

PUBLICATION

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ATTENTION: Each sub theme above should be linked with all abststact of the papers which are shown below:

SUB-THEME: SUSTAINABLE SOIL MANAGEMENT

1. THE EFFECT OF *SESBANIA SESBAN* FALLOWS ON STRIGA INCIDENCES AND MAIZE YIELD IN TABORA REGION

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Abstract

One of the major constraints to maize production in most farmers' fields in Tabora Region is nitrogen deficiency and Striga infestation. Trials were conducted on in farmer's fields in Tabora and Nzega Districts for a period of three years (1999-2001) to investigate the effect of *Sesbania sesban* improved fallow on Striga infestation and maize yield. The treatments were: *Sesbania sesban*, fertilized maize and control with no fertilizer and no of *Sesbania* tree. Fertilized and unfertilized treatments were continuously cropped with maize but *Sesbania sesban* were cropped in the third year. Application of mineral fertilizer and incorporation of *Sesbania sesban* significantly ($P < 0.05$) increased maize yield when compared to control. Maize grain yield (Kgha^{-1}) was 1,013,425 and 1,345 for fertilized, unfertilized and *S. sesban* fallow. *S. sesban* fallow reduced Striga incidences considerably after cutting and incorporating the leafy biomass into plots in the third year of the trial.

2. VECTOR ANALYSIS OF NUTRIENT INTERACTIONS IN MAIZE-BASE ROTATIONAL WOODLOT CROPPING SYSTEMS AT MKUNDI, MOROGORO, TANZANIA

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Abstract

Earlier studies have shown that soil nutrient enrichments by trees during the fallow phase of rotational woodlot systems may be inadequate to improve crop yields due to short fallow period. This implies that nutrient requirement for crops may be met by nutrients released from slash applied as green manure after wood harvests. This implies that, litter quality of tree fallow species may greatly influence soil nutrients availability to crops through their differential decomposition and nutrients release patterns. Therefore, we hypothesized that type of fallow species would influence nutrient dynamics and maize yields after clearing the woodlot. Effects of tree species and fertilizations on available nitrogen, maize yields and nutrient uptake in a split-plot experiment using Randomized Complete Block Design (RCBD) in order to compare species effects against fertilizer effects. Similarly, the RCBD experiment was adopted to assess species effects on leaf decomposition and nutrient release. Leaves of *Gliricidia sepium*, *Leucaena diversifolia* and *Acacia polyacantha* decomposed fast and released more N than leaves of Australian *Acacia* species which immobilized N; limiting its availability to maize. Mineralization of P and K occurred in all tree fallows with K exhibiting the highest release compared to other elements probably because it is neither structurally bound in plant tissues nor readily retranslocated prior to leaf senescence. Vector analysis depicted synergistic interactions between N and P on maize growth with N being the most limiting nutrient. This synergism was closely related to patterns of nutrients release from the decomposing leaf biomass. Maize growth responses in exotic *Acacia* fallows were mainly driven by P supply due to N immobilization while in other tree fallows both N and P were responsible for improving maize yields because of nutrient mineralization during green manure decompositions. Consequently, maize yields were highest after *G. sepium*, *L. diversifolia* and *A. polyacantha* fallows; ranging from 3.1 – 3.4 Mg ha⁻¹ in the first cropping season. These yields were equivalent to full rates of N and P fertilizers. Maize yields and nutrients uptakes in sequential cropping were consistent with synergisms and nutrient release patterns observed in different tree fallows. This study, suggests that the type of fallow species plays a great role in influencing residual effects of rotational woodlots on maize production and *A. polyacantha* and *L. diversifolia* are appropriate species.

3. EFFECT OF *GLIRICIDIA SEPIUM* GREEN MANURE PLACEMENT ON MINJINGU PHOSPHATE ROCK SOLUBILITY AND MAIZE YIELDS IN ACIDIC PHOSPHORUS DEFICIENT SOILS OF MOROGORO, TANZANIA

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Abstract

Organic matter is known to improve dissolution of phosphate rocks and increases soil phosphorus (P) availability by releasing organic acids during decomposition and reducing soil P-fixing capacities. While incorporation of green manure into soil is known to be superior to mulching in terms of maize yield and nitrogen (N) recovery, the information regarding effects of these placement methods on Minjingu Phosphate Rock (MPR) dissolutions is scanty. Therefore, a factorial experiment, laid out in a Complete Randomized Block Design (CRBD) with three replications, was carried out at Sokoine University of Agriculture (SUA) farm to assess the effects of surface applied and soil incorporated *Gliricidia sepium* (Jaqua) green manure and MPR application rates on soil P availability and maize yields. Green manure significantly improved extractable P, maize yields and nutrients uptakes with higher values observed in incorporation than mulching treatments. Four weeks after maize planting, these treatments had respectively improved Bray 1 P by 43 and 27 % over the control. Corresponding maize grain yields were 2.6 and 2.3 Mg ha⁻¹ respectively. Higher performance of soil incorporated green manure than its application as mulch was attributed to fast decomposition and enhanced soil contact. Vector analysis indicated that P was the most limiting nutrient for maize production. Bray 1 P and maize yields and nutrients uptakes increased with MPR applications rates; affirming P deficiency revealed by the vector analysis. Our results suggest that incorporation of green manure in combination with MPR is more effective in improving soil P availability than its application as mulch.

4. EFFECT OF ROTATING *TEPHROSIA VOGELII* FALLOW AND MAIZE ON MAIZE YIELD AND SOIL FERTILITY REGENERATION IN SUB-HUMID CLIMATE OF EASTERN TANZANIA

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Abstract

A field experiment was conducted on acidic N and P deficient Ferralsol to determine the effect of *T. vogelii* fallow-rotation with maize on soil fertility regeneration. The experiment was conducted sequentially for four years, with 22-months old *T. vogelii* fallows followed by two subsequent sole maize cropping. The 22-months old *T. vogelii* fallows

were applied with 0 or 80 kg P ha⁻¹, while the following maize crop was applied with *T. vogelii* biomass or sulphate of ammonia alone as N sources, co-applied with TSP or Minjingu Phosphate Rock (MPR). Soil pH, and exchangeable K, Mg and Ca were monitored both in the fallows and in the maize crop. Incorporation of accumulated litter and foliar biomass alone into the soil increased soil pH towards neutrality and exchangeable Ca, Mg and K significantly. The contribution of Natural fallow in increasing exchangeable Mg was much higher than that of plots amended with *T. vogelii* biomass. These results suggest that medium duration *T. vogelii* fallows-in rotation with maize can substantially regenerate soil fertility in acidic, N and P deficient Ferralsol in sub-humid climate of eastern Tanzania.

5. COMPONENTS PERFORMANCE AND RESIDUAL EFFECT IN RELAY INTERCROPPING OF *TEPHROSIA VOGELII* AND MAIZE IN SEMIARID GAIRO, TANZANIA

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Abstract

Producing sufficient shrub biomass to enhance soil fertility and maize yield in subsequent season without compromising yield of current crop in simultaneous agroforestry system was the main task of this research work in land scarce semi arid Gairo. A split plot design with main plot factor as time of planting having levels 0, 2 and 4 weeks after maize and spacing as minor plots factor with levels 30 (Tv30), 60 (Tv60) and 90 (Tv90) cm intra-row spacing (intercrop and monoculture *Tephrosia vogelii*) plus control (maize monoculture), was laid in the first season. For second and third seasons, a split-split-plot design was laid, where spacing treatment was split to two levels of fertilizer (without and with half and full recommended doses of N and P respectively). Maize height and stover yield were assessed at tasselling while grain yield was assessed at maturity. *Tephrosia* biomass yield was assessed at three, six and eleven months. In the second and third seasons, field mineral nitrogen and maize yield were assessed. Highest maize yield was maintained with Wk2Tv60 in first season. At three months in intercrops, total shrub biomass was significantly higher ($P < 0.05$) in Wk2Tv30 than the rest. Total shrub yields at eleven months in monoculture plots were 2-6 times higher than intercrops. Mean shrub biomass increment, mean shrub height increment and mean shrub diameter increment were significantly higher ($P < 0.05$) in Wk0Tv90 than the rest between six and eleven month assessments for intercrops. Soil properties after eleven months did not consistently differ, but monoculture *Tephrosia* showed superiority in most cases over intercrops. Maize yield was maximized with fertilized monoculture *Tephrosia*, but unfertilized intercrops recorded 50 and 58 percent increase over unfertilized maize monoculture in second and third seasons, respectively. The study concludes that *Tephrosia* relay-intercropped with maize can enhance sustainable maize production in land-scarce semi arid areas and recommends further study on continuous intercropping involving various provenances of *Tephrosia vogelii*.

6. WATER USE AND NUTRIENT SUPPLY BY TREES IN WOODLOTS SYSTEM IN WESTERN TANZANIA

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Abstract

Farmers in western Tanzania are establishing rotations of trees and crops in an attempt to overcome the shortage of wood, reverse deforestation of natural forests and improve soil fertility for food security enhancement. However, over-exploitation of soil water resources and immobilization of soil nutrients have been suggested as possible negative effects of growing trees on farms in the semi-arid tropics. Such possible pitfalls undermine and even threaten a successful implementation of the woodlot technology at larger scale. The study presents results based on field trials that were established with five-year rotational woodlots in Tabora Region. There was no evidence that trees were over-exploiting the water reserves after four years. Transpiration was greatest in *A. crassicaarpa* and was related to stem diameter, size of the tree canopy and soil water availability. The benefits of tree fallows compared to natural fallows were obvious, in terms of maize yield increases. Non-fertilized maize yielded more after acacias than after the other trees and natural fallow. N ha⁻¹ and P ha⁻¹ were the most limiting nutrients in the study area. Application of 50 to 100 kg N and 20 kg P h⁻¹ will suffice to get maize yields of about 3 to 4 t ha⁻¹ after woodlots, and the fallow type has little effect on it. There was no need to apply fertilizer K in the study area. This could mean that the acacias are mining the soil for P and K. Therefore long-term trials are needed to examine the sustainability of the system of rotational woodlots.

7. AGROFORESTRY TECHNOLOGIES FOR SEMI-ARID AND SUB-HUMID AREAS OF TANZANIA: AN OVERVIEW

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Abstract

Agroforestry (AF) research at Sokoine University of Agriculture up to the mid 90s had concentrated largely on the testing of the potential of mixed cropping and alley cropping for semi-arid areas. Later on it was realized that crop failure was severe under these systems due to competitions for growth resources, particularly moisture between tree and crop component. Consequently, alternative technologies were considered for semiarid conditions. From 1995 to date, a number of technologies such as improved fallow (IF), relay intercropping (RI) and rotational woodlot (RWL) have been tested for suitability in semi-arid and sub-humid areas. Along with these technologies, trials were established to screen appropriate provenances/species and improve soil phosphorus (P) availability in P deficient soils with high P-fixing capacity. This paper reviews progress made so far with the objectives of providing information on findings that are available for scaling up and identifying gap(s) for future research. Results of provenances trials indicated that growth and yield differences among provenances were attributed to differences in climatic conditions, altitude and edaphic factors between native range and study sites affirming the need for screening tests prior to final selection of provenance and/or species to plant. Generally, *G. sepium* provenances showed highest survival, biomass yields and nutritive values than other tested provenances and/or species in all three sites; demonstrating wide

adaptability to different agro-ecological zones and high potential for use in AF systems. Of the evaluated *Leucaena* species/provenances, *L. diversifolia* Ex Veracruz had the highest *psyllid* resistance and would be appropriate for replacing *L. leucocephala*. Two-year old IF of *G. sepium* and *T. vogelii* at Gairo were sufficient to improve soil fertility and have potential to reduce costs of N and P fertilizer by 50 % without adversely affecting maize yields. One-year narrow-spaced IF of *T. vogelii* yielded 3 Mg ha⁻¹ of maize grain which is close to 4.41 Mg ha⁻¹ from a two-year wide-spaced IF of the same species; reflecting increased foliage biomass production per unit area at narrow spacing. This technology together with RI may be appropriate for optimizing land use and sustaining crop production in areas with scarcity of arable land. Appropriate design of planting space and time may minimize competitions for moisture under RI in semi-arid conditions, as demonstrated by highest maize and *T. vogelii* biomass yields in plots in which *T. vogelii* was planted two weeks after maize sowing at a spacing of 30 cm and 90 cm within and between rows respectively. Wood production from one hectare of RWL was sufficient to meet household firewood demand for 7 – 16 years; demonstrating the potential to be an alternative source of firewood and reduce harvesting pressure to natural forests. *Acacia crassifolia*, *A. leptocarpa* and *A. mangium* produced the highest wood biomass at the lowest nutrient costs reflecting low nutrient exports per unit biomass at harvests and would be appropriate for sustaining wood production under this system. Crop growth and yields in AF systems on acidic soils with high P fixing potentials may be improved when green manure and Minjingu phosphate rock are incorporated into the soil rather than surface applied as mulch. In order to improve crop productivity under AF systems in semi-arid and sub-humid areas, further research is needed in the following areas: (1) evaluation of biological nitrogen fixing capacity and site x interactions of tree/shrub species/provenances as strategies to refine selection criteria, (2) foliar nutrient analysis of tree/shrub species as a criterion for assessing the potentials for use as fodder and green manure, (3) screening of indigenous tree/shrub leguminous species with potential to use in AF (4) partitioning the effects of competitions for soil moisture, nutrient and light on growth and yields of tree/shrub and maize under RI.

8. COMBINING *TITHONIA DIVERSIFOLIA* AND MINJINGU PHOSPHATE ROCK FOR IMPROVEMENT OF P AVAILABILITY AND MAIZE GRAIN YIELDS ON A CHROMIC ACRISOL IN MOROGORO, TANZANIA

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Abstract

A two-year field experiment was conducted to evaluate the effects of *Tithonia diversifolia* green manure combined with either Minjingu phosphate rock (MPR) or triple super phosphate (TSP) on soil chemical properties that influence P availability, P pools and maize grain yields, on a Chromic Acrisol in Morogoro, Tanzania. Leafy biomass of tithonia was applied before maize planting for two consecutive growing seasons. Treatments compared were the control, MPR and TSP each at 80 kg P ha⁻¹; tithonia alone at 2.5, 5.0, and 7.5 Mg ha⁻¹ dry matter and tithonia combined with MPR or TSP at 40 kg P ha⁻¹. Tithonia led to significant increases in soil pH, exchangeable Ca, labile (resin and NaHCO₃-Pi), and moderately labile inorganic P (NaOH-Pi). It reduced exchangeable Al and P sorption. Application of MPR alone had liming effects and resulted in increase in labile P. Combining tithonia with MPR had similar but more intense effects. Triple superphosphate alone led to acidification and this was reversed when TSP was co-applied with tithonia. Increasing the application rates of tithonia either alone or in combination with TSP or MPR led to more pronounced liming effects but the differences between 2.5 and 5.0 Mg tithonia ha⁻¹ were not significant due to moisture stress that was experienced during the season. The P and Ca concentrations of the maize plants at tasselling increased with the application of tithonia alone or combined with MPR or TSP, and were significantly correlated with maize grain yields ($r = 0.75$ and 0.64 for MPR and TSP, respectively). Tithonia added consecutively for two years increased total maize grain yields by 70% compared to that in the control. The relative agronomic effectiveness (RAE) of MPR increased from 46% in the first year of application to >142% in the second year, indicating that the initially slow dissolution of MPR improved by combined application of tithonia and MPR, attributed to reduction of P sorption. It is concluded that

tithonia can enhance P availability from the Chromic Acrisol through modification of soil properties associated with P transformation and availability. In cases where tithonia is found within the farmers' fields its combined application with MPR can increase maize yields at a much-reduced cost associated with tithonia procurement.

SUB-THEME: FODDER PRODUCTION

9. EFFECT OF CUTTING MANAGEMENT ON FODDER PRODUCTION AND QUALITY OF *LEUCAENA PALLIDA* AND *A. ANGUSTISSIMA* FODDER BANKS

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Abstract

An experiment to determine dry matter yields and nutritive value of *L. pallida* and *A. angustissima* browse fodder was conducted on-farm in three villages of Tumbi, Kazima and Mtakuja in Tabora, Western Tanzania. One plot for each browse species was randomly selected in each of the villages and divided into 4 sub-plots each with 4-6 rows on ridges at 0.75 m within and 1.0 m between rows. Four cutting regimes at 1-month, 2-months, 3-months and a control (coppice regrowths harvested at about 1.0 m height) were applied on each respective sub-plot. At harvesting time, plants were cut at 0.5 m above ground and fodder materials separated into mature leaves, young leaves and tender twigs (< 0.5 mm diameter) and whole edible fractions. These fractions were then used to determine fodder yield and for chemical analysis. There were differences ($P < 0.05$) in dry matter yields between cutting regimes. The 3-months cutting interval had the highest fodder yield (3.44 and 5.41 t Dmha⁻¹ for *L. pallida* and *A. angustissima*, respectively) while 1-month cutting regime had the lowest fodder yield (2.8 and 3.4 t DM/ha for *L. pallida* and *A. angustissima*, respectively). Nitrogen and mineral contents varied between cuttings and edible fractions, which ranged from 27.1 to 47.7 for nitrogen, 2.37 to 8.49 for calcium, 1.40 to 4.90 for phosphorus and 11.6 to 23.1 gkg⁻¹ DM for potassium. The Neutral Detergent Fibre (NDF) was higher in *L. pallida* than in *A. angustissima* at each cutting and ranged from 351 – 494 and 427 – 531 gkg⁻¹ DM for *A. angustissima* and *L. pallida*, respectively. These results indicate that optimal yield and quality fodder materials of the two browse species could be obtained at 2-months cuttings. *Leucaena pallida* and *A. angustissima* are potentially good sources of supplemental protein and minerals for dairy cattle.

10. THE PERFORMANCE OF LACTATING DAIRY COWS FED LOW QUALITY GRASS HAY SUPPLEMENTED WITH *LEUCAENA PALLIDA* AND *ACACIA ANGUSTISSIMA* DRIED LEAF MEALS

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Abstract

Two experiments were conducted to evaluate the feeding value of *Leucaena pallida* and *Acacia angustissima* dried leaf meals as supplement to a basal diet of low quality hay. Experiment 1 was a milk production study and experiment two was an *in-vivo* digestibility and nitrogen balance study. In both experiments, four lactating dairy cows were fed on four diets in a 4 × 4 Latin Square Design (LSD) experiment. The diets were: LP = basal feed and *L. pallida* leaf meal (2.28 kg day⁻¹), AA = basal feed and *A. angustissima* leaf meal (2.07 kg day⁻¹), LPAA = basal feed, 50% *L. pallida* leaf meal and 50% *A. angustissima* leaf meal and CSC = basal feed and cotton seed cake. In all treatment diets, cows were fed 90 g cow⁻¹ day⁻¹ of mineral mixture and hominy meal was used as an energy source. Dry matter intake and milk yield was highest for cows fed on CSC (11.1 kg DMI⁻¹ day⁻¹ and 9.94 kg milk day⁻¹) and lowest for cows fed on LP (10.4 kg DMI day⁻¹ and 7.78 kg milk day⁻¹). Treatment diets had no effect on milk components. Apparent DM and N digestibility were higher for cows fed on CSC (588g kg⁻¹ and 931g kg⁻¹ for DM and N, respectively) and lowest for cows fed on LP (466 g kg⁻¹ and 603 g kg⁻¹ DM for DM and N, respectively). The N absorbed was more efficiently retained (P < 0.05) with cows fed CSC (21.8 g day⁻¹) and poorly retained with cows fed LP (4.24 g day⁻¹). The cows fed LP, AA and CSC lost weight at an average of 70, 130, and 60 g day⁻¹, respectively, while cows fed LPAA gained weight at an average of 70 g day⁻¹. Both browse leaf meals proved to be potential protein supplements for milk production.

11. THE POTENTIAL OF *MORINGA OLEIFERA* TREE LEAF MEAL AS A PROTEIN SOURCE IN COMMERCIAL EGG STRAIN CHICKENS IN TANZANIA

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Abstract

In Tanzania poultry feeding particularly protein sources has been one of the most critical constraints causing low productivity in both commercial and traditional sub- sector. Nevertheless, the major sources of protein in commercial poultry production has been fish meal and oil seed meals such as sunflower and cotton seed meals which are usually scarce, expensive and used extensively by other livestock species and humans. This situation has created a need to look for cheap, locally available and less competitive protein source ingredients for commercial chicken feeding. Therefore the study was conducted to assess the effect of substituting *Moringa oleifera* leaf meal (MOLM) for sunflower seed meal (SSM) on the egg production performance of layers. It aimed to increase an alternative use of cheap and locally available protein sources ingredients in commercial chickens feeding. In the experiment, four dietary treatments based on MOLM and SSC as plant protein sources were formulated such that MOLM replaced SSC giving the treatments containing 0 (control), 5, 10 and 20% MOLM levels for T1, T2, T3 and T4, respectively. All dietary treatments were iso-nitrogenous (17%CP) and iso-caloric (11MJ ME kg⁻¹ DM). A total of 96, at 20 weeks of age egg-

strain commercial pullets were randomly allocated to the treatments. In both experiments data obtained were analyzed by General Linear Model (GLM) Inc, (1998). In this experiment, dietary treatments had a significant effect laying percentage (LP), egg mass (EM), Feed Conversion Ratio (FCR), Daily Feed Intake (DFI) and Daily Dry Matter Intake (DDMI). LP had a slight decreasing trend as MOLM levels increased and ranged between 75.43 and 80.36% for T4 and T1, respectively. Further, EM was significantly low (40.46 g bird⁻¹) in T4. DFI and DMI significantly had a progressive increase in T3 and T4 and had a range of 108.93 to 114.55 g bird⁻¹ and 100.16 to 105.28 g bird⁻¹ for T1 and T4, respectively. FCR (g feed intake g⁻¹ egg mass) were significantly higher (3.29) in T4. But, egg weight (EWT) was significantly lowest in T4. Therefore, it can be concluded that substitution of MOLM for SSM to 10% in laying chickens is optimal for better feed efficiency, egg production and weight. However, where quality of eggs can fetch high premium and MOLM is obtained free complete (20%) substitution of SSM with MOLM is highly encouraged. Therefore, MOLM could be utilized as an alternative source of protein for laying chickens. Promotion of integrating Moringa trees in Agro-forestry production system as a source of protein in livestock feeding is highly recommended.

12. CONTENT OF MINERALS AND POLYPHENOLICS AND EFFECT OF TANNIN ON IN *VITRO* DIGESTIBILITY OF *ACACIAS* AND SELECTED BROWSE TREE SPECIES LEAVES

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Abstract

Browse tree and shrub foliages could form cheap protein and mineral supplements for ruminants. However, optimal utilisation of browse feed could be limited by scanty information on type, nature and levels of feed anti-nutritive factors (ANFs) such as phenolics and tannins. Leaves of six species of *Acacia* (*A. angustissima*, *A. drepanolobium*, *A. nilotica*, *A. polyacantha*, *A. tortilis* and *A. senegal*); *Dichrostachys cinerea*, *Flagea villosa*, *Harrisonia abyssinica* and *Piliostigma thorningii* were screened to quantify levels of conventional chemical composition including minerals; extractable total phenolics (TEP), extractable tannin (TET) and condensed tannin (CT), protein-bound and fibre-bound CT using chemical assays. Proanthocyanidins (PAs) flavonoid composition was assayed using high performance liquid chromatography (HPLC) technique. Effect of tannins on *in vitro* organic matter digestibility (OMD) was assessed by polyethylene glycol (PEG, MW 6000) tannin bioassay. Crude protein (CP) varied ($P<0.05$) among the species from 109 (*P. thorningii*) to 229 g kg⁻¹ DM (*A. angustissima*). The species had variable ($P<0.05$) and low levels of fibres. Calcium (Ca), phosphorus (P), magnesium (Mg) and sulphur (S) varied among the species from 6.6-31.5, 3.5-5.2, 1.4-3.8 and 1.7-2.8 g kg⁻¹ DM, respectively. Copper (Cu), molybdenum (Mo), iron (Fe), manganese (Mn), zinc (Zn) and cobalt (Co) ranged from 4.5-23.8, 54.1-173.6, 146-432, 41.0-177.9, 10.9-22.2 and 0.05-0.65 mg kg⁻¹ DM, respectively. The species had variable ($P<0.05$) levels of TEP and TET that ranged from 99-281 and 84-256 g kg⁻¹ DM in *A. drepanolobium* and *A. nilotica*, respectively. Total CT ranged from 52.8 (*A. nilotica*) to 98.3 g/kg DM (*A. polyacantha* and *P. thorningii*). Most of CT was bound to protein (22.2-50.5 g kg⁻¹ DM). Characterisation of PAs of selected species' leaves revealed presence of flavan-3-ol and flavan-3,4-diols flavonoids. These species represent good sources of CP and mineral supplements to ruminants. The feeds would satisfy requirements of Ca, P, Mg and S for different functions and classes of ruminants. Assayed Cu, Mn, Zn and Co would satisfy the lower range of recommended dietary levels in ruminants. Supplementation of PEG *in vitro* increased gas production, OMD and metabolisable energy (ME) content with the highest response ($P<0.05$) in *A. angustissima* compared to other species. Increased gas production due to PEG supplementation represent recovered feed nutrient by PEG binding tannins. High levels of phenolics and tannins of these species' leaves could limit their nutritive potential as CP and mineral supplements in ruminants. There is a need to identify natural PEG analogies that could be fed as a mixture with tanniferous browse supplements to neutralise tannin anti-nutritive activity.

13. EFFECTS OF *ACACIA NILOTICA*, *A. POLYACANTHA* AND *LEUCAENA LEUCOCEPHALA* LEAF MEAL SUPPLEMENTATION ON GROWTH PERFORMANCE OF SMALL EAST AFRICAN GOATS FED ON NATIVE PASTURE HAY BASAL FORAGES IN WESTERN TANZANIA

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Abstract

Browse tree foliages represent cheap nitrogen (N) or crude protein (CP) supplements for ruminant livestock in the tropics although their optimal utilisation is limited by scanty available information on their feed nutritive potential. Two studies were conducted to 1.) determine rate and extent of ruminal dry matter (DM) degradability (DMD), and 2.) investigate effect of sun-dried *Acacia nilotica* (NLM), *A. polyacantha* (PLM) and *Leucaena leucocephala* leaf meal (LLM) supplementation on growth performance of 20 growing Small East African male goats (randomised into four treatment groups) fed on native pasture hay (NPH) basal diet for 84 d in Meatu district. Three supplement diets: 115.3 g NLM (T₂), 125.9 g PLM (T₃), and 124.1 g LLM (T₄), which was used as a positive control, were supplemented to the three animal groups fed on NPH (basal diet) compared to the animals in a control group that were fed on NPH without browse supplementation (T₁). NLM, PLM and LLM had ($P < 0.05$) higher CP (159, 195 and 187 g kg⁻¹ DM, respectively) than NPH (45.5 g kg⁻¹ DM). NPH had lower ruminal DM degradability characteristics and ME ($P < 0.05$) than NLM, PLM and LLM. Supplementation of the animals with browse resulted to ($P < 0.05$) higher average daily weight gains (ADG) of 157.1 g d⁻¹ in T₄ than the animals fed on T₂ (114.3 g d⁻¹) and T₃ (42.9 g d⁻¹), and even to those fed on T₁ (control), which lost weight (-71.4 g d⁻¹). Improved weight gains were mainly due to corrected feed N or CP due to supplementation of the animals with browse fodder. Higher ADG due to LLM (T₄) and NLM (T₂) supplementation suggest optimised weight gains due to browse supplementation; while lower weight gains of the animals on PLM (T₃) indicate the possible utilisation of *A. polyacantha* leaves to overcome weight losses especially during dry seasons.

14. EFFECT OF COCONUT CANOPY RADIUS ON DRY MATTER YIELD AND QUALITY OF PASTURE SPECIES

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Abstract

Four pasture species were established in Chambezi coconut plantation in Bagamoyo district between March 2002 and July 2003 to assess dry matter yield, chemical composition and dry matter degradation. The pastures were established at 0 – 50, 50 – 100% coconut canopy radius (CR) and in open area and harvested at flowering stage using 0.25 m quadrat. The harvested pastures were oven dried at 65°C for 48 hours. Dry matter yield (DMY), chemical composition and dry matter degradability (DMD) were determined using standard methods. *Brachiaria ruziziensis* and *Macroptilium atropurpureum* were found to produce more DMY (7.29 – 8.28 and 6.5 – 8.14 t/ha, respectively) followed by *Digitaria mombasana* (3.05 – 7.68 t/ha) and *Panicum trichocladum* (1.03 – 1.49 t/ha). Except for *D. mombasana*, the DMY of other pastures were not reduced ($P > 0.05$) by the CR. The crude protein (% DM) ranged from 5.36 – 6.61 for *D. mombasana* to 12.5 – 13.6 for *M. atropurpureum*. With exception of *M. atropurpureum*, the crude protein in other pasture species was higher ($P < 0.05$) under coconut canopy than in open area. The DMD was highest in *M.*

atropurpureum (66.35%) and lowest in *P. trichocladum* (42.0%). Among the grasses, *Brachiaria ruziziensis* had highest DMD and higher ($P<0.05$) DMD under the coconut canopy than in open area. The overall mineral contents of the pastures were 0.452 Ca, 0.176 P and 0.791 K and they were higher ($P<0.05$) under the coconut canopy than in open area. Basing on the findings from this study, *M. atropurpureum* and *B. ruziziensis* are recommended for integration in the coconut plantations.

SUB-THEME: DOMESTICATION OF INDIGENOUS FRUITS AND MEDICINAL PLANTS

15. GENDER AND SOCIO-ECONOMIC FACTORS AFFECTING DOMESTICATION OF MEDICINAL PLANTS AS AN INDIGENOUS AGROFORESTRY PRACTICE IN WEST USAMBARA MOUNTAINS, TANZANIA

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Abstract

A study to investigate the impact of gender and socio-economic factors on indigenous agroforestry practices with the main focus on domestication of medicinal plants was conducted in the West Usambara Mountains, Tanzania. Participatory Rural Appraisal (RPA), questionnaire surveys, Semi-Structured Interviews (SSI), botanical surveys and participant observations were the main methods employed in data collection. It was revealed that, being an important practice in agroforestry, domestication has played fundamental role in conservation of medicinal plants in the study area. Twenty-three (66%) out of 35, and 6 (55%) out of 11 forest plant species domesticated on farms and around homesteads respectively, were medicinal plants. Furthermore, although 89% of the respondents had domesticated medicinal plants on their farms and around homesteads, gender and socio-economic factors had influence on the number of domesticated medicinal plants. Male-headed households had significantly domesticated more medicinal plants than female-headed households. Age, education, wealth, farm size, household size and ethnicity had also influence on the number of domesticated medicinal plants. It is concluded that, being a strategy for conservation of threatened medicinal plants in farmlands and around homesteads, domestication has been influenced by gender and socio-economic factors. Therefore, agroforestry research in area of domestication should focus on devising new strategies for better integration of forest resources into farmlands and their related socio-cultural, socio-economic and institutional aspects.

SUB-THEME: WOOD PRODUCTION

16. SOME WOOD PROPERTIES OF FIVE TREE SPECIES GROWN UNDER AGROFORESTRY SYSTEM IN SHINYANGA AND COAST REGIONS

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Abstract

Some physical and strength properties of five tree species grown under agroforestry system at the Natural Forestry Resources Management and Agroforestry Centre (NAFRAC) Shinyanga Region and Ruvu Fuelwood Pilot Project (RFPP) in Coast Region were determined. Trees studied from NAFRAC included, *A. polyacantha*, *Eucalyptus camaldulensis* and *Melia azedarach* while from RFPP were *Acacia mangium* and *Eucalyptus tereticornis*. A total of 3 trees per species were randomly sampled with elimination basing on free from defects and tree form and then felled. For each tree felled, three logs were extracted (at 1.3 m (DBH), 50% and 75% of the tree height), test samples were prepared and tested for basic density and some strength properties. For each sampled trees, a total of 60 test samples were used for each property test. The data were analysed using Microsoft Excel computer software and SAS statistical programme. Strength properties determined included modulus of elasticity, modulus of rupture, work to maximum load, total work, compression parallel to grain, shear parallel to grain and cleavage strength. The physical property assessed was basic density. At the age of 15 years *E. camaldulensis* had both high basic density (621.09 Kg^m⁻³) and strength values. At the age of 4 and 5 years *M. azedarach* and *A. mangium* had low basic density (381.95 Kg^m⁻³ and 455.18 Kg^m⁻³ respectively) as well as strength values. However *A. polyacantha* (9 years) and *E. tereticornis* (4 years) had medium basic density (503.95 Kg^m⁻³ and 528.23 Kg^m⁻³ respectively) and strength values. Utilization of *E. camaldulensis* for poles, furniture and construction purposes will depend on proper air drying in order to produce timber with minimum splits. *A. polyacantha* and *E. tereticornis* had slightly high strength properties at 9 and 4 years respectively thus timber use from these trees at that young age is limited to areas which demand medium strength properties. Despite low basic density and strength values of *M. azedarach* and *A. mangium*, they can be used for fuelwood production and simple furniture at young age of 4 and 5 years. The properties tested have tendency to improve with age and equations should be developed for each species to predict strength and physical properties at older ages.

17. WOOD BIOMASS, NUTRIENT ACCUMULATION AND CARBON SEQUESTRATION IN ROTATIONAL WOODLOTS AGROFORESTRY SYSTEM IN WESTERN TANZANIA

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Abstract

Deforestation contributes significant quantities of gases and particulate matter to the atmosphere. An effort to surmount deforestation involves the promotion of village and community forestry, including planting trees using several agroforestry systems. Agroforestry systems can have a beneficial influence on the global climate. Here we indicate how planting trees in the form of woodlots can slow or reverse the release of carbon (C) into the atmosphere. We compared woodlots of *Acacia crassicaarpa*, *A. julifera*, *A. leptocarpa*, *Leucaena pallida* and *Senna siamea*. The aim of

the study was to analyze the effectiveness of woodlots in sequestering carbon. After 5 years, trees were harvested, biomass allocation for wood, leaves and twigs were measured and analyzed for C content. Wood constituted 32 to 85% of the total aboveground biomass. Large amounts of nutrients are withdrawn with the harvested wood biomass, making application of nutrients from external sources (e.g. fertilizers) essential for sustainable woodlots. Results also indicated that different trees planted in woodlots after five years affected C sequestration differently due to their biomass allocation patterns and C mass fractions. Acacia species were superior in C sequestration, and among the *Acacia* species, *A. leptocarpa* and *A. crassicarpa* sequestered almost twice as much as *A. julifera*, especially in the wood fraction. *Senna siamea* and *L. pallida* had the lowest C sequestration potential among the tested trees. Wood production at the end of the five-year growing period ranged from 30 to 90 Mg ha⁻¹. The total storage of C in foliage plus wood ranged from 13.3 to 30.3 Mg ha⁻¹ at 5 years, indicating that all species do have the potential for C sequestration and thereby to mitigate CO₂ emissions into the atmosphere. Agroforestry plantations, such as woodlots, are clearly a carbon reservoir and do contribute to saving natural miombo forest ecosystems, to nearby provision of wood fuel and to a net C sequestration. Wise stewardship practices can mean more carbon is sequestered in an agroforestry system than is lost to the atmosphere.

SUB-THEME: ADOPTION, IMPACT OF AGROFORESTRY/INFORMATION AND DISSEMINATION

18. EXPLORING MARKET OPTIONS FOR SCALING UP AGRO-FORESTRY IN TANZANIA

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Abstract

Agro-forestry has a big potential for improving the livelihoods of the majority of Tanzanians, particularly in rural areas through sustainable use and management of natural resources. Benefits are many as evidenced for instance in Shinyanga region through Hifadhi Ardhi Shinyanga (HASHI), which is a development-oriented conservation project that has yielded very encouraging results. However, many of the agro-forestry programmes in the country including the aforementioned do not address the role of market. Many of the agro-forestry practices do not yield products for sale but mainly provide substitutes for purchased inputs, such as fodder for dairy feeds or improved fallows for mineral fertilizers. Yet other agro-forestry products such as fruit and timber may be sold and the potential benefits for marketing them are huge. Moreover most agro-forestry research does not focus in developing market options. Hence, this is an area that requires research in order to explore the potential of market in scaling up agro-forestry and ultimately contribute to increased social, economic and environmental benefits in Tanzania, consistent with the national policy guiding documents e.g. NSGRP (or MKUKUTA). Hence, this paper attempts to first assess the role of market in scaling up agro-forestry and second recommend strategies for scaling up agro-forestry through research in agro-forestry product development and marketing. The paper does so by subjecting for analysis secondary data from a study on the social, economic and environmental impacts of forest landscape restoration on Shinyanga region. The results indicate that the Non-Timber Forest Products are highly undervalued due to inadequate marketing system. This is a big disincentive factor for sustainability of agro-forestry in the region once the project duration ends. Therefore, exploring market options for scaling up agro-forestry in Tanzania is vital.

19. ON-FARM TREE RESOURCES AND FARMER MOTIVES FOR ON FARM TREE RETENTION AND MANAGEMENT IN BUMBULI WARD, LUSHOTO DISTRICT NORTH WESTERN TANZANIA

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Abstract

On farm tree retention has formed the basis for the present day agroforestry systems in many traditions. We assessed species richness and diversity of on farm trees, farmer motives for tree management and contribution of on farm trees to household tree based needs in Lushoto District. About 46 tree species belonging to 25 families were identified. The most dominant species included *Albizia gummifera*, *Parinari excelsa*, *Newtonia buchananii*, *Cinchona* sp. *Syzygium guineense*, *Ficus capensis*, and *Caesaria engleri*. The Simpson's and Shannon-Wiener indexes of diversity were 0.07 and 2.8 respectively. This shows a high diversity of on-farm tree species comparable to natural forests. The motives for tree retention on farm ranged from supply of timber to edible fruits, medicine and soil erosion control. About 30% of household tree based needs are obtained from on farm sources. There is apparently high species richness and diversity in on farm trees in Lushoto. Most of on farm trees were retained on farm during farm clearing. A relatively high proportion of household wood based needs is still met by on farm sources. Sustainable management of on farm tree resources hinges much on more information and enhancement of indigenous tree management systems with supplements from afforestation efforts using appropriate fast growing tree species.

20. FACTORS AFFECTING ADOPTION AND DISSEMINATION OF AGROFORESTRY TECHNOLOGIES IN TANZANIA: A CASE OF HASHI/ICRAF AND RUVU FUELWOOD PILOT PROJECT

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Abstract

A study to investigate factors that contribute to the limited adoption of agroforestry (AF) technologies and delivery of AF information to the end users was conducted in 2004 at HASHI/ICRAF (now NAFRAC) and Ruvu Fuelwood Pilot Project (RFPP) (now Ruvu Fuelwood Development Project). Data were collected using Participatory Rural Appraisal (PRA), semi-structured interviews (SSI), participant observations, questionnaire surveys and use of secondary data. Six AF technologies namely rotational woodlots, boundary planting, improved fallow, fodder bank, scattered trees on farms and traditional and improved *ngitili* have been introduced and practiced at HASHI/ICRAF and only rotational woodlots were introduced at RFPP. Three major AF dissemination methods namely: individual, group and mass methods were revealed at both projects. At RFPP, individual and group extension methods were the most common methods and were reported by 67% and 87% respondents, respectively. At HASHI/ICRAF, mass media method was most popular (100% of respondents) though individual and group methods were also used. Factors that hindered adoption and dissemination of AF technologies included inadequate provision of extension services due to insufficient number of extension staff, inappropriate dissemination methods and language of the extension materials, lack of transparency at project level, land tenure system that hindered investment in tree planting, poor institutional linkage, lack of frontline actors to link the projects extension officers and farmers. It is recommended that factors affecting dissemination and adoption of AF technologies have to be analyzed prior to the initiation of AF programme for proper adoption and

dissemination of AF technologies. In addition, a combination of individual, group and mass media depending on circumstances and objectives of AF programme is highly recommended for effectiveness in disseminating agroforestry technologies.

21. IMPACTS OF SCALING UP SUCCESSFUL AGROFORESTRY TECHNOLOGIES ON RURAL LIVELIHOODS IN WESTERN TANZANIA

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Abstract

ICRAF and partners since 1987 in collaboration with farmers and national institutions have developed promising agroforestry technologies that provide significant benefits to smallholder farmers. In order for agroforestry to have impact on rural poverty, food security and environmental conditions, these technologies need to be scaled up to many farmers, and spread widely across the landscape and to have a critical mass of capacity at grass root levels. In this paper we present results of work by ICRAF and partners that is helping farmers and their families take steps out of chronic poverty and gaining sustainable development towards Africa green revolution. Today over 417,503 farmers in Malawi, Tanzania, Zambia, Zimbabwe and Mozambique (189,854 farmers in western Tanzania) are enjoying benefits through agroforestry focusing on working trees grown on farms and rural landscapes, that include "Fertilizer" trees for land regeneration, soil health and food security, fruit trees for nutrition, fodder trees that improve small holder livestock production, timber and fuelwood trees for shelter and energy and trees that produce various products and medicinal trees that combat diseases.

22. SCALING UP SUCCESSFUL AGROFORESTRY TECHNOLOGIES THROUGH SCHOOLS IN SHINYANGA AND TABORA REGIONS OF WESTERN TANZANIA

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Abstract

There is need for scaling up of agroforestry benefits to reach most of the population in Tanzania, in order to uplift their standard of living. Schools provide the right environment for scaling up, due to their strategic location among the rural communities. They are suitable grounds for training present farmers (adults) and building foundation for farmers of the future (young). Through the schools there is potential to reach directly 635 primary schools, 4225 primary teachers and 270,000 students in our target areas of Tabora and Shinyanga regions. In collaboration with World Vision (Nzega) and Education department, Tabora primary school teachers and farmers, participated in a study tour to Shinyanga, and Tabora regions in order to get practical experiences of agroforestry. The teachers and farmers were impressed and interested in most of the agroforestry technologies, that included, improved fallows for soil fertility, woodlots as sources

of fuelwood, fodder banks for dry season fodder and domestication of fruit and medicinal trees. The teachers have now adopted some technologies in their schools and farms. Currently over 100 schools in Uyui, Nzega, Igunga, Tabora have agroforestry demonstrations of woodlots, improved fallows, fodder banks, fruit and medicinal trees in various configurations. There is a wider diversity of species, and some schools have started benefiting from the environmental services of wind erosion control, shade, while some from the established fruit orchards students are now enjoying fruits as snacks. These schools are serving as learning and training centers for surrounding communities.

SUB-THEME: NATURAL RESOURCES POLICIES ON AGROFORESTRY

23. NEED FOR POLICY ON AGROFORESTRY RESEARCH AND DEVELOPMENT IN TANZANIA

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Abstract

Agroforestry is a practice of growing trees and shrubs with crops or livestock. While its importance in terms of improving peoples' livelihood is well known, there is inadequate policy and legislation on Research and Development in Tanzania. This paper examines existing policies in agriculture and natural resources sectors with a view of checking how Agroforestry features in policy documents of agriculture and natural resources sectors. Past and recent Sector policy documents on agriculture and natural resources sectors were examined in order to find out to what extent the practice of growing trees and shrubs with crops or livestock features in these documents. Views/opinions of different stakeholders were collected through interviews and discussions with researchers and farmers. Additionally, several current and past Agroforestry projects were examined to see if they were motivated by government and local policies. The findings indicate that although there are currently a number of government and local policies aiming at improved both the agricultural sector and natural resources sectors, no distinct policy statements exist on agroforestry. In the forestry policy documents, though, there are many policy statements and directives on woodfuel, farm forestry and trade on forestry products but all these ostensibly refer to forestry. Farmers wanted assistance in getting inputs (seeds, seedlings) and information on markets of Agroforestry products. Researchers were worried about the low adoption rates of technologies so far developed. Traders want information about quality and safety of Agroforestry products. Due to importance of agroforestry in improving livelihood of Tanzanians, formulation of policy statements/directives to guide agroforestry development are suggested.

24 THE ROLE OF NON GOVERNMENTAL ORGANISATIONS IN INTEGRATING GENDER ON LAND CONSERVATION IN REFUGEE AFFECTED AREAS IN TANZANIA: A CASE OF NGARA DISTRICT, NORTH WESTER TANZANIA

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Abstract

A study to examine the role of NGOs in integrating gender on land conservation in refugee affected areas of North Western Tanzania was conducted in Ngara district with the view to recommend strategies that would foster gender sensitive and responsive land conservation projects in these areas. A Cross Sectional Research Design (CSR) was adopted. Data collection process made use of a structured questionnaires which were administered to a sample of 43 men and 43 women. Data were coded and analysed using Statistical Package for Social Sciences (SPSS) computer programme. Results showed that NGOs have been involving both men and women in land conservation initiatives through public meetings for awareness creation, training on land conservation and provision of forest inputs. The major land conservation activities in which men and women participated were tree nursery establishment and tree planting. Participation of men and women in these activities was significantly associated ($P < 0.05$) with their awareness on land degradation and on land conservation project. The study also found that project planning process involving local communities in land conservation had not been adopted by NGOs. It was further revealed that the issue of establishment of Village Environmental Committees as part of empowering local communities was not seriously taken. Majority of men and women who were involved in land conservation participated at the level of implementation. The major factor which was found to limit full gender integration in land conservation was lack of regular mobilisation particularly for women. The study came out with the following recommendations: (i) mobilisation of rural men and women through regular and gender balanced public meetings, and training on land conservation initiatives (ii) NGOs land conservation activities should be co-ordinated and monitored by the District Natural Resources related departments (iii) encourage formation and/or strengthening of gender equity in Village Environmental Committees (iv) project planning process should ensure participation of intended beneficiaries and NGOs and (v) land conservation initiatives should focus more to rural communities than schools and church related institutions.