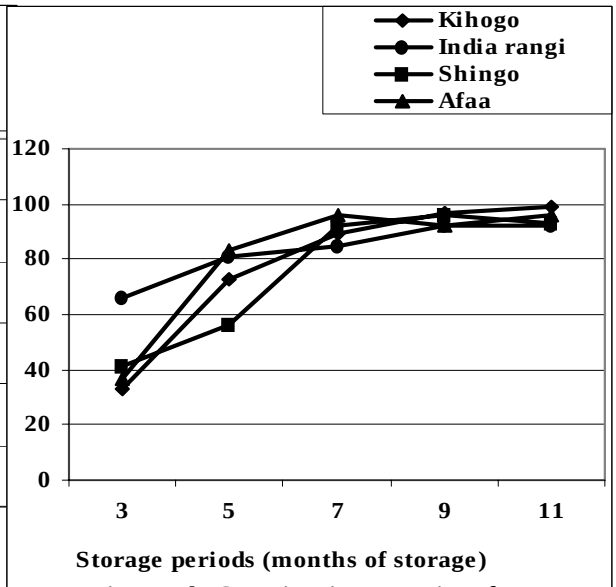

Figure 1b. Germination capacity of landraces over storage periods (4 DAS)

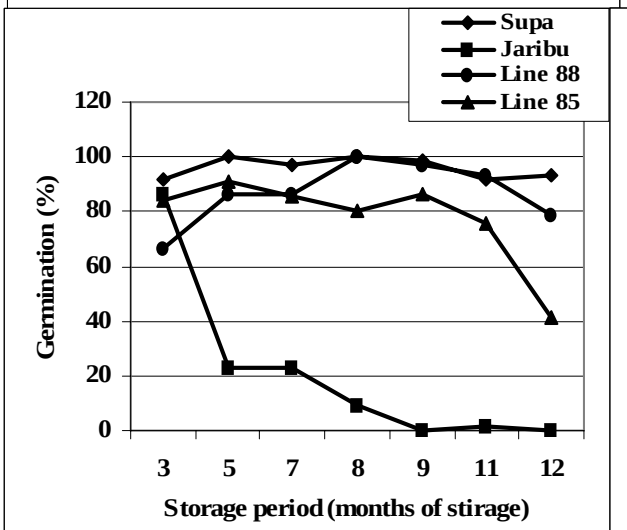

Figure 2b. Germination capacity of improved cultivars over storage periods (7DAS)

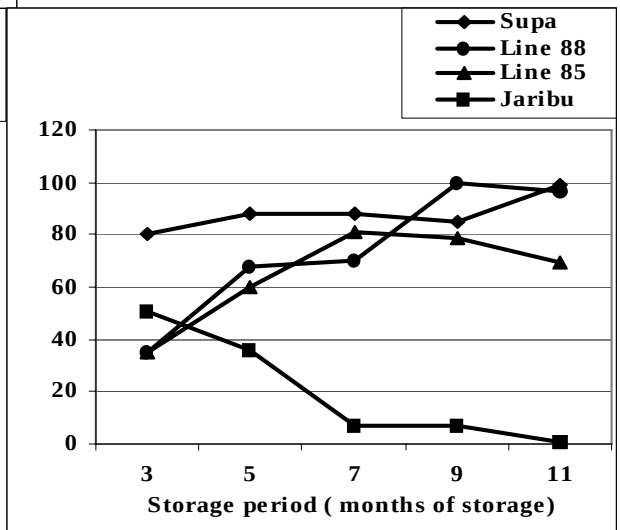

Figure 2a. Germination capacity of improved cultivars over storage periods (4DAS)

References

Campbell, N.A., Mitchell L.G and J.**B. Reece** 1997. Biology; Concepts and Connections. Addison and W. Longman Inc., New York

Das R.C. 1985. Role of hull in inheritance of seed dormancy in rice. Exptl. Genetics 1(2): 119-125.

FAO 2001. Bulletin of Statistics: 8 ½ FAO Rome, Italy..

Gardner, F.P., Pearce, R.B. and **R. Mitchell** 1985. Physiology of crop plants. 1st ed. Iowa State University Press, Ames.

Gomez, K.A and **A.A Gomez** 1984. Statistical procedures for agricultural research. 2nd ed.John Wiley & Sons,Inc.USA.

Sheshu, D.V. and **M.E. Sorrells,** 1986. Genetic studies on seed dormancy in rice. IRRI (ed.), Rice Genetics, pp: 269-382.

Takahashi, T. 1997. Inheritance of seed germination and dormancy. In Science of the Rice Plant Genetics. Vol. 3. Eds. T. Matsuo et al 1997. FAO Policy Center, Tokyo

Takahashi, T. 1962. Physio-genetical studies on germination of rice seeds with special reference to its genetic factors. Bull. Inst. Res. Tohoku University 14|:1-879 (J)

Tomar, J.B. 1984. Genetics of grain dormancy in rice (Oryza sativa L.) Genetica Algeria. 38(4):443-446.

Performance of progenies of Brazilian dwarf cashew clones in Southern Tanzania[1]

P. A. L. Masawe, S. Mfune and Z. Mbunda

Abstract

Halfsib progenies of three Brazilian dwarf cashew clones were tested for their yield potential and nut quality at Nachingwea in the Southern part of Tanzania. Yield and vegetative data were recorded for a period of four years. Results show that yield and nut quality of CP09 progenies is superior among the Brazilian dwarf genotypes. Nine halfsib progenies which were identified to have promising results in the trial have been earmarked for further evaluation.

Introduction

In recent years, cashew (*Anacardium occidentale* Linn) has become an important export crop and source of revenue for many Tanzanians. Unfortunately most cashew trees in farmers' fields constitute unselected seeds of common cashew types (Masawe 1990; Mneney and Mantell 2002).

Cashew trees are highly heterozygous in their genetic makeup leading to variation in yields among cashew trees (Mneney and Mantell 2002; Ohler 1979; Foltan and Ludders 1995). Vegetative propagation in cashew started in 1990 (Bashiru 1997), to replace seed propagation which is the dominant method in most cashew growing countries. Recently Cashew Research Programme at ARI Naliendele acquired improved cashew clones and hybrids developed from the local and exotic germplasm.

Dwarf cashew allows high-density cultivation resulting into higher yields per unit area. High density cultivation reduces farm operations such as pruning, control of insect-pests and diseases which could be very expensive (Barros *et al*., 1984; Almeida *et al*., 1993; Cardoso *et al.*, 1998). Most importantly dwarf cashew clones have big nuts which fetch high prices in the market.

The identification of high yielding dwarf cashew trees is useful in improving the nut quality of the existing local germplasm. This paper presents the performance of the half-sib progenies of the Brazilian dwarf and suggests promising ones for further evaluation in the advanced germplasm trials.

Materials and Methods

Seeds of Brazilian dwarf clones namely CP06, CP09 and CP1001 were raised in polythene bags for five weeks and the seedlings transplanted in March 1993. The design was 4x4 Latin square, 2 replicates, at a spacing of 7 m within rows and 7 m between rows with eight trees per plot. A local selected cashew clone AZA2 (Plates 1a-c) was used as control in this experiment.

Data on yield and vegetative measurements were recorded from 1998 to 2001. The data on height and canopy diameter used in the analysis were recorded in 2002 season. Nut picking and weighing from each tree was carried out daily from September to December of the review period. Statistical data analysis was conducted using SAS software package.

Results and Discussion

There was significant yield difference (P=0.005) between replicates in the four years of observation. However, the difference between clones on nut and kernel weight, percentage kernel weight and height was not significant. Overall, the yield performance of genotypes AZA2 (3.77 kg/tree) and CP09 (3.42 kg/tree) was the most outstanding. The genotypes had same performance on the nut and kernel weight and percentage kernel weight. These results reveal that genotype CP09 is more promising among the Brazilian dwarf genotypes.

The assessment of individual progenies within genotypes based on nut weight above 7g, kernel weight above 2g and percentage kernel weight greater than 25 per cent shows that five progenies of genotype CP09, three progenies of genotype CP1001 and only one progeny of genotype CP06 performed the best in the trial.

Conclusion

The progenies from genotypes CP09, CP1001 and CP06 showed promising performance in yield, nut weight, and kernel weight. These materials will be further evaluated in the advanced yield trial. Since yield was based on single tree performance, the materials will be evaluated to determine genetic and environmental influence on yield potential.

Plate 1a. A young flush of genotypes AZA2

[1] Naliendele Agricultural Research Institute, P.O. Box 509 Mtwara, Tanzania;
Email: utafiti@makondenet.com

Plate 1b. An inflorescence of genotypes AZA2

Plate 1c. Mature apples of genotype AZA2

References

Almeida J. I. L., Araújo F. E. and **Lopes J. G. V.** 1993. Evaluçao do cajeiro anão precoce na Estação Expermenta de Pacajus, Cearã (Evaluation of early dwarf cashew at Pacaju Experimetal Station). Tanzania

Barros L. M., Araújo F. E., Almeida J. I. L. and T**eixeira L. M. S.** 1984. A culturaa do cajeiro anão) dwarf cashew crop). EPACE Document 2. Fortaleza –CE Brazil.

Bashiru R.A. 1997. Studies on vegetative propagation methods of cashew in Tanzania. *Proc. Int. Cashew and Coconut Conference* Tanzania. Biohybrids Int. Ltd Reading, UK, 302-308.

Cardoso J. E., Cavalcanti J. J. V., Cavalcante M.de J. B., Aragão M.do and **Felipe E.M.** 1998. Genetic resistance of dwarf cashew (*Anacardium occidentale* L) to anthracnose, black molds and angular leaf spot. Crop Protection 18 (1999): 23-27.

Foltan H. and **P. Ludders,** 1995. Flowering, fruit set and genotype compatibility in Cashew. Angew. Bot 69, 215-220.

Masawe P. A. L. 1990. The need for an improved cashew genetic base in Tanzania. Plant Genetic Resources and Biotechnology. Proceedings of the first workshop held at Arusha, Tanzania, January 16-20, 1990.

Mneney E. E. and **Mantell S. H.** 2002. Clonal Propagation of cashew (*Anacardium occidenatle* L.) by tissue culture. Journal of Horticulture & Biotechnology, (200) 77 (6): 649-657.

Ohler J.G. 1979. Cashew: *Communication No. 71*. Department of Agricultural Research of the Royal Tropical Institute, Amsterdam.

Progress of Agricultural Sector Support Programme (ASSP)

Background

In order for the Agricultural Sector Development Strategy/Agricultural Sector Development Program (ASDS/ASDP) to be operational, the Agricultural Sector Lead Ministries (ASLMs) appointed Multi-stakeholder Task Forces (MTL) in early 2003. These were Task Force 1 (TF-1): Investment and Implementation at District and Field Level; Task Force 2 (TF-2): Policy, Regulatory and Institutional Framework; Task Force 3 (TF-3): Agricultural Research, Extension, Information, Training, Technical Services and Empowerment; and Task Force 4 (TF-4): Crosscutting and Cross-sectoral Issues to oversee the detailed formulation of priority ASDP intervention areas.

On its part, TF-3 launched Working Groups and support studies on Research, Extension, Farmer Empowerment and Organizations, and Information and Communication. In November 2003, the TF-3 recommended that reforms and future operations be based on a unified strategy encompassing both agriculture and livestock services, while ensuring integration of the various elements of agricultural services, in particular research, extension, information and communication, as well as training

In March 2004, a joint Government-Development Partner Programme Formulation Team finalised a Concept Paper, which outlined a possible Agricultural Services Support Programme (ASSP) to induce agricultural services reforms and finance agricultural services within the ASDP framework. Endorsed by the Government in April 2004, the Concept Paper provided the basis for preparing the Programme Document, provided detailed description and cost estimates of the components and specific interventions.

The final draft Programme Document was finalized and endorsed by the Government in July 2004 and circulated to all the potential development partners willing to support ASSP, including those in the Food and Agricultural Sector Working Group (FASWOG). Even though all FASWOG members were requested to pledge their support for the ASSP, only the World Bank/IDA and the International Fund for Agricultural Development (IFAD) had confirmed their support by 31 December 2004.

Progress Made as of December 2004

While the Programme Formulation Team continued with stakeholder consultations, particularly at the national level, the Programme was further reviewed and appraised, leading to loan negotiations and approval.

Review and Appraisal of the ASSP

Immediately after the Programme Document was endorsed in mid-July 2004, IFAD appraised the Programme in August 2004. At the same time, the World Bank/IDA reviewed the Programme in August 2004 with the intention of linking it with the intended sector-wide support within the ASDP framework.

Appointment of ASSP Facilitation Team

One of the key activities on the part of the Government was the appointment of the key staff to oversee the implementation of the ASSP. As detailed in the Programme Document, the Agricultural Services Facilitation Team was supposed to be in place immediately after the endorsement of the Programme Document, in order to expedite the follow-up activities, such as the preparation of the Programme Implementation Plan (PIP), among other activities. This was also underscored in the IFAD Appraisal Report and the World Bank/IDA Review Report of August 2004.

Since the key staff of the Facilitation Team had to be drawn from the ASLMs consultations across the Ministries was necessary and these led to some delays. It had been anticipated that the ASSP Facilitation Team would be in place by the end of August 2004.

Except for the Programme Manager/Team Leader, who was appointed by MAFS in early December 2004, the process to recruit/second other key staff from other ASLMs i.e. Ministry of Cooperatives and Marketing (MCM), Ministry of Water and Livestock Development (MWLD) and Regional Administration and Local Government (PO-RALG) is on going.

Development Partner Support

As indicated above, only IFAD and the World Bank/IDA have confirmed their support to ASSP so far.

While IFAD has confirmed its support to the Programme, a World Bank Appraisal Mission is planned for February/March 2005, after which details will emerge.

Plant Breeders Right Legislation in Tanzania

Dr. A. Rutabanzibwa[1]

Introduction

The Bill entitled "The Protection of New Plant Varieties (Plant Breeders Rights)" Act of 2002 was enacted by Parliament of United Republic of Tanzania on 7th November 2002.

Plant Breeders Rights is an area of Intellectual Property Rights (IPR) in Agricultural Innovations. Generally, intellectual property rights represent a specialized area of property rights, which may be divided into: (i) Industrial property (Patents, trader marks and special rights (e.g. Plant breeders' rights); (ii) Library and artistic property (copyrights, rights of performers, etc.)

Plant variety protection is often excluded from lists of intellectual property rights categories. It is nevertheless a form of industrial property right, normally categorized under a *sui generis* system (a system of its own or of a special right category).

This paper highlights the new legislation and creates awareness to stakeholders for the implementation of the Act.

Intellectual Property Right legislation

The Intellectual property law has the objectives to (i) provide legal rights to creators and innovators as a reward for investing time and energy in research and for their consequential achievements; (ii) protect rights of originators thereby providing incentives for creativity and innovation and for economic, social and cultural progress; and (iii) provide a legalised mechanism for the transfer of technology. Categories of intellectual property rights relevant to plants are Trademarks, Patents and *Sui Generis* i.e. Plant Breeders Rights.

Trade Marks have a small role, though important, as far as plants are concerned. They include (i) identification of plant products such as newly developed seeds and genotypes seeds of a particular enterprise, (ii) convey to customers an indication of the quality of the products; (iii) plant variety traders may want to use trademarks of a particular enterprise because of that enterprise known attributes or qualities.

Patents are industrial innovations which unlike PBR, patents were protected in Tanzania since colonial times under the **"**Patents Ordinance" of 1939 (Cap. 217). They are now protected under the "Patents (Registration) Act" (No. 1 of 1987 that was operational through the GN. No. 262 of 1995. In some countries such as the United States of America, patents legislation is used to protect Plant Breeders Rights.

However, in Tanzania, under section 7(2) of the Patents Act, "plant or animal varieties or essentially biological processes for the production of plants or animals, other than microbiological and products of such process" are not part of "invention", according to the definition in the Act.

Importance of PBR legislation to Tanzania

Plant Breeders' Rights Legislation is important to Tanzania because it:

- Assists in providing a sustainable compensation to our breeders' long years of involvement in developing and testing new varieties;
- Assists in controlling unauthorized multiplications of Government seeds;
- Provides an incentive to local (public and private) and international breeders to involve themselves fully in plant varieties breeding in the country;
- Facilitates technology generation and transfer through shared breeding and licensing;
- Brings about revolution in the seed industry and hence contribute to the attainment of the national goal of economic development and food security.

To the contrary, in a situation where a country operates without a PBR legislation the following could happen:

- Breeders and seed traders from outside the country would be unwilling to bring into the country their naturally pollinated varieties; and,
- Government varieties bred in the country would be lost;
- There would be fewer opportunities for technological development or training in the seed industry;
- Farmers would continue to use lower quality seeds and hybrids with low productivity.

PBR legislation and international obligations

Tanzania is a member of the World Trade Organization (WTO) in which Clause 27(3)(b) of one of the agreements, namely Trade Related Intellectual Property Rights Agreement (TRIPS)

[1] Principal State Attorney, Ministry of Agriculture and Food Security

provides that:

"Members shall provide for the protection of plant varieties either by patents or by and effective sui generis system or by any combination thereof".

Countries which have plant breeders' rights legislation, are members to the International Union for the Protection of New Varieties of Plants (UPOV). The UPOV recognizes the need for plant breeders to seek protection not only in the country in which the variety was developed but also in all places with similar agro-economic conditions. In future Tanzania might decide to join UPOV for the benefits of protecting its varieties beyond the country's borders.

There are also initiatives at the East Africa Community level (EAC) to harmonize PBR legislation and establish a common list or register, which will eventually lead to what will be known as "East African Plant Varieties". Kenya had PBR legislation since *1975*, now Tanzania has passed one and the Uganda one is in its final stages.

PBR legislation and international concerns

The Convention on Biological Diversity (CBD)

There were concerns that the PBR legal requirement of "uniformity" and "stability" will reduce the number of varieties and therefore affect the biodiversity of the country and right to access the material. Article 16.4 of the CBD requires members to have legislations that will facilitate joint development and transfer of technology for the benefits of public and private sectors of the developing countries. PBR legislation of Tanzania is one of the ways to fulfil the CBD agreement.

There were arguments that in the PBR legislation there has to be safety provisions or in a separate one, guiding against dangers of affecting biodiversity and balancing the benefits of PBR against the potential risks. It was later decided that separate initiatives will be pursued to comply with the CBD and that the PBR legislation should deal with the intellectual property rights of new plant varieties. The introduction of the National Plant Genetic Resource Centre is one of such initiatives.

The International Treaty on Plant Genetic Resource for Food and Agriculture

The treaty aims at enforcing the CBD by protecting plant genetic resource from extinction as well as countries and persons who possess them from losing the benefits of this resource through in attention and exploitation. It has provision for ownership of "traditional varieties" in the form of farmers' rights. It also proposes development of a programme of compensation for contributions by the local communities in the conservation of plant varieties, which have led to the current knowledge, plant formulations and ecosystem conservation.

Although the PBR legislation or any other legislation for that matter has to consider the role the local communities have played as custodians of the varieties, which are used by breeders to develop new varieties, the PBR Act does not make a provision for farmers' rights or local community's rights. Legislation on Plant Genetic Resource for Food and Agriculture, Conservation and Exploitation, will be prepared to take care of these rights.

The government policy on PBR

The enactment of the PBR legislation is within the national vision and its goal of achieving food security and economic development of a normal Tanzanian to a middle-income earner by the year 2025. The agricultural policy and its implementation strategy provide that the "the Ministry of Agriculture will safeguard the plant breeders' property rights, through enactment of an appropriate legislation for Tanzania" (ALP, 1997). This policy statement has now being realised.

The way forward

The PBR legislation will be in full force once the President assents and on publication in the Government Gazette by the Minister of Agriculture and Food Security. Meanwhile there are important tasks to be undertaken by both the government and sector stakeholders. The government responsibilities are:

- Prepare regulations for implementation of the legislation;
- Design the modality on administrative enforcement of legislation;
- Establish the office of the Registrar of PBR;
- Appoint the Registrar and other assistant officers
- Train Stakeholders on the implementation of the PBR
- Prepare legislation interpretation manuals;

Some of these tasks such as preparation of regulations, establishment of the office and appointment of the registrar have been done. The main tasks of stakeholders are:-

- Forming associations from which they can have appointed representative to the Plant Breeders' Right Advisory committee;
- Getting well acquainted with the legislation and regulation especially on their rights and duties.

Annual Conference and General meeting of the Soil Science Society of East Africa

Mary Lutkamu[1]

The 22nd Annual Conference and General meeting of the Soil Science Society of East Africa (SSSEA) was held from 29th November to 3rd December 2004 at New Safari Hotel in Arusha. The theme of the conference was "*Land Resource Management to enhance livelihood of land users in East Africa*". The Sub- themes included:

- Land Resources management to enhance and sustain soil productivity and food security
- Scaling up of technologies for enhancing and sustaining soil productivity and food Security.
- Soil and water conservation in relation to land productivity and food security.

The meeting was opened by Mr. Fulgence Saria, the District Commissioner for Arusha and closed by Ms. Flora Matemu the District Administrative Secretary for Arusha District. A total of 90 papers were presented in the conference including 2 keynote papers, and 5 farmers presentations. Eighty-five participants from Uganda, Kenya and Tanzania attended the conference and these were drawn from research institutions, universities and international soil related organizations operating in the East Africa Region. On 1st December 2004 there was an excursion in which the participants had a chance to visit small farmers' farming practices and some land use related problems; notably the consequences of poor land management at Kisongo and lake Manyara. The participants observed severe consequences of poor land management in Arumeru and Monduli Districts (including gullies, salinization, lake sedimentation), and informed that similar degradation of land resources is being experienced also in Kenya and Uganda. At its 22nd Annual General Meeting, the SSSEA came up with the following resolutions.

- That there scientists should use a holistic/ integrated approach to deal with such problems at the catchment level; whereby all the key stakeholders i.e. farmers/local community, researchers, extension staff and government leaders will be involved. Sensitisation of political and government leaders is essential in the whole process.
- That, problems on land resources should be solved jointly by the land users, government and political leaders, with the SSSEA providing the necessary technical backstopping.
- That there are certain areas of land resource management in which researchers have produced useful technologies (e.g. use of Minjingu rock phosphate, Rhizobia) for fertility improvement and that they should be disseminated to farmers.
- That policy makers should be sensitised by researchers on the technologies so that they can assist in the formulation of enabling policies for promoting their uptake and to provide the necessary financial support.
- That there are areas of land resource management that still require further research e.g. the effectiveness of open vs tied ridges for soil and water conservation and the use of human manure (night soil) for fertility improvement.
- That, scientists should work more on such technologies to come up with conclusive results.
- That land users in different segments of a catchment are not well linked with each other and are not aware of the consequences of their activities on the land resources of the respective segments of the catchment e.g. the abstraction of water resources for irrigation by farmers upstream, poor land husbandry in the upper catchment areas etc.
- That, farmers should be sensitised through their local leaders on the relationship between the upstream and downstream segments of the catchment.
- That still large areas of the East African region have not yet been adequately characterized to rate their potential for different uses.
- That, governments should put more financial resources to map land resources at appropriate scales for planning purposes.
- That communication between scientists, extensionists, farmers, policy makers and other stakeholders in the issues of land resources management is inadequate.
- That communication among the various stakeholders in land resource management should be advocated and strengthened.

[1] Assitant Director Natural Research Management Reserach, Department of Research & Training, P.O. Box 2066 Dar es Salaam, Tanzania

Connected to the Internet? A few Tips for Effective Searching

Barnabas Kapange

The Internet is a network of networks, linking computers to computers sharing of the TCP/IP protocols. Each runs a software to provide or "serve" information and/or to access and view information. The Internet is the transport vehicle for the information stored in files or documents on another computer. It is slightly incorrect to say a "document was found *on* the Internet." Rather it would be more correct to say it was found *through* or *using* the Internet. Actually, an information is found in (or on) one of the computers that is linked to the Internet.

The World Wide Web (WWW) and its functioning

The WWW incorporates all of the Internet services above and much more. You can retrieve documents, view images, animation, video and listen to sound files, speak and hear voice, and view programs that run on practically any software in the world, provided your computer has the hardware and software to do these things. When you log onto the Internet using Netscape or Microsoft Internet Explorer or some other browsers, you are viewing documents on the World Wide Web.

Internet searching

Finding Web documents (Web "pages" or "sites") can be easy or difficult. This is in part due to the sheer size of the WWW, currently estimated to contain 3 billion documents. It is also because the WWW is not indexed in any standard vocabulary. Unlike the library catalogs that use standardized subject headings to find books in most libraries, in web searching you are always guessing what words will be in the pages you want to find or guessing what subject terms were chosen by someone to organize a web page or site covering some topic.

When you do what is called "searching the web," you are NOT searching it directly. It is not possible to search the WWW directly. The Web is the totality of the many web pages, which reside on computers (called "servers") all over the world. Your computer cannot access all of them directly at the same time. What you are able to do through your computer is to access one or more of many intermediate search tools available at any time. You search a search tool's database or collection of sites — a relatively small subset of the entire World Wide Web.

Recommended Search Strategy

The purpose of thinking about your topic before you start searching is to **determine what terms to search for** and **what features you need** to search successfully. The table below can help guide you in the search:

Features of your search inquiry	Matching Search Tools Features worth learning and using
Are you looking for a **proper name** or a **distinct phrase** ? • The name of an organization or society or movement A distinctive string of words generally associated with your topic	**Phrase Searching** is a feature you want in every search tools you choose. Requires your terms all to appear in exactly the order you enter them. Enclose the phrase in double quotations " " e.g. **"world health organization", "a person's name"** Capitalizing initial letters will cause the terms to be searched as phrase
Are some of your terms **common words** with **many meanings and contexts** ? *Children* in conjunction with *television* and also *violence*	**BOOLEAN AND** will help: **children AND television AND violence** **Google** and **AllTheWeb** and most other search engines put AND in between words automatically (by default): **children television violence**
Do you anticipate lots of search **results with terms you do not want** ? • Your search for *biomedical engineering and cancer* brings you lots of academic programs, and you want research reports. So you try to exclude documents containing Department *of* or *School of*	**BOOLEAN AND NOT** will help: **"biomedical engineering" AND cancer AND NOT "Department of" AND NOT "School of"** or its -EXCLUDES near equivalent: **"biomedical engineering" cancer -"Department of" -"School of"**
Are there **synonyms**, **spelling variations**, or **foreign spellings** for some of your terms? • *women, females* with *networking* • *Sarajevo, Sarayevo* with *peace* • *literature, litterature* with *French, francaise*	**BOOLEAN OR** will help: **(women OR females) AND networking** **(Sarajevo OR Sarayevo) AND peace** **(literature OR litterature) AND (French or francaise)** In **Google**, capitalize OR (no need to type "and"): **peace sarajevo OR sarayevo** **literature OR litterature french OR francaise** In AllTheWeb, use parentheses and omit the OR: **peace (sarajevo sarayevo)** **(literature litterature) (french francaise)**

Are you looking for **home pages** and/or other documents **primarily about** your term(s)? • The home page of the *American Dietetic Association* • Pages primarily about *Affirmative Action*	**LIMIT TO TITLE FIELD** IN DOCUMENTS **title:"American Dietetic Association"** **title:"affirmative action"** In **Google**, use **allintitle:"affirmative action"**
Are you looking for terms with **many possible endings** ? • *Feminism, feminist, feminine* • *Children, child*	**TRUNCATION** permits retrieving all these variations in one search term (ONLY IN ALTA VISTA): **femini*** matches *feminine, feminist, feminism,* etc. **child*** retrieves *child* and *children*

Recommended Search Engines: Table of Features

For most searches, Google is the best place to start. It has one of the largest, if not the largest, database of Web pages, including many other types of Web documents (e.g., PDFs, Word or Excel documents, PowerPoints). Google's popularity ranking often makes pages worth looking at rise near the top of search results. However, Google alone is not sufficient. Less than half the searchable Web is fully indexed in Google. Teoma, Vivisimo (a meta-search engine that indirectly searches three huge search engine databases), or AlltheWeb

Search Engine	**Google** www.google.com	**Teoma** www.teoma.com	**AllTheWeb** Type alltheweb and click Advanced search	**Alta Vista** www.av.com then click Advanced search
Size, type Size varies frequently and widely.	HUGE. Over 2 billion. Claims over 3 billion but about 1 billion are not fully indexed. Unindexed pages are retrieved if your search matches their titles or match other pages linking to them.	LARGE. Claims to have 1 billion fully indexed, searchable pages, and 1 billion more partially indexed.	HUGE. Over 2 billion fully indexed, searchable pages. Advanced search worth mastering.	LARGE, but smaller than Google or AllTheWeb. Use the Advanced search.
Noteworthy features and limitations	Limit of 10 words per search, excluding OR. Indexes the first 101KB of a Web page, and 120KB of PDFs.	Suggests terms within results to refine Suggests pages within results with many links.	Nostop words. URL investigators to find out about a page. Conversion of weights and measures.	Full Boolean searching and powerful Searching within results using SORT BY box in Advanced search.
Phrase searching (term definition)	Yes. Use " ". Searches common "stop words" if in phrases in quotes.	Yes. Use " ". Searches common "stop words" if in phrases in quotes.	Yes. Use " "	Yes. Use " "
Boolean logic (term definition)	Partial. AND assumed between words. Capitalize OR. - excludes. No ( ) or nesting. In Advanced search, partial Boolean available in boxes.	Partial. AND assumed between words. Capitalize OR. - excludes. No ( ) or nesting.	If **Boolean expression** is selected in Advanced Search, accepts AND, OR, ANDNOT, and ( ).	AND, OR, AND NOT, NEAR (within 10 words). Use only in Advanced Search. Do NOT use in A-V simple Search.
Sub-Searching (term definition)	Sort of. At bottom of results page, click "Search within results" and enter more terms. Adds terms.	No. Add terms. REFINE list offers "communities" or sub-topics within results.	No. Add terms.	Yes. Use *Sorted by* box under Boolean search box. Sorts and filters search results.
Results Ranking (term definition)	Based on page popularity measured in links to it from other pages: high rank if a lot of other pages link to it. Fuzzy AND also invoked. Matching and ranking based on "cached" version of pages that may not be the most recent version.	Based on Subject-Specific Popularity™, links to a page by related pages.	Automatic Fuzzy AND. Also seems to use "importance" and links to pages. In Advanced search, SHOULD INCLUDE gives higher priority to word or phrase in box.	By the terms you specify in *Sorted by* box under Boolean search box. Relevancy ranked if left blank.

Truncation (term definition)	No. Search variant endings and synonyms separately, separating with OR (capitalized): *airline OR airlines*	No. Search variant endings and synonyms separately, separating with OR (capitalized): *airline OR airlines*	No. Enclose variants in ( ) in top box to create OR search. *(airline airlines)*	Yes. Use *.
Case sensitivity (term definition)	No.	No.	No.	Yes. Upper case retrieves matching upper case. Lower case retrieves lower or upper case.
Translation	Yes, in Translate this page link following some pages. To English from major European languages.	No.	No.	Yes, to and from English and other languages. Click on Translate following result.

Finding Databases on Your Subject (The Invisible Web)

If you discover a database devoted to your field of inquiry, it can be like striking gold. Databases exist on all sorts of topics and for many purposes (social, scholarly, scientific, research, legal, commercial, trivial, ...) Here are some ways to hunt. Keep your approach VERY broad and general

Title	URL	Remarks
The Invisible Web	www.invisibleweb.com/	Claims to be the largest collection of searchable databases on the Web.
Direct Search	http://www.freepint.com/gary/direct.htm	From Gary Price, author of the List of Lists (above), a browsable collection of useful links to over 800 searchable sites on many research topics.
Internets	www.internets.com/	Large collection of searchable databases.
A Collection of Search Engines	www.leidenuniv.nl/ub/biv/freebase.htm	A browsable list of many resources. Invisible Web sites begin about 1/3 the way down the page.
Complete Planet	www.completeplanet.com/	A huge collection of searchable databases that also contains other types of sites.
Freeality Internet Search	Freeality.com/	Browsable collection of mostly popular searchable databases with some good niche categories of possible academic interest.

The Ten Commandments of Internet Searching

There are right ways — and wrong ways — of using the Internet as a search resource. Newcomers often make the mistake of thinking that "everything" can be found on the net. Wizened information professionals often mistakenly believe that the Net is nothing but an online cyberslum offering nothing of merit. The Ten Commandments of Internet Searching

1. Know your search engine. Remembering that only a portion of all the websites is indexed by the best search engines leads right into #2.
2. Use multiple search engines (or metacrawlers)
3. Don't count on being anonymous. Don't forget about those cookies!
4. Search for sources, not just information. Look for people you can call to get more detailed information.
5. Consider the source of what you find. Just because it is in print, doesn't mean it's true. Information can be typed incorrectly or copied from another source that was wrong. Or perhaps it is written just to be misleading.
6. Be prepared to spend some money to get the really good stuff.
7. Ask, "Is there any reason to believe what I want is out there?" BEFORE going on-line.
8. Don't use the Internet to do a database service's work.
9. Know your outcome. Searching or surfing? Searching has an outcome in mind. Surfing implies enjoying the ride letting yourself be taken along where links lead you. Each has its purpose — understand the difference.
10. Buy a timer. If you don't watch yourself, you will spend hours looking for something that can't be found or you will end up surfing instead of searching.

Evaluation of the potential of green manure and plant extracts for the control of witchweed (*Striga asiatica L. Kuntze*) in upland rice (*Oryza sativaL.*) in Kyela,Mbeya Tanzania. *Kayeke J. M. (2004). PhD Thesis Sokoine, University of Agriculture, Morogoro,Tanzania*

Witcthweed (Striga asiatica) is a serious problem in upland rice in Kyela Tanzania. The use of inorganic nitrogen fertilizer urea assures control of the weed. Resource poor farmers cannot adopt the technology due to unavailability and higher prices of inorganic fertilizers. Therefore, the use of green manure available in upland rice fields will be a plausible alternative. Three experiments were conducted to evaluate the potential of green manure and plant extracts for the control of *Striga asiatica* (L.) Kuntze on upland rice *(Oryza sativa* L).

The first experiment was to evaluate decomposition of green manure

The second experiment was to determine the effect of green manure and inorganic fertilizer on *Striga* and rice yield and

The third experiment to determine the influence of green manure and plant extracts on the germination of *Striga.*

Decomposition of roots and shoots of *Crotolaria ochroleuca* G. (sunhemp), *Mimosa invisa* L. (Colla), *and Cassia obtusfolia* L. (Sicklepod) was determined. Results showed that by the 2nd week shoots had lost 51 per cent of the biomass while by the 6th week roots had lost 50 per cent of the biomass.

Then inorganic fertilizer urea at 0 N, 25 kg N ha^{-1} and 50 kg N ha^{-1} was superimposed in green manure plots. Generally, it was found that *Striga* infestation was reduced by 100% while the yield of rice increased from 1238 kg ha^{-1} to 2846 kg ha^{-1}. However, the residual effect of green manures did not reduce *Striga* but increased rice yield.

High benefit per unit cost was realised when *C. ochroleuca* was combined with 50 kg N ha^{-1}. Green manure application method of ploughing under, mulch was also superimposed with inorganic fertiliser urea (0 N, 25 kg N ha^{-1} and 50 kg N ha^{-1}). Results showed that there was no significant difference between mulch and ploughing under on *Striga* except in rice grain yield. Mulch was found to be more economical than ploughing under.

The potential of green manure to stimulate *Striga g*ermination, plant extracts to suppress *Striga* germination and application methods was also determined in the laboratory and field. *Striga* germination was found to be in the order *C. ochroleuca> C. obtusifolia > M. invisa* (both field and laboratory). Plant extracts were collected from *C. ochlroleuca, M. invisa, C. obtusifolia, Vernonia amygdalina* Del. (bitter leaf), *Neuritanenia mitis, Dolichos kilimandcharicus* and *Gnidia kraussiana* Meisn. (yellow heads). It was found that *Striga* seed germination was reduced while *D. kilimandcharicus* and *G. kraussiana* were found to be effective in suppressing *Striga* seeds germination. Seed hardening was selected as a good application method. *Crotalaria ochroleuca* and *C. btusifolia* were recommended for *Striga* control and improvement of soil fertility in Kyela.

Integrating conventional and participatory research: Experiences from trials with rice farmers in South eastern Tanzania. *Elly Minani Kafiriti (2004)PhD Thesis Katholieke Universiteit Leuven*

Rice *(Oryza sativa* L.) is one of the most important food crops in South eastern Tanzania. However, production is very low, below an annual average of 40 thousand tones from an estimated cultivated area of about *35* thousand hectares. This is in spite of the fact that South eastern Tanzania is endowed with a number of coastal valleys most of which seem under utilized. Lack of improved preferred high yielding varieties, poor water and soil management practices in irrigated fields are some of the factors to which farmers often attribute low production.

The main objective of this study is to investigate measures that can contribute to enhance sustainable and increased rice production in irrigated fields of South Eastern Tanzania. Conventional and Farmer Participatory Research approaches were integrated to take on board farmers' perceptions and knowledge.

From 2000 to 2002, agronomic field trials were conducted in irrigated farmers' fields of Kitere and Kinyope villages, South eastern Tanzania. In order to get background information for trials on agronomic aspects of rice cultivation, the potentials and constraints of coastal valleys were studied by combining PRAs with conventional land evaluation methods. Surveys were done in eight villages spread over two valleys with a perennial stream and two with a seasonal stream. Whereas the PRAs enabled to get insights into the variability within the villages, the parametric approach for land evaluation enabled to compare the soil suitability across the valleys. The results indicate that *Vertisols* occur more frequently in valleys with a seasonal stream, while *Fluvisols* and *Gleysols* occur more frequently in valleys with a perennial stream. However, in terms of soil suitability there were no statistically significant differences between the valleys. Shortage of capital and labour are major constraints given by farmers for expanding the cultivation of rice in the valleys. If farmers could make bunds and apply supplementary irrigation, yields would be increased substantially.

A simulation study conducted to establish the benefits of bunds in rain fed lowland rice indicates grain yield can be increased up to 40%. However, the effect of bunds on yield is not pronounced on soils with high percolation rate.

The agronomic characteristics of thirteen improved rice varieties were compared with farmers' own ones. The main aims were to provide farmers with new improved rice varieties and to identify the selection criteria farmers consider important in irrigated rice cultivation. Variation of the agronomic characteristics between the varieties was analyzed with principal component analysis. Farmers evaluated the varieties at maturity prior to harvest and at post-harvest stages. The differences in structural characteristics and grain characteristics were statistically significant, while this was not the case for the differences in yield. Nevertheless, farmers preferred and selected varieties with short to medium maturity period, which produce many tillers and

mature uniformly; and with long translucent aromatic grains for their own use and marketing. This highlights the importance of farmers' participation in variety development. If the conventional procedure for selecting varieties would have been followed, it is unlikely that breeders would have retained these varieties.

In collaboration with farmers, researchers' designed - farmers' managed fertilizer trials were conducted in-order to determine optimum nitrogen fertilizer rate for optimal rice yields in irrigated fields. Nitrogen rates tested were 0, 30, 60, 90 and 120 kg N ha^{-1} whereas *Azolla* was compared with the fertilizer levels in Kitere villages where it is commonly used. In conjunction with this, farmers tested four levels of nitrogen (0, 30, 60 and 90 kg N ha^{-1}) in their own fields under actual farmers' management. This enabled evaluation of nitrogen fertilizer under different but realistic farmers' circumstances. The results indicate that 50 kg N ha' is the farmers' optimum fertilizer rate for optimal rice grain yields in both villages. The findings further indicate that *AzoIla* could complement inorganic nitrogen fertilizers for increased rice grain yield. Non-experimental variables such as water management, time of planting, plant population and weed management can influence the performance of the fertilizer when trials are conducted under pure farmers' management.

The results of this study indicate that Farmer Participatory Research shortens the research process and enhances acceptability and adoption of the results. However, without addressing some of the important limitations such as absence of subsidies and poor input distribution network fertilizer adoption in South eastern Tanzania is very unlikely. The implication for future rice research in South eastern Tanzania is that a shift in emphasis should be given to incorporate farmers' selection criteria in the breeding programme next to traditional criteria. Other soil management practices including organic fertilizers need to be studied to give farmers a wide range of options.

Adapting to change in banana-based farming systems of northwest Tanzania: The potential role of herbaceous legumes. *Baijukya, F.P. (2004). PhD Thesis Wageningen University. The Netherlands*.

This study describes the changes and explores opportunities for integrating herbaceous legumes, to act as an engine for maintaining the farming system and ameliorating the fertility of soils of annual crop fields. The study showed that the grasslands area have decreased over 50 years by 40 per cent whereas that of annual crop fields increased by 225 per cent. Encroachment on grasslands reduced the ability of farmers to restore soil fertility through keeping of livestock, thus diminishing the supply of manure. This had a consequence on nutrient balances whereby the home gardens receiving manure, had positive balances of N, P and K whereas the home gardens receiving no manure had negative nutrient balances. Nutrient balances of annual crops were negative particularly with maize, indicating that they are vulnerable to impoverishment.

Field experiments showed that the biomass, N accumulation and N_2-fixation varied among the legume species. The performance of legumes was regulated by the soil N and the soil pH. The non-forage species *Tephrosia candida, Crotalaria grahamiana* and the forage species *Mucuna pruriens* and *Macrotyloma axillare* performed better among the tested legumes, and were selected by farmers on the basis of biomass yield, weed suppression and tolerance to pest and diseases. Laboratory experiments showed that the rate of N release from decomposing legume residues depended on the quality [(polyphenols + lignin)-to-N ratio, lignin-to-N ratio and lignin content] of residues, whereby residues with low (polyphenols + lignin)-to-N ratio, lignin-to-N ratio or lignin contents decomposed faster. Maize yield doubled or tripled when legume residues were applied though the yield response to legume residues was limited when compared with the application of the recommended rate of mineral N fertilisers (50 kg N ha'). It was further observed that, in short term, application of large quantities of legume residue (above 2 Mg ha^{-1}) does not result to a significantly higher maize yield. In the degraded soils, the biomass yield and N accumulation of legume species increased by 100 per cent when established with farmyard manure and had higher residual effect (80%) on the yield of the subsequent maize. Mulching with legume residues was the best option to apply legume residues as it suppressed weeds in the maize crop and had higher labour productivity.

Field experiments with farmers showed that growing of legumes as improved fallows increase maize yield and maintaines a positive N balance. However, growing legumes for fodder was in conflict with maize production and N balance of annual crop fields. Modelling the experiments with a multiple goal liner programming (MGLP) model showed that legumes can act as an engine to maintain the farming system by providing fodder to the cattle, hence manure to the home gardens and ameliorating the fertility of soils of annual crop fields as improved fallows. Farmers have different preferences on legumes and therefore the choice of legumes to be introduced in the farming system should be based on farmer production objectives. The main policy implication of the findings is that promotion of legumes is best approached by taking the socio-economic systems into account. These include securing other farm inputs and marketing of farm produce with reliable and attractive markets.

Key words: LAND USE CHANGES; HE BACEOUS LEGUMES; ADOPTABILITY; N_2 FIXATION; RESIDUAL EFFECT; LEGUME MANAGEMENT; EXPLORATION OF OP-TIONS, NUTRIENT DEPLETED SOILSI

Maize-sesame intercropping in South east Tanzania: Farmers' practices and perceptions, and intercrop performance. *Mkamilo, G. S. 2004. Ph.D Thesis. Wageningen University, The Netherlands*

Farmers' motives for adopting maize-sesame intercropping systems were studied concurrently with experiments to evaluate the performance of the maize-sesame intercropping systems and to explore options for improvement. About 90 per cent of the farmers intercropped maize and sesame to diversify their cash income. All farmers consider maize as more important crop, because it provides the basic food requirements of the household. The risk of crop failure associated with growing sesame in pure stand is an important reason for sesame intercropping with maize. The intercropping also puts less demand on labour and fertile land, both of which are limited in supply. Furthermore, maize and sesame are compatible crops, which additionally contribute to the restoration of soil fertility and suppression of weeds.

Simultaneous sowing of maize and sesame caused reductions in maize grain yield, of on average 27 per cent. Yield reduction decreased with delayed inter-seeding times. Conversely, delayed seeding led to significant reductions in the yield of sesame caused by a direct effect of sowing time and an increased competition from maize. Based on a long-term average maize, sesame price ratio of 1:3.5, simultaneous sowing turned out to be the option with the highest gross financial returns. At the same time, the study demonstrated that there are associated risks with simultaneous sowing such as sesame seed mortality due to water logging and severe reductions in maize grain yield (up to 60%). Farmers generally introduce sesame about two weeks after maize, to reduce those risks. This study showed however that the recently developed improved sesame varieties are not very well suited for late introduction, due to their poor competitiveness. As sesame is mainly grown in intercrop, future breeding efforts should not only consider characteristics as yield, seed colour and seed oil content, but should also take into account characteristics such as competitive ability and growth duration, that determine the suitability of sesame in intercropping systems.

Density experiments revealed that maize was more competitive than sesame, but more importantly the experiments also demonstrated that maize and sesame are partially complementary in resource acquisition. Niche differentiation forms the basis for a yield advantage in intercropping. This observation confirms the notion of farmers that maize and sesame are good companion crops. At both the relatively high fertile site and the poorly fertile site, P/N ratios of shoot tissue of maize and sesame were high (between 1/1.5 and 1/6.4), indicating that nitrogen was a major limiting factor in the study area. At the low soil fertility site (Mkumba), both maize and sesame in pure stand responded significantly to N and NP-fertilization. At this site, the application of nitrogen fertilizer resulted in 2.5 and 3.6 fold increases compared to pure stand yield of maize and sesame, respectively. In intercrop, N fertilization increased the dominant position of maize in the intercrop. Consequently, only maize benefited from N fertilization. In the case of sesame, the advantage of additional N was counterbalanced by the presence of a more competitive maize crop. Nitrogen recovery was highest in the intercrop.

The results raised questions on the general fertilizer recommendations, which advice to supply N and P in nearly equal amounts. Studies on spatial arrangement showed that both in pure stand and intercrop, sesame seed yield was independent of sowing method (row or broadcast). In the intercrop, grain yield of maize was affected by the method of sowing sesame. When broadcasted sesame caused reductions in maize grain yield ranging from 53 to 69 per cent. The yield reductions were only 19 to 55 per cent with row sowing. Two to three maize plants per station were found to be optimal in pure stand as well as in intercrop. The latter result indicates that farmers' practice of growing 2-3 plants per station is superior to the institutional recommendation of growing one plant per station.

The results of this study clearly indicate that recommendations for intercropping should be based on intercropping research and cannot simply be extrapolated from results obtained with pure stands of the respective component crops. Efforts for breeding improved varieties should also consider appropriate crops for use in intercropping systems. Furthermore, a proper analysis of the experimental results requires a thorough understanding of farmers' objectives and production constraints.

At the same time, an inventory of farmers' objectives and production constraints without exploring the options for improvement seem ineffective. For these reasons it was recommended that future research projects should put emphasis on participatory research involing teams of social scientists, technical scientists and farmers in the process of co-innovation to improve the well being of farmers and rural households.

Key words: Intercropping, farm household objectives, marginal factor of returns, cost-benefit analysis, inter-seeding time, Land Equivalent Ratio, maize, sesame, niche differentiation, arrangement.

DRT Head Office

Director
Department of Research and Training
Ministry of Agriculture Food security and Cooperatives
P.O. Box 2066 Dar es Salaam, TANZANIA
Tel: +255-22-2865313/2865322/2865319/18/20
Fax: +255-22- 2865312
Telex: 41246 KILIMO TZ
E-mail: drt@kilimo.go.tz
jeremiah.haki@kilimo.go.tz
Website: http://www.drd.mafs.go.tz
http://www.agriculture.go.tz
Physical address: Nelson Mandela/Kilimo Road, KILIMO II Building, 1st and 2nd Floors

Lake Zone

Zonal Director (L)
ARI Ukiriguru
P.O. Box 1433 MWANZA
Tel: 255-28-25502 15 Fax: 255-28-2550214
E-mail: ukiriguru@iwayafrica.com

Principal
MATI Ukiriguru
P.O Box 1434 MWANZA
E-mail: matiukiriguru@coolgoose.com
Tel: 255-28 2550215
255-28 2502555
Fax: 255-28 2550214
255-28 2550169

Officer In charge
Maruku ARDI
P.O.Box 127
Bukoba
Tel: 0282220721
Email: jmnkuba@yahoo.com

Southern Highlands Zone

Zonal Director (SH), ARI Uyole
P.O. Box 400 MBEYA
Tel: 255-25-2510062 Fax: 255-25-2510065
E-mail: mmmsabaha@yahoo.co.uk, ariuyole@iwayafrica.com

Principal
MATI Uyole
P.O. Box 2292 MBEYA
Tel: 025 2510015
E-mail: matiuyole@atma.co.tz

Officer In charge
Kifyulilo Research Sub-station
P.O.Box 93, Mufindi
Mobile: 0784373270

Principal
MATI Igurusi
P.O.Box 336. MBEYA
Mobile: 0744766884 or 0745040816

Northern Zone

Zonal Director (N)
ARI Seliani
P.O. Box 6024
ARUSHA
Tel: 255-27-2503883/2505211/2505212
Fax: 255-27-25023971/2548557
E-mail: sari@habari.co.tz

Principal
Horticulture Research Institute Tengeru
P.O. Box 1253,
Arusha, Tanzania
Tel.: + 255 027 2553094 / 2553067
Fax + 255 027 2553067
Email: **hortitengeru@afsat.com**

Principal
KATC, MOSHI
P.O. Box 1241 MOSHI
Tel: 027 2752293
027 2754247
Fax: 027 2752293
E-mail: katc@kilionline.com

Southern Zone

Zonal Director (S)
ARI Naliendele
P.O. Box 509 MTWARA
Tel: 255-23-2333836 Fax:255-23-2333 141
E-mail: utafiti@makondenet.com

Principal
MATI Mtwara
P.O. Box 121 MTWARA
Tel: 023 2333837
Telegrams: kilichuomtwara
E-mail: mtwara@yahoo.com

Central Zone

Zonal Director
Makutupora Viticulture Research Institute
P.O. Box 1676 MPWAPWA
E-mail: Imroso@yahoo.com

Officer In Charge
ARI Hombolo
Box:
Mobile: 0754751375
Email:

Eastern Zone

Zonal Director (E)
ARI Ilonga
P.O. Ilonga
KILOSA, MOROGORO
Tel: 255-23-2623201 Fax: 255-23-2623284
E-mail: ilonga@iwayafrica.com

Principal
MATI Ilonga
P.O.Box 66 KILOSA
Tel: 255-23-2623064
Email: ilonga@iwayafrica.com

Principal
National Sugar Institute(NSI)Kidatu
P.O. Box 97 KIDATU
Tel: 255-23- 2626050
Fax: 255-23-2626440
Email: nsi@raha.com

Deputy Zonal Director (E)
ARI Mlingano
P.O. Box 5088 TANGA
Tel: 255-27-2647647/2647680 Fax: 255-27-2642577
E-mail: mlingano@iwayafrica.com

Principal
MATI Mlingano
P.O. Box 5051 TANGA
Tel: 027 2642884
E-mail: matimlingano@hotmail.com

Officer In Charge
ARI Mikocheni
P.O.Box 6226
Tel: 255 22 2700161/601
Dar es Salaam

Officer In Charge
ARI KATRIN
Private Bag, Ifakara
Tel: 255 23 2625078
Fax: 255 23 2625361

Officer In Charge
ARI Dakawa
P.O.Box
Tel: 255 23 2628677
Fax: 255 23 2628677
Email: asps.dakawa@cats-net.com

Officer In Charge
Sugar Research Institute
P.O. Box 30031, Kibaha
Tel: 255 23 2402038
Email: sri@africaonline.co.tz

Western Zone
Zonal Director (W)
Agricultural Research Institute Tumbi
P.O. Box 306 TABORA
Tel: 255-26-2604142
E-mail: zdrdwz@yahoo.com, Benjamingama@hotmail.com

Principal
MATI Tumbi
P.O. Box 603 TABORA
E-mail: principalmatitumbi@yahoo.com