

THEME: INCLUSION

EFFECT OF CONTRACT FARMING ON FARMERS' INCOME: EMPIRICAL EVIDENCE FROM SMALLHOLDER FARMERS IN MAGUDE DISTRICT, SOUTHERN MOZAMBIQUE

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One popular policy proposal among donors and multilateral agencies is for recipient governments to facilitate the expansion of contract farming (Eaton & Shepherd, 2001; Bellemare & Bloem, 2018) wherein firms support farmers during the production and/or marketing process by providing inputs, technical support, and secured output markets. Findings regarding contract farming are mixed with studies pointing towards both positive and negative effects, which highlights the diversity that exists in terms of commodities involved, contracts offered, and regions studied. The purpose of this study is to analyse the effect of contract farming on farmer's income in Magude district, southern Mozambique. The contract farming model analysed in this study is the nuclear state model (Eaton and Shepherd, 2001) practiced by Xinavane mill as the contractor that not only buy sugar cane from independent producers, but also it has its own production fields. This research was based on interpretivist research philosophy and constructivist paradigm implemented by a case study, combining quantitative and qualitative research approaches. The empirical analysis is based on non-probabilistic sample survey of 100 household heads (50 with contracts with Xinavane mill, and 50 without contracts) selected by convenience or accessibility in 4 farmers' associations in Magude district for interviews. Collected data and information include farmer's sources of income, agricultural production, livestock, and quantities of goods, sold and/or provided services and their cost. Semi-structured interviews were also meant to capture farmers' and Xinavane mill manager's perceptions about contract farming. Semi structured interviews were performed between September and December 2017. Quantitative data was systematized using the Microsoft Office Excel software package and analysed using STATA computer package comparing farmers' income (with contract farming with Xinavane mill and those without contracts in 2015 and 2016). There were significant differences on farmer's income of household's heads with contract farming and households without a contract ($p = 0.0000$), the trend continued in 2016, where the two groups income difference is about 36%, suggesting that farmer's integration in contract farming may be one of the factors that contribute to income increase. The observed improvement in farmer's income in this study is consistent with empirical observations by Mosca (2014) who indicates that there are social mobility's for the benefit of smallholder farmers under outgrower schemes, which are reflected by increase of cultivated areas, wage earning, increased incomes and use of more productive techniques. Farmer's integration in contract farming may improve farmer's income. However, statistic results are not enough for making final and complete inferences regarding the influences of contract farming and other variables on farmers' income as the simple comparison of mean differences does not account for different factors and their relations. The observed increase on farmers' incomes may be associated to three factors, namely assured access to the market, and the stability of income source, and the reduction of production and marketing risks.

Keywords: Agriculture, Sugar cane, Xinavane.

ANALYSIS OF ECONOMIC AND FINANCIAL PROFITABILITY IN THE PRODUCTION
AND MARKETING OF COWPEA [*Vigna unguiculata* (L.) WALP.] IN OF SMALL
FARMERS OF IN MOGOVOLAS AND RIBAUÉ DISTRICTS

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The cowpea [*Vigna unguiculata* (L.) Walp], is a legume that provides the main source of protein, minerals, and fiber of smallholders farmers. In Mozambique, it is produced by the family sector in small areas with an average yield of 253 kg/ha. Despite of being a very important crop, its production, productivity, marketing, and profitability are affected by biotic and abiotic factors. Another predominant factor for of small farmers is the perception of the economic and financial profitability of this crop. The purpose of this study was to analyze the economic and financial profitability of cowpea [*Vigna unguiculata* (L.) Walp] for of small farmers in the Mogovolas and Ribaué Districts in the 2021/2022 growing season. The research was conducted in a mixed, explanatory manner where the data were collected was through interviews and questionnaires. The study had a total handled a sample of 145 participants, with 4 district representatives interviewed and 141 small farmers questioned, inferred through a non-probabilistic convenience sample. The data were analyzed using content analysis and the chi-square test using SPSS V28 software version and the CONAB, IEA, and IIAM methodology. The results showed differences in the forms and strategies of production, marketing, and economic and financial profitability between small farmers in the two Districts. The highest economic and financial profitability was obtained by small farmers with high incomes in the Ribaué District with an average of 14,746.20 MT, compared to those with high incomes in the Mogovolas District who had 1,534.35 MT. On the other hand, low income smallholders in the two Districts recorded negative and unsustainable economic and financial profitability of around -6,106.20 MT for Mogovolas and, -2,907.00 MT for Ribaué. Therefore, the smallholder farmers of lowest income group should focus on adoption of improved technologies, that are used by the highest income group, or should allocate their labor to highest income group that could afford the labor of low income group.

Keywords: Cowpea, economic and financial profitability, production, small farmers.

SUSTAINABLE DEVELOPMENT: women's participation and challenges in agriculture

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Women participate in agriculture, but there is limited knowledge about the extent of their contribution. The UN 2030 Agenda, which defines the Sustainable Development Goals, advocates integrated and inclusive development, encouraging the participation of all actors, paying attention to vulnerable groups, including women. This work aims to identify and analyze the role that women play in agriculture in the context of sustainable development, including the challenges for its strengthening. It is a bibliographic review whose object of analysis was the results resulting from several studies worldwide, privileging the experiences of Southern Africa, highlighting Mozambique. The work will contribute to consolidating information about women in sustainable agriculture by trying to envision the visibility of their work, presenting options to improve interventions. The results allow us to understand that women actively participate in sustainable agriculture, participating in a varied way in the various segments, and their performance may vary depending on the crop practiced. The analysis showed that women are versatile, performing domestic and agrarian activities, revealing an organizational capacity in the redistribution of tasks throughout the year. Meanwhile, his work is invisible, especially in terms of statistics. On a social level, it appears as a “helper” of man even in tasks where it is a precursor. The lack of recognition of women's work aggravates the differential treatment that they are victims of in agriculture, in relation to men in similar circumstances. This is reflected in its exclusion from accessing resources and making decisions about the tasks it performs. The study concluded that women play a key role in food and nutrition security and in the family economy. They participate and contribute to the use of sustainability practices in production, postharvest and agro-processing, marketing, on-farm research and the dissemination of information and agricultural technologies. This work of women is not always visible by the way it is interpreted and documented. There are limitations that affect women's performance in sustainable agriculture, combined with the status of subordination and exclusion that society has cultivated, with the consequent exclusion in access to resources and decision-making. Thus, a change in vision and strategy on women's work as a path to sustainable development is required.

Keywords: Sustainability, Sustainable Development, Women and Sustainable

THEME: PRODUCTION SYSTEMS

CHALLENGES OF PLANT BREEDING IN MOZAMBIQUE

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Crop improvement programs have been established over years focusing on agronomic trait improvement. Currently, plant breeding programs are focused on major production challenges, addressing the production constraints to respond to the increasing population growth in food demand, market needs and environmental quality. According to Francisco (2010), in the last 100 years from 1891, Mozambican population doubled twice from 7.6 million in 1961 and 15.8 million in 1995. Based on the statistics, the actual population in Mozambique has reached the third duplication. Other major consequences of high population growth rate include: environmental related issues, such as a soil degradation, global warming with all related affects. Increase of population was more reported from urban centers where primary food production is limited. Therefore, use of robust and modern technologies in crop production is needed. Other challenges faced by crop breeding programs are low use of input and adoption of new technologies by famers. In Mozambique, the use of improved seed is bellow to 10%, inorganic fertilizer is 8%, pesticides are 7% and herbicides is 3% (MADER, 2021). All these production limitations affect negatively the impact of breeding programs. The strategies for successful crop improvement program are based on three major pillars: The land, as physical support and vehicle for water, air and nutrients for plants; the manpower, responsible for management in the field; and the seed that can contribute significantly for higher yield (Penido, Reis, Carvalho, & Reis, 2020). Therefore, apart from all these challenges, crop improvement programs can be structured to respond to commercial needs by increasing genetic diversity promoted by greater exchange of information between plant breeders, use of molecular markers to increase the probability of success and rapid integration of biotechnology in elite products. Therefore, the expectation is to develop robust and productive varieties, adapted to different agricultural systems, an increase in new private seed companies, an even greater reduction in public sector involvement in seed production.

Keywords: Environmental, Population, Technology.

STABILITY ANALYSIS OF BAMBARA GROUNDNUT [*Vigna subterranean* (L.)
VerdcERDC]) GENOTYPES IN NORTHERN MOZAMBIQUE USING AMMI AND GGE
BIPLOT

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Bambara groundnut is a potential cash crop and a great source of food and nutrition for resource poor farmers living in rural areas and without access to agricultural inputs. However, the crop has been neglected when it comes to allocate research funds. This study aimed at identifying high yielding genotypes with a wide range adaptability. Six bambara groundnut were evaluation including 6 lines introduced from Tanzania and 2 2 lines collected in Mozambique. These genotypes were teste during 3 consecutive cropping seasons, and 3 locations (Nampula, Namapa and Montepuez) in experiments set up in randomized complete block design with 4 replicationse. Rach plot was 6m long plot and 6 rows, with a spacing of 0.5 m between rows and 0.20 m between plants. Data collected during the study included plant height, primary grain color, pod shape, pod maturity, shelling percentage, number of pods per plant, total pod weight, weight of 100 seed weight s, and grain yield. These data were subjected to analysis of variance (ANOVA) and correlations. Stability analysis for yield was carried out using regression tools, AMMI and GGE biplot approaches. The results showed that the tested genotypes performed differently ($P < 0.05$) in several evaluated parameters analyses. Stability analysis indicated that the Chiure 3 and Chiure 4 genotypes, in addition to high yield presented better stability in most of the environments. Based on the results of this study Chiure 3 and Chiure 4 genotypes were selected for registration and release within the testing environments.

Keywords: Bambara groundnut, Mozambique, stability analysis.

UNDERSTANDING BAMBARA GROUNDNUT [*Vigna subterranean* (L.) Verdc] CROP IN THE NORTHERN REGION OF MOZAMBIQUE: production, uses and myths

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In Mozambique, Bambara groundnut is a neglected and underutilized crop even despite its high nutritional value. Consequently, there is limited information on agronomic management practices, production constraints, farmers' preferred traits, seed and improved varieties. To understand the major production constraint and uses of Bambara groundnut crop in Mozambique, a participatory rural appraisal (PRA) was conducted. The objectives of the survey were to: 1) identify major constraints limiting Bambara production; and 2) identify the main uses of the crop. The study was carried out in three districts of northern Mozambique, namely Chiure and Memba (in Cabo Delgado and Nampula provinces respectively), and Mulevala (in Zambezia province). Survey tools included a semi-structured questionnaire, transect walk, problem listing, and focused group discussions. Additionally, interviews were also carried out with key informants comprising community leaders and local extension officers, and these data were triangulated with the data gathered from transect walk, problem listing and focused group discussion and used to support and validate the information obtained from the semi-structured questionnaire. Other supporting information was obtained through reports from other sources such as the Ministry of Agriculture and National Institute of Statistics. Key informants, community leaders and local extension officers were contacted in the process to validate the data. Analysis performed included association, frequencies and descriptive statistics using the statistical software SPSS. Results indicate that drought was considered the major limiting factor for bambara production in all districts villages. Also, diseases and insect pests were indicated as a prominent fact that explains the low bambara yields. Additionally, seed unavailability and lack of improved varieties were also reported as an important constraint responsible for the low yields. Farmers indicated that the purpose of bambara production include household income, by selling either in town or at village market, home consumption and seed for the following season. This study revealed that farmers are aware of the major constraints that affect production production in Cabo Delgado, Nampula and Zambezia provinces.

Keywords: Bambara groundnut, Mozambique, neglected crops, underutilized crops.

MORPHOLOGICAL CHARACTERIZATION OF 18 RICE VARIETIES

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In the present study, 18 varieties were characterized using morphological markers. The experiment was conducted in the experimental field of the Regional Center for Rice Leadership and Research/IIAM. The varieties were evaluated in a completely randomized block design with three replications. 16 descriptors proposed by IRRI were collected, 6 qualitative descriptors (ligule color, auricle color, leaf color, flag leaf posture, stem growth habit and leaf pubescence), and 10 quantitative descriptors (days until flowering, stem length, stem diameter, panicle length, number of tillers, fertile tillers, days until harvest, mass of 1000 grains and the yield). The RStudio statistical package was used for data analysis. For the quantitative variables, he initially performed the normality and homogeneity tests of the errors, the analysis of variance and the mean tests at the level of significance at 5%. Regarding yield, there were statistical differences between the averages and the Simao variety had the highest yield of 2614.17Kg/ha. The greatest distances from Manhattan were 53,140 between the genotypes (Mantega and Oziveliwa) and 51,691 (Vitamin and Oziveliwa), being one of the crosses to be considered for the generation of genetic variability in the Rice breeding program. The dendrogram was obtained by the method of grouping means/average and showed three groups: Group 1 (Oziveliwa, Faya, Simao, Zm30-57 and ITA34), group 2 (Roza Nhanguela, Mantega, Vitamina Namurava and Casambaua), group 3 (Sinabibi, Muworoma, Humwenhe, Nene, Mamima, Mbiguidi, Bebe and Chupa).

Keywords: Characterization, Diversity, Genetic improvement, Rice.

POPULATION GENETIC ANALYSIS OF CASSAVA BROWN STREAK VIRUS IN
MOZAMBIQUE, TANZANIA AND KENYA AND GENETIC DIFFERENTIATION OF CBSV
ASSOCIATED VIRUS SPECIES

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Cassava brown streak disease is caused by Cassava brown streak virus (CBSV) and Uganda cassava brown streak virus (UCBSV). Previous phylogenetic analyses using full genome and individual genes sequences have demonstrated that among the CBSV sequences there are two main clades: CBSV clade 1 and CBSV clade 2, suggesting further speciation. Comparison of the levels of nucleotide diversity (π) between and within related species may provide relevant information for understand the genetic differentiation and demographic history of these species and signatures of past selection events. Using full genome sequence of CBSV from this study with other retrieved from Genbank we performed genetic differentiation and diversity of the closely related species associated to CBSV. Additionally we determined the Population genetic analysis of Cassava brown streak virus from Mozambique, Tanzania and Kenya. The results, revealed lower nucleotide diversity within UCBSV ($\pi=0.08258$) than that in CBSV ($\pi=0.11246$). Separate analysis between the two clades of CBSV indicated highest (two times higher) nucleotide diversity of isolates belong to CBSV clade 2 ($\pi=0.09251$) than CBSV clade 1 ($\pi=0.04858$). Based on the individual genes within each CBSV species, P1 gene showed the highest π values: overall CBSV (0.17483), UCBSV (0.10977), Clade 2 ($\pi=0.16900$), except isolates belong to CBSV clade 1 which HAM1 was the gene with highest π value (0.06288). On the other hand, Coat protein (CP) was the gene with lowest nucleotide diversity values: CBSV (0.05012), UCBSV (0.06363), and CBSV clade 2 (0.05588), except for the isolates belong to clade1 which the lowest π values (0.03410) was recorded in 6K1 gene. CBSV Population genetic analysis showed that π varied between the geographical locations indicate that CBSV population from Mozambique has the lowest level of nucleotide diversity ($\pi=0.06843$) than population from Kenya and Tanzania.

Keywords: Cassava, CBSV, genetic analysis, UCBSV

ADAPTABILITY OF THE FORMOSANA BANANA VARIETY IN THE SOUTHERN AGROECOLOGICAL ZONE

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Panama disease, caused by the fungus *Fusarium oxysporum* f. sp. *cubense* (Foc) tropical race 4 (TR4), has impacted banana cultivation in various countries worldwide. Mozambique stands as the sole country on the continent afflicted by this disease. The aim of this study was to assess the adaptability of the Formosana variety within the southern agroecological zone, as it currently represents the only variety exhibiting tolerance to Panama disease. Sowing was conducted in February 2022, employing a completely randomized block design with four replications and four blocks. Data collection encompassed measurements such as plant height, pseudostem diameter, leaf count, dimensions of leaf 3 (length and width), pseudostem height and diameter at flowering, bunch weight, number of hands, fruit length and diameter, brix value, number of days from planting to harvest, number of days from planting to flowering, and number of days from flowering to harvest. Data analysis utilized the STATA version 16 software, encompassing ANOVA calculations at a 5% significance level, determination of means, and the coefficient of variance for each variable. According to the test results, significant differences were observed between the two varieties in terms of height. At the conclusion of the cycle, the recorded data for Formosana and Williams were 2.8 and 2.9, respectively. For diameter, no significant differences were noted between the two varieties, with recorded values of 64.3 for both varieties in December. Regarding post-harvest measurements, the data indicate a bunch weight of 40 kg for the Formosana variety and 37.3 kg for the Williams variety. Banana length was measured at 24.3 for Formosana and 23.3 for Williams. The width of bananas for Formosana was 13 cm, while for Williams, it was 12.3 cm. Both the Formosana and Williams varieties exhibited 12 hands per bunch. In terms of days from planting to harvest, Formosana required 424.3 days, while Williams required 423.7 days. Days from planting to flowering were 314 for Formosana and 311.5 for Williams. The period from flowering to harvest was consistent for both varieties at 124.3 days. The Brix results for the Formosana variety averaged 22.6, while for the Williams variety, the value obtained was 22.3. Additionally, 12.25 leaves were obtained for the Formosana variety, compared to 12.50 leaves for the Williams variety. Regarding leaf dimensions, the leaves of the Williams variety were larger, measuring 0.88 m wide and 2.33 m long, compared to the leaves of the Formosana variety, which measured 0.78 m and 2.22 m wide and long, respectively. The coefficient of variation (CV) indicates high precision for all variables in both varieties. Significant differences were observed between the two varieties in plant height, leaf width and length, fruit length and diameter, and bunch weight. These disparities can be attributed to inherent characteristics of each variety's genotype. The Williams variety showed higher values in the dimensions of the third leaf. However, the Formosana variety surpassed the Williams variety in fruit length and diameter, as well as bunch weight, with 40 kg per bunch compared to Williams' 37.3 kg per bunch.

Keywords: Banana, Formosana.

EVALUATION OF DIFFERENT SOWING DATES ON THE AGRONOMIC
PERFORMANCE OF ONION VARIETIES (*Allium cepa* L.) AT THE UMBELUZI
RESEARCH STATION

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Onion production is largely affected by several factors, where the sowing date is an important and essential component, with effects on productivity and the final quality of the bulbs. Therefore, the present work was elaborated, aimed to evaluate the agronomic performance of five onion varieties (*Allium cepa* L.) submitted to eight sowing dates. The trial was conducted at Estação Agronômica de Umbeluzi, the experimental field of the Instituto de Investigação Agrária de Moçambique (IIAM), in Boane district. The design used was Random Complete Blocks (DBCC), based on split plot with four (4) repetitions, divided into main factor (plots) represented by Eight (8) Sowing dates and secondary factor (sub-plots) represented by five (5) onion varieties (Red Creole, Texas grano 502, IPA 10, IPA 11 and Alfa San Francisco). The experiment included 40 treatments and 160 experimental units, the data were collected in the useful area of the sub-plot, consisting on 10 plants from the two central lines, excluding the borders. The Statistical analysis showed higher yield performance and bulb weight in the varieties Alfa Sao Francisco (19.31 t ha⁻¹) and IPA 10 (18.01 t ha⁻¹), followed by IPA 11 (15.23 t ha⁻¹) and Texas Grano (14.59 t ha⁻¹) compared to Red Creole (7.17 t ha⁻¹) which presented low yield and high number of non-commercial bulbs (known as waste). However, there was isolated effect on the sowing dates factor indicated greater yield performance on March 6th and April 2nd and 16th however, sowing is not recommended on March 21st, June 5th and 17th because, of low yield recorded on these date respectively.

Keywords: *Allium cepa* L., Yield and sowing dates, Onion.

GRAIN YIELD, STABILITY AND BACTERIAL BROWN SPOT DISEASE OF DARK RED
KIDNEY DRY BEAN (*Phaseolus vulgaris* L.) GENOTYPES ACROSS SIX
ENVIRONMENTS IN SOUTH AFRICA

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Dry bean (*Phaseolus vulgaris* L.) is grown under an extensive range of agro-climatic conditions and is an essential source of protein and income globally. This study aimed to evaluate yield performance, stability, and bacterial brown spot (BBS) disease resistance of fourteen dark red kidney genotypes across environments in South Africa namely Carolina, Clarens, Cedara, Middelburg, Potchefstroom, and Warden. Analysis of variance (ANOVA), additive main effects and multiplicative interaction (AMMI) and the genotype plus genotype by environment interaction (GGE-biplot) analysis were used to evaluate grain yield performance, stability, and BBS disease resistance. The AMMI ANOVA revealed that mean squares for grain yield and BBS severity for the environment, genotype, and genotype by environment interaction were highly significant ($P < 0.001$). Four interaction principal components (IPCA1 - 4) for grain yield and IPCA1 for BBS severity were highly significant ($P < 0.001$, $P < 0.01$). Genotype G12 showed broad adaptation for both high grain yield and low BBS severity across the six environments, while genotypes G08, G06, G03, G02, G05, and G04 had specific adaption for high grain yield and low BBS severity. These genotypes recorded grain yield above the grand mean and the best check cultivar, both with 1.43 t ha⁻¹, and BBS severity below the grand mean (31.90%) and the best check (48.89%). The genotypes identified with either broad or specific adaptation can be released in the environments they are adapted to, or used as parents in breeding programmes aiming to improve grain yield and BBS disease resistance of dry bean for farmers in South Africa.

Keywords: AMMI stability value (ASV), bacterial brown spot severity, broad adaption.

MORPHOLOGICAL CHARACTERIZATION OF PAPAYA GERMPLASM (*Carica papaya* L.) COLLECTED IN DIFFERENT LOCATIONS ALONG THE NACALA CORRIDOR, NAMPULA PROVINCE – MOZAMBIQUE

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Papaya (*Carica papaya* L.) stands as a vital fruit globally, esteemed for its social, economic, and nutritional merits. Its rich vitamin A, B, and C content, coupled with its low acidity, render it as a favorite among consumers. Notably, papaya cultivation offers a lucrative avenue for small-scale farmers, given its year-round harvest cycle. However, its cultivation within the recourse poor family sector remains nascent, with individual producers typically limiting subsistence planting to less than a hectare. This limited expansion in Mozambique may stem from inadequate access to improved plant varieties suited to local conditions. This study endeavors to characterize 79 papaya accessions sourced from Monapo, Meconta, and Nampula districts along the Nacala Corridor, Nampula province, during September – November 2021. Morphological characterization employed fifteen IBPGR descriptors, comprising nine quantitative and six qualitative parameters. Descriptive statistics and multivariate analyses, particularly Principal Component Analysis (PCA), were conducted on quantitative traits. The resultant dendrogram, employing the UPGMA clustering method, delineated two distinct groups, A and B, based on average Euclidean distances. Quantitative analyses revealed significant diversity among local accessions, with fruit weight ranging from 125 g to 2513 g, and maximum soluble solids content reaching 14°Brix. Noteworthy variations in flesh color were observed, with 71% exhibiting yellow, 24% orange, and 3% red hues. These findings underscore the diverse traits inherent in local papaya accessions, laying a robust foundation for initiating a papaya breeding program tailored to Mozambique's agricultural landscape.

Keywords: *Carica papaya*, diversity, local access, Mozambique.

GENOTYPE BY ENVIRONMENT INTERACTION, ADAPTABILITY AND STABILITY
ANALYSIS OF COTTON (*Gossypium hirsutum* L. Race Latifolium H.) IN NORTHERN
MOZAMBIQUE

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Cotton, the “white gold”, is one of the most important crops in the world. In Mozambique, cotton is a cash and foreign exchange crop and is regularly on the list of agricultural exports. Cotton cultivation in the country is mainly done by the small-scale farmers, which faces many challenges, characterized by low yields ($< 500 \text{ kg.ha}^{-1}$), due to the use of seed from unimproved varieties that are poorly adapted to local cultivation conditions and systematic use of recycled and non-certified seed. Research has been introducing new varieties in addition to the genotypes developed in the country. The objective of this study was to evaluate the adaptability and stability of 2 cotton varieties and 2 inbred lines for cottonseed and fiber yield. The trials were conducted under rainfed conditions in three consecutive seasons, 2021, 2022 and 2023 in Namialo, Namapa, Montepuez, Ribaue and two seasons, 2001 and 2023 in Cuamba, making a total of 14 environments. The treatments, consisted of 9 cotton varieties/genotypes were established in a RCBD in 4 replications. Individual and combine ANOVA for seedcotton and fiber yields were carried out and adaptability and stability were applied using the GGE methodology. The PL-164/2 genotype was the most stable, with greater predictability, followed by Flash and MP2020. The MP2020 genotype showed greater fiber maturity; whereas, PL-164/2 had a standard fiber length in relation to the minimum required. Thus, PL-164/2, Flash and MP2020 are recommended to be registered and released for production.

Keywords: Biplot, cottonseed yield, fiber quality, GGE analysis, inbred lines.

UNLOCKING THE POTENTIAL OF SORGHUM: a comparative study exploring the physical, chemical, technological, and digestibility properties of new cultivars from Mozambique

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This study aimed to evaluate the physical, chemical, technological, and digestibility of three sorghum cultivars (Mucuvea, Otela, and Tocale) and compared them to a Local variety (criola) grown in Mozambique. Thousand-grain weight, hectolitre weight, and colour were determined in the grains. Proximal composition, antinutritional factors, starch and protein digestibility, and antioxidant activity were analysed in flours; starch was isolated and characterised by its physical, chemical, morphological, and digestibility properties. The grain characterisation varied among the cultivars compared to the Local variety, but not between the cultivars. The cultivars showed lower amounts of protein, lipids, free phenolics, tannin, soluble protein, digestibility of starch flour and proteins, and higher flavonoids and antioxidant activity. A high content of amylose (~37%), glycemic index (~82), Tp (64.83 °C), and resistant starch (57.73%) were verified in all cultivars. The peak viscosity of Local variety was higher (343.25 RVU) than the Other cultivars, while the breakdown (less than 106.54 RVU) of the cultivars was significantly lower than Local (182.25 RVU). Such data suggest great potential use of Local variety in bakery products and the cultivars in products that require greater viscosity. These results will reinforce the research, production, and manufacture of new products in Africa, especially in sorghum-producing countries.

Keywords: Protein solubility, resistant, sorghum flour, starch, starch in vitro digestibility.

EVALUATION OF PLANTING DATES AND WHEAT GENOTYPES FOR OPTIMIZATION OF RAINFED PRODUCTION IN THE LICHINGA PLATEAU

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The growing need to reduce spending on wheat imports in Mozambique and reduce vulnerability to fluctuations in the international market motivated the exploitation of national production. Given the deficient local irrigation infrastructure, rainfed wheat production emerges as a viable alternative. This study aims to identify optimal planting dates and best wheat varieties in the Lichinga Plateau, as a technological solution to the productive sector dominated by small farmers. The experiment was carried out in a randomized block design with 3 replications, using a factorial scheme (11x5), including 10 elite CIMMYT genotypes (G5, G7, G8, G11, G14, G17, G21, G24, G27 and G33), a variety from Zimbabwe (Nduna), and five sowing dates, spaced fortnightly between December 31 and February 28. The analysis of yield and incidence data for ears with hollow grains (2022/2023 and 2023/2024), using ANOVA with a significance of 5% and Tukey's test, revealed significant yield differences between dates and genotypes, with no interaction between the factors. The genotypes G11, G14, G17, G33, G5 and G7, sown between January 29 (D3) and February 14 (D4), showed higher yields, ranging from 2.3 to 4.5 t/ha, and lower percentages of hollow grains, from 15% to 35%. The correlation using Pearson's test was slightly weak and negative (-41.7%) among the variables analyzed. These preliminary results indicate promising dates and genotypes for rainfed wheat production in this region, contributing to the reduction of the trade deficit due to imports.

Keywords: Elite genotypes, Lichinga Plateau, planting dates, rainfed, wheat.

EVALUATION OF ADAPTABILITY AND STABILITY OF EIGHT POTATO CLONES IN NIASSA PROVINCE, MOZAMBIQUE

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Potato (*Solanum tuberosum* L.) is one of the most important non-cereal crops in Mozambique. It is the third most important food crop in the country after Maize, rice and wheat. One of the challenges in its cultivation is the shortage of seed to meet farmer's needs. The objective of this study was to evaluate the agronomic performance of eight potato clones in Niassa province. The experiment was set up as randomized complete block design with three replications during the 2021/2022 and 2022/2023 cropping seasons in three districts of Chimbunila, Sanga and Lichinga, the eight clones 398990.605, 396033.102, 398190.59, 398098.99, 3992797.23, 398098.70, 398208.570, 304350.100, were the treatments plus variety Calinga (control). All agronomic practices were applied uniformly across all the treatments. Analysis of variance using the GGE biplot method. On average the clone 3992797.23 presented the best yield while clone 398098.7 had the lowest yield over the two seasons. The clone 398190.605 had best yield in Sanga district.

Keyword: Adaptability, clone, district, stability.

EVALUATION OF THE NUTRITIONAL QUALITY OF SUNFLOWER (*Helianthus annuus* L.) GENOTYPES OF DIFFERENT COLORS OF ACHENE PRODUCED AT IIAM – NAMPULA

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The sunflower (*Helianthus annuus* L.) is an annual plant of the Asteraceae Family whose center of origin is probably North America. Among the oilseeds, it is among the ones with the highest growth rates in the world, due to the production of vegetable oil of excellent nutritional and organoleptic quality, with high physicochemical and nutritional characteristics. It is considered a versatile plant, and can also be used as grains for human and animal food, in the production of concentrated protein, as raw material for the production of biofuels and in the production of silage for ruminant feed. This research had a hybrid character (on station and on lab) with the objective of evaluating the Nutritional Quality of sunflower genotypes (*Helianthus Annuus* l.) of different achene colors, produced at the Institute of Agrarian Research of Mozambique (IIAM) – Nampula. The samples were collected at the agronomic post of Nampula based on the main criterion of achene color and number of stems. The analyses were carried out in the UniRovuma laboratory for humidity, dry matter, ash and organic matter parameters, according to the methodology of the Adolfo Lutz Institute and the Ceil Laboratory of UniLurio. For the determination of roteins the Kjeldahl method was used and the determination of lipids was used using the Soxhlet method. In general, the studied sunflower genotypes showed average values of: moisture 7.20%, dry matter 92.79%, total ash 2.65%, protein in terms of 11.38 % and the lipid content was 26.823%. Based on the results obtained, it is concluded that the sunflower genotypes showed better adaptability in the agroclimatic conditions of Mozambique because they presented better agronomic and morphological characteristic. In terms of nutrients, they had low protein and lipid content, a fact that can be justified by the environmental conditions, such as altitude, climate and soil composition that influence the content of substances that constitute the plants.

Keywords: Lipids, Proteins, Sunflower, Total Ash.

EFFECT OF DIFFERENT CONCENTRATIONS OF SUCROSE ON THE IN VITRO GROWTH OF CASSAVA CULTIVARS (*Manihot esculenta* Crantz)

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The establishment of slow growing conditions is fundamental to the management of an *in vitro* bank. This work aimed to evaluate the effect of different concentrations of sucrose in the reduction of *in vitro* growth of cassava plants (*Manihot esculenta* Crantz). The work was carried out in the biotechnology laboratory of Agrarian Research Institute of Mozambique with 4 cultivars realized by national cassava program namely Chinhembwe, Umbeluzi 2, Tapioca, Cucci and Amarelinha. Shoot tips were inoculated on MS medium, supplemented with 1.0 mg. L⁻¹ of thiamine, 100 mg. L⁻¹ of inositol, 0.02 mg.L⁻¹ of NAA, 0.04 mg. L⁻¹ of BA, 0.05 mg.L⁻¹ of GA3, 20 g.L⁻¹ of sucrose and 2.4 g.L⁻¹ of Phytigel® with pH adjusted to 5.8. The shoot tips were incubated in a growth chamber at 27 ± 1 °C, photoperiod of 16 hours and light intensity of 22 µE m⁻²s⁻¹ for 30 days. Three subcultures were done in order to produce the plants to be used in the conservation assay established with 8S medium culture supplemented with 0g.L⁻¹, 10 g.L⁻¹, 20 g.L⁻¹, 40 g.L⁻¹, 80 g.L⁻¹ of sucrose. The incubation conditions of this experiment was 22 °C temperature, light intensity of 2.0 x 10⁷ µmoles.m⁻²s⁻¹ and a photoperiod of 12h. The best results were obtained with 10 and 20 g.L⁻¹ of sucrose considering all evaluated cultivars. The concentrations of 40 g.L⁻¹ promoted more growth in most varieties with exception of Tapioca. On the other hand, the cultivar Umbeluzi 2 was more efficient to retain leaves during the 12 months conservation period.

Keywords: Germplasm, in vitro conservation, osmotic regulator, sucrose.

DEVELOPMENT OF IMPROVED RICE VARIETIES FOR RAINFED LOWLAND ECOSYSTEM

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For registration and release purposes, field experiments were carried out in 6 Districts of 3 Provinces in Central and North Mozambique, namely, Zambezia (Maganja da Costa, Nicoadala and Mopeia), Nampula (Angoche and Mogovolas) and Sofala (Caia), during 2016 and 2017 growing season to assess the adaptability and stability of rice lines in rainfed lowland ecosystem, following the randomized complete block design (RCBD), with three replications and 10 treatments. Data on Plant height, Tillering ability, days to 50% flowering, days to maturity, Grain yield, and Grain quality were assessed and analyzed. In the set of 12 environments of the lowland rainfed ecosystem (6 sites x 2 years), the lines CXT30 (7.8t/ha), IR50404 (7.8t/ha), and Mocuba (6.8t/ha), showed better yields than the control C4-63(4.6). In terms of days to 50% flowering, the earliest line was IR50404 (77) followed by CXT30 (82), when compared with C4-63 (104) in the global of the 12 environments. As for plant height, it shows that the genotypes had different average plant heights, with Mocuba having the highest average (120.95cm) and C4-63 having the lowest average (87.54 cm). According to the study carried out, was possible to find genotypes (CXT30, IR50404, and Mocuba) with greater yield potential than C4-63. The study also showed that the lines (CXT30, IR50404, and Mocuba) are relatively earlier than (C4-63). During participatory selection, farmers preferred the CXT30, IR50404, and Mocuba lines because of acceptable yield and grain quality (long to extra-long grain, aroma, translucent, cooking quality, and flavor).

Keywords: Adaptability, lines, rainfed lowland, stability, yield.

FACTORS THAT INFLUENCE THE CONSUMPTION OF BIOFORTIFIED YELLOW MAIZE PROVITAMIN A

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The biofortification of agricultural crops with the aim of developing staple crop varieties rich in micronutrients, in order to achieve provitamin A, has been proposed to contribute in reducing the vitamin A deficit that affects thousands of children in sub-Saharan countries. Studies conducted in several African countries, including Mozambique, show poor preference for provitamin A biofortified yellow maize when compared to white maize, and there are few studies in Mozambique that examine the factors that determine the consumption of biofortified yellow maize. In the presente study, the social, personal and psychological factors that influence the consumption of biofortified provitamin A maize were examined, using as a reference the yellow maize that is widely known in Mozambique. The research was carried out in the districts of Boane, Moamba and Manhica in the province of Maputo, in southern Mozambique, where maize is one of the basic foods and one of the most produced agricultural crops. The sample size was 213 households. The surveyed households were selected randomly. For data analysis, binary logistic regression was used in STATA 15. The results show that four out of fourteen variables tested are significant, namely the education, age, paid employment and producing yellow maize. Education and producing yellow maize have a positive relationship with yellow maize consumption, while the remaining variables have a negative relationship with yellow maize consumption.

Keywords: Biofortified provitamin A, consumption, Mozambique, Yellow maize.

GENETIC DIVERSITY OF *Coffea* spp. IN MOZAMBIQUE

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The genus *Coffea* is native to Africa and comprises more than 130 species, of which Only two dominate the world market: *C. arabica* L. (Arabica type of coffee) and *C. canephora* Pierre ex A. Froehner (Robusta type of coffee). In Mozambique, a community-based flagship project (GorongosaCoffee) is being developed in the Gorongosa Mountains, where an agroforestry management system with coffee and native trees was implemented, aiming to promote socio-economic development and revert deforestation. Integrated in this project, we are characterizing the introduced and native *Coffea* species based on distribution, taxonomic and genetic diversity studies of plants. Current distribution of the genus *Coffea* was assessed through herbarium data (IIAM, UEM, LMU and LISC), and validated through field surveys. Taxonomic analysis was based on morphological descriptors, and genetic barcodes (matK, rbcL, and ITS). Moreover, Microsatellites (SSRs) were used to assess genetic diversity and gene flow between *Coffea* populations in Mozambique. Genetic barcodes revealed the presence of cryptic species of *Coffea*, which is also supported by the presence of wide genetic variation values. A decrease in population genetic diversity was found between data obtained from herbarium vouchers and recently collected samples. The studied populations of *Coffea* in Mozambique showed high levels of genetic diversity, quickly reacting to changes in landscape structure and anthropogenic pressure despite the loss of native germplasm.

Keywords: *Coffea* sp, genetic diversity.

EVALUATION OF THE MICROBIOLOGICAL, SENSORIAL AND PHYSICOCHEMICAL QUALITY OF SOY MILK DERIVED FROM TGX 1904-6F ZAMBOANE VARIETY FROM THE PROVINCE OF ZAMBEZIA, MOÇAMBIQUE

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Soy milk (SM) has been known since ancient times for not containing lactose in its composition, unlike cow's milk. It is used as a food alternative in people with lactase deficiency. The study aimed to evaluate the quality of SM extracted from TGx 1904-6F Zamboane variety soybean variety produced in Zambezia province, Mozambique. The extraction of the SM was followed by sensory analysis based on an acceptance test using a hedonic scale from 1 (I really disliked it) to 7 (I really liked it) points to evaluate flavor, color and aroma. Then we performed the microbiological analysis and the physicochemical evaluation. Our study demonstrated that there was no significant difference ($p > 0.05$) in relation to the sensory analysis of SM (aroma=4.69 1.36, color=4.48 1.55 and flavor=3.94 1.68) on the hedonic scale. The physicochemical properties were: moisture (94.3 ± 0.06), ash (0.28 ± 0.35), proteins (2.39 ± 0.18), fat (1.1 ± 0.14) and carbohydrates (1.88 ± 0.22). Despite slight differences, these results are within the standards. In the microbiological aspect, the results demonstrated the absence of Staphylococcus, Coliforms (at 45°C) and Salmonella. In conclusion, the SM was notable for its good sensory acceptability for human consumption due to the fact that it does not have an astringent taste. Moreover, its physicochemical Properties suggest that this product is could be recommended for human consumption. Thus, the massification of TGx 1904-6F Zamboane variety soybean variety will contribute to increase the consumption of plant-based milk, an alternative source of protein for communities with few resources.

Keywords: Chemical composition, sensory analysis, soy milk, TGZ 19046F soybean.

IMPACT OF PHOTON FLUX DENSITY AND LIGHT SPECTRAL QUALITY ON BIOMASS PRODUCTION AND ARBUTIN COMPOUND ACCUMULATION IN *Origanum majorana* L. PLANTLETS

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Light is one of the factors that influence the growth, development and synthesis of secondary metabolites of different plant species *in vitro*. *Origanum majorana* is an aromatic plant belonging to a group of plants that produce arbutin, a substance of importance in the cosmetic industry. The objective of this study was to verify the effect of light intensity and wavelength on the growth and accumulation of arbutin *in vitro* in plantlets. Nodal segments were grown in MS culture medium under photon flux densities of 26, 51, 69, 94 and 130 $\mu\text{mol m}^{-2} \text{s}^{-1}$. In the light spectrum, nodal segments were grown under different light-emitting diodes LED: red; blue; a combination of blue and red light (30% B:70% R; 50% B:50% R; 70% B:30% R); and white, yellow and green. After 40 days, the growth, photosynthetic pigments and arbutin accumulation were evaluated by HPLC-DAD. The lowest light intensity (26 $\mu\text{mol m}^{-2} \text{s}^{-1}$) provided a higher content of photosynthetic pigments, and the intensity of 94 $\mu\text{mol m}^{-2} \text{s}^{-1}$ increased dry biomass accumulation. Greater accumulation of arbutin was observed under a higher light intensity of 130 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Regarding the quality of light, different wavelengths did not significantly affect the number of shoots or shoot length. The white light spectrum stimulated a greater accumulation of dry biomass. The green light provided a greater accumulation of photosynthetic pigments. The amount of arbutin was influenced by the different light spectra. The red spectrum promoted the highest arbutin content, and the yellow inhibited.

Keywords: HPLC, *in vitro*, light-emitting diodes, marjoram.

THEME: RESILIENCE

IDENTIFICATION OF TAS14 AS A CANDIDATE GENE FOR DROUGHT TOLERANCE BY RNA-SEQ IN SWEET POTATO

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Sweet potato (*Ipomoea batatas*) is a crop grown predominantly in drought-prone areas, and it is considered to be adapted to hot and dry conditions. Yet, drought causes yield reduction in this crop. There is a need to improve the levels of drought tolerance in sweet potato varieties that are of interest to growers. The utilization of drought-tolerant cultivars is an approach to deal with this issue. This approach can be used for improving the tolerance to drought in sensitive varieties or for the adoption of tolerant genotypes. RNA sequencing (RNA-Seq) was performed for a comparative transcriptomic analysis of two varieties of sweet potato, Beauregard and Resisto, that were previously studied in a phenotypic assessment for drought tolerance. Leaf tissues of the two cultivars were collected during three time points: 24 hours before drought (24BD), 24 and 48 hours after (24AD and 48AD) the plants were exposed to drought. Drought stress is associated with the biosynthesis of abscisic acid (ABA) in plants and this hormone induces stomatal closure. There was a decrease in the stomatal conductance of both Beauregard and Resisto at 24AD and 48AD. The drop in the stomatal conductance was higher in Resisto than in Beauregard. The results of the transcriptomic analysis showed that the abscisic acid and environmental stress-inducible protein-like gene (TAS14) was differently expressed in both varieties through the drought events (24AD and 48AD). There was an overexpression of the TAS14 gene in both varieties when water deficit stress was imposed. The TAS14 gene was expressed at 24AD with a proportion of the fold change of Beauregard/Resisto of 1.21 and at 48AD the ratio was increased by 1.66. The Beauregard/Resisto ratio increase of the TAS14 gene was in accordance with the decrease of stomatal conductance in both cultivars. The TAS14 gene, a dehydrin, is a protein involved in protective reactions to plant dehydration and has been associated with drought tolerance in other studies. Based on the results of the phenotypic and transcriptomic analyses, it was concluded that TAS14 could be a candidate gene for drought tolerance in sweet potato. The changes in this gene were associated with stomatal closure when the plants were under a water-stress deficit. The recommendation for this study is to include the cultivar Beauregard in further studies for drought tolerance in sweet potato.

Keywords: Beauregard, drought tolerance, Resisto, Sweet potato, transcriptomics.

EVALUATION OF THE EFFICACY OF THE USE OF SYNTHETIC AND INORGANIC ORGANIC FERTILIZERS ON THE PERFORMANCE OF MAIZE VARIETIES INTRODUCED FROM SPAIN AT THE SUSSUNDENGA AGRARIAN STATION

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To achieve maize high productivity there is a need to add nutrients to the soil, which can be of mineral origin and/or synthetic organic. The study aimed to evaluate the effect of synthetic and inorganic organic fertilizers on maize cultivation and adaptability of yellow maize varieties introduced from Spain (Borja, CZH0524, Girona, Manacor, Oropesa, Pombal, Zamora). The work was conducted at the Sussundenga Agrarian Station, Where two levels of synthetic organic fertilizers were used, one inorganic, one control, 6 yellow corn hybrids introduced from Spain and four local varieties, two hybrids and two open pollination (OPvs). The levels of fertilizer tested included: N0 (control); N1.1 (120-60-30 kg/ha inorg.1); N1.2 (120-39-42 kg/ha organ.1); N2 (62-21-24 kg/ha organ.2). The 10 varieties of maize included were: 1-Zamora, 2-Girona, 3-Pombal, 4-Oropesa, 5-Borja, 6-Manacor, 7-CZH0524, 8-PAN 53, 9-Dimba and 10-Matuba. The trial in total had 40 treatments. The experimental design was a randomized complete block, with split-plots and three replications. The application of synthetic organic fertilizers was done in different phases (1- 7 days before sowing, 2- on the day of sowing, 3-plants with 55 cm height, 4- in flowering, 5- in the milky phase, 6- any stress of Strong winds and rains) of corn development and inorganic fertilizer was applied at the time of planting and as a topdressing at 35 days after planting. The parameters evaluated were: Grain yield, flowering, plant and cob height, number of plants at the beginning and at harvest, number of cobs at harvest, aspects of the plants and cob and pests and diseases. There was no significant difference in maize yield when synthetic and inorganic organic fertilizers were applied. There were significant differences between the organic levels (N2) with an average of 5,515 kg/ha and/or inorganic (N1.1) with an average of 4,842 kg/ha and the control with an average of 2,543kg/ha. There were also significant differences between the grain yield of the varieties under study as well as significant differences in the interaction between varieties and fertilizer. However, the local variety PAN 53 had a yield above all with an average of 6,054 kg/ha and the worst variety was the introduced Girona. Of note is a variety introduced from Spain, CZH0524 which came in second place with an average of 4,900 kg/ha, even without significant differences between PAN53. It is thus up to the researchers to carry out further studies in various environments with the same material to reverify the effectiveness between synthetic and inorganic organic fertilizers in Mozambique.

Keywords: Adaptability and Synthetics, Inorganic fertilizers, organic fertilizers, varieties.

IMPROVING SOIL HEALTH, FOOD SECURITY AND INCOME OF SMALLHOLDER FARMERS IN MOZAMBIQUE THROUGH THE DEVELOPMENT AND USE OF APPROPRIATE FERTILIZER FORMULATIONS FOR MAIZE AND SOYBEAN IN THE BEIRA CORRIDOR

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Low soil fertility associated with fertility decline over time due to inappropriate agricultural practices puts the agricultural sector in Mozambique in a vicious cycle with a tendency to collapse if appropriate measures are not taken to reverse the scenario. In addition, the application of inorganic fertilizers in general is low and, even in places where it is applied, the formulation is often not adequate taking into account and considering the type of soils and the crop in question. In order to reverse this scenario, at least at the level of the Beira corridor, a consortium composed of 5 public and private institutions, namely: Institute of Agrarian Research of Mozambique – IIAM (Consortium Leader); Eduardo Mondlane University – UEM-FAEF (Partner); the National Directorate of Agriculture and Forestry (Partner), Public Extension at district level (SDAE's) (Partner); YARA / Greenbelt fertilizers Group (Partner); and Mozambique Fertilizer Company (MFC) (Partner) have carried out research with the aim of developing and validating new balanced fertilizer blends adapted to specific locations and crops. To this end, soil samples were georeferenced and collected using a transect approach in the Provinces of Manica (Gondoa and Barue), Sofala (Nhamatanda and Gorongosa) and Tete (Tsangano and Moatize). The soil samples were then sent to the soil laboratory for macro and micronutrient analysis. Based on the laboratory results of soil samples, the nutrient deficiency was calculated and the rates for corn and soybean were established. The formulas were proposed using the South African Recommendation Sheet. Then, validation tests were carried out for 3 years in the above-mentioned districts, which are part of agro-ecological regions 4, 7 and 10. Statistical analyses were performed in the R statistical package and maps were produced using spatial statistical tools in Arcmap. The results indicate that for the corn crop, fertilizers with the following formulations: 24N-21P-5K+5S; 15N-30P-5K+5S+0.2B+0.5Zn and; 29N-10P-5K+5S+0.2B+5Zn had better agronomic and economic performance. For soybean crops, the formulations that stood out the best were: 5N+25P+0K+5S+0.2Mn; 5N+30P+0K+8.5S+0.2B+0.5Zn and; 5N+25P+0K+5S+0.2B.

Keywords: Agro-ecological regions, corn and soybeans, fertilizers

AGRICULTURAL LAND USE IS INCREASING SOIL LOSS IN THE LUGENDA RIVER BASIN, PART OF ONE OF THE LARGEST CONSERVATION AREAS IN AFRICA: a multitemporal analysis

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Soil loss is a natural geomorphological process in which precipitation, soil cover, slope and soil characteristics interact. However, this process has been significantly altered by human action, especially agriculture. The objective of this study was to evaluate soil loss in different covers in the Lugenda River basin, located in northern Mozambique, with a special focus on the Niassa Special Reserve. Soil and rainfall erodibility factors, topography and cover were used to calculate soil losses using the Universal Soil Loss Equation (USLE). The analyses were structured in an interval between the years 2000 and 2019, analyzing losses by type of coverage, as well as quantifying them inside and outside the Niassa Special Reserve. Statistical analyses were used to compare losses in different covers (evergreen forest, deciduous forest, mixed forest, tree savanna, savannah, grasslands, wetlands, agricultural zones) based on the years of analysis (2000, 2005, 2010, 2015 and 2019). The results show a reduction in soil losses between the years 2000 and 2005, by 4.15 and 2.95 ton/ha outside and inside the reserve, respectively. A reduction that can be explained largely due to the low values of rainfall erodibility and the reduction in the loss of vegetation cover in almost the entire basin. However, the loss process increased again from 2005 to 2019 by 7.33 and 5.34 ton/ha, outside and inside the reserve respectively. An increase that can be explained by the increase in the erodibility of rainfall and the reduction of the soil cover factor. From the analysis carried out over the period in reference, there were highly significant losses of soil outside the reserve (agricultural areas), compared to the interior of the reserve (with soils mostly with vegetation cover).

Keywords: Geographic information system, land cover, Niassa Special Reserve, soil loss.

GENE ACTION AND HERITABILITY CONTROLLING MAIZE WEEVIL AND LARGER GRAIN BORER RESISTANCE IN TROPICAL MAIZE GERMPLASM

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The maize weevil (MW), *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) and the larger grain borer (LGB) *Prostephanus truncatus* (Horn) (Coleoptera:Bostrichidae) are the most damaging post-harvest insect pests of maize in Africa causing losses of up to 90% when maize is stored without use of chemical protectants. Host plant resistance is thus a vital component of an integrated pest management strategy against them and small-scale farmers can greatly benefit from resistant maize cultivars. This study aimed at determining the genetic action influencing inheritance of resistance to MW and LGB using generation mean analysis in two crosses, CKDHL120731×CKDHL120918 (cross one) and CKDHL120517×CKDHL120918 (cross two). The inbred lines CKDHL120731 and CKDHL120517 are resistant to MW and LGB while CKDHL120918 is susceptible. Six generations (P1, P2, F1, F2, BCP1 and BCP2) were developed from each cross. The various generations were evaluated in separate experiments for MW and LGB in a post-harvest laboratory in Kiboko- Kenya, in a complete randomized design, replicated twice in three months. Fifteen cobs were used for P1, P2 and F1, 30 cobs for BCP1 and BCP2 and 60 cobs for F2. Data was collected on weight loss, kernel damage and number of living insects. The resistance traits for MW did not fit a simple additive-dominance model in both crosses, suggesting the existence of epistasis effects. However, for LGB resistance, cross one fitted well on it but cross two did not, suggesting both simple model and digenic interaction model were present in the inheritance of LGB resistance, depending on the genetic background of the parent used. Additive, dominance and epistasis gene effects played a significant role in the inheritance of resistance to both insects in the selected maize genotypes. This was further confirmed by moderate narrow-sense heritability estimates. This suggest that it is feasible to improve maize genotypes for insect resistance.

Keywords: *Sitophilus zeamais*, post-harvest pest resistance, *Prostephanus truncatus*,

EVALUATION OF COWPEA ELITE LINES (*Vigna unguiculata*) FOR DROUGHT TOLERANCE IN NAMPULA – MOZAMBIQUE

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The development of high yielding and stable cultivars of various crops is crucial for raising production and productivity, consequently increase of food security and nutrition among small household farmers across the country. This study, therefore, focused on evaluating of cowpea (*Vigna unguiculata* (L.) Walp.) lines sourced at IITA, IIAM, LUANAR and TARI for yield, stability and drought tolerance at Nampula Research Station under stress and non-stress environments, using the additive main effects and multiplicative interaction (AMMI) analysis, and genotype plus genotype by environment interactions (GGE biplot), drought susceptibility index (DSI) and rank summation index (RSI). Ninety-two cowpea elite lines were evaluated during the 2021/22 growing season in split plot design (incomplete block design) replicated two times. The analysis of variance revealed that the genotype (G), water regime (WR) and genotype x environment interaction (GEI) effects were highly significant ($p < 0.001$), with contributions to total observed variation of 58.33, 16.33 and 14.88 %, respectively. Grain yield and related components such as leave area index (LAI), day to flowering (DF), days to physiologic maturity (DPM), number of seed per pod (NSP), hundred seed weight (100SW), number of pods per plant (NPP), plant height (PH), pod length (PL), and grain yield, explained 78.74, 74.58, 84.52, 75.96, 85.99, 64.37, 68.24, 78.99 and 90.98% of coefficient of determination (R^2), respectively. The AMMI ANOVA revealed that the G, E and GEI effects were highly significant ($P < 0.001$). The GEI effect accounted for 16.68 % of the total variation whilst genotype and environment main effects contributed 68.14 and 18.19 %, respectively. The IPCA1 was highly significant ($P < 0.001$) and explained 100% of total GEI sum of squares. The mean yield of the best genotypes under non stressed water regime ranged from 1.11 ton ha⁻¹ to 1.74 ton ha⁻¹. Whereas under stressed water regime the mean grain yield ranged from 0.66 ton ha⁻¹ to 1.32 ton ha⁻¹. Genotypes Guariba, IT97K-1069-6 (MW), IT99K573-1-1, IT10K-817-3, IT07K-299-6, Danila, IT04K-227-4, IT00K-126-3 (MZ), IT97K-1069-6 (MZ), IT-16 and IT98-390-2 had higher grain mean yield under both environments, non-stressed and stressed water regime. The genotypes selected had the mean grain yield above the grand mean (0.65-ton ha⁻¹). The results of RSI of geometric mean of grain yield (GM), DSI, 100SW, NPP, NSP and PL of the cowpea genotypes shows the first ten genotypes are Guariba, IT97K-1069-6 (MW), IT10K-985-3, IT93K-452-1, IT-16, IT00K-126-3 (MZ), IT07K-299-6, CB27, Danila and IT99K573-1-1 are ranked among the best drought tolerant and grain yield potentials cowpea lines under stress and non-stress water regimes. Therefore, these genotypes can be exploited as drought tolerant parentes in plant breeding program.

Keywords: AMMI ANOVA, Cowpea DSI, GEI, Yield.

EVALUATION OF THE EFFECTS OF POTASSIUM TOP DRESSING FERTILIZATION ON STRAWBERRY YIELD AND PLANT GRAY MOLD (*Botrytis cinerea*) DISEASE SEVERITY

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Agronomic research has sought to reduce production costs and the impact of pesticides on the environment by using low-cost and less polluting products. Thus, the use of potassium can constitute an important alternative for managing pests and diseases, which can have a positive impact on strawberry productivity. The present research aimed to evaluate the effects of potassium top dressing with on strawberry yield and plant gray mold (*Botrytis cinerea*) disease severity. The study was conducted at the Agricultural Research Institute of Mozambique (IIAM), in the district of Boane. The study was performed in a randomized complete block design, with the following treatments: four levels of potassium (0, 50, 100, and 150Kg/ha), two levels of difenoconazole fungicide (first level, second level) and two (2) levels of gray mold inoculation levels (inoculated and not inoculated). In this assessment, incidence, severity, area under the disease progression curve, and yield were evaluated. In this study, it was found that the interaction between potassium, fungicide and inoculum demonstrated a significant effect on the following parameters: gray mold disease incidence and severity, area under the disease progression curve and yield. However, the interactions of potassium x inoculum, fungicide x inoculum and potassium x fungicide x inoculum, did not have a significant effect on the severity parameter in the plant. The application of potassium doses significantly affected the expression of *Botrytis cinerea* since plots with potassium application and without fungicide resulted in significantly lower levels of disease incidence. When compared to plots without potassium application and without fungicide. The potassium top dressing fertilization could have induced plants to conserve more. water in their issues when they developed the gray mold disease. The application of potassium could also have helped plants to resist the invasion of microorganisms, strengthening the structure of the cell wall. From the study, it was concluded that Potassium had a significant effect on gray mold severity and strawberry yield.

Keywords: Gray mold disease, potassium, strawberry.

MODELLING IMPACTS OF CLIMATE CHANGES ON YIELD AND WATER REQUIREMENTS OF SUGARCANE (*Saccharum officinarum* L) IN INCOMATI RIVER BASIN: CASE OF MANHICA DISTRICT

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The objective of this study was to quantify the impacts of climate changes on sugarcane yield and water requirements, using modeling techniques and scenario analysis. Climate data projected for end of century (2080 to 2100) with baseline 1980 to 2010, from IPSL model (dry scenario) and CNRM (wet scenarios) model under A1B emission of IPCC AR4 were used. FAO Aquacrop model was employed to simulate yield and water requirements. The study also evaluated adaptations measures such as mulching and altering planting dates. Statistical analysis consists on linear regression and trend analysis test for baseline dataset, and t test for quantifying variation in yield and water requirements, between future and baseline. The results showed that only minimum temperature exhibited increasing trends by 0.032 C. year⁻¹ during baseline period. The IPSL and CNRM models projected increasing of maximum temperature in 2.6 C and 3.7 C, respectively, and minimum temperature in 4.3 C and 4.7 C, respectively. The Aquacrop model accurately simulated sugarcane yields ($r^2 = 0.72$, $d = 0.5 \text{ ton.ha}^{-1}$, and $E = -1.7 \text{ ton.ha}^{-1}$). Sugarcane yield is projected to increase by 10.8 % and 12.2% under CNRM and IPSL scenarios, respectively, while crop water requirements only will increase in 16.3 % under IPSL scenario. Mulching and altering planting dates Only influenced in water requirements, reducing under baseline (6%) and CNRM (17.5%) scenarios, while altering planting dates increasing water requirements under IPSL and reducing under CNRM. These projected changes in yield and water requirements are primarily driven by increases in temperature and CO₂ concentrations and changing in rainfall pattern. Mulching is identified as a technical viable adaptation strategy, while optimal planting dates will be April for IPSL and July for CNRM scenarios.

Keywords: Aquacrop model, Adaptation measures, Sugarcane yield, water requirements.

CO-OCCURRENCE AND NICHE DIFFERENTIATION OF LEPIDOPTERAN PEST AND ITS PREDATOR (*Doru luteipes*) IN MAIZE IN CONSERVATION AGRICULTURE IN NAMPULA, MOZAMBIQUE

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In Mozambique, maize is infested by different lepidopteran pests. *S. frugiperda* is an invasive species that has been introduced since 2017, little is known about its co-occurrence and spatial distribution in relation to native pests and their associated natural enemies. The objective of this study was to evaluate the co-occurrence and niche differentiation between lepidopteran pests, stem borers (*Chilo partellus*), (*Sesamia calamistis*) and fall armyworm (*Spodoptera frugiperda*, JE Smith) and its earwig predator (*Doru luteipes*) in maize (*Zea mays*) in a conservation agriculture system. Rainfed field trials under natural infestation were established in the districts of Meconta (Namilao), Ribaué (Morrocanhe). Five maize genotypes (Matuba, Tsangano, PRIS 601, ZM 523 and Sussuma) were used associated with cowpea (*Vigna unguiculata*) and allocated to two plots. In the first plot, minimum tillage was applied with residue retention and in the second conventional tillage was carried out. Data collection for *S. frugiperda* infestation and earwig density were done at 45, 50, 65 and 70 days after emergence and for infestation of the borers was done after corn Harvest in 10 plants randomly per plot, determining the population density of the earwig and pest infestation. An infested plant was considered to be one with signs or presence of pests. The results indicate that there is spatial distribution of pests in the same plant, especially in the leaf, stem and ear, causing defoliation, boring and ear damage. The pests *C. partellus* and *S. calamistis* brooded stem and ear for their feeding and shelter, while *S. frugiperda* established itself in the leaves and funnel of the corn plant for its feeding and shelter. Lepidopteran pest infestation varied significantly as a function of the regions and species occurring together. Maize genotypes were more infested by *S. frugiperda* and less by *S. calamistis* regardless of the cropping system used. The minimal tillage with retention of residues in the soil and the agroecological conditions of Namilao in the district of Meconta in Nampula, independently, favored more the biology and niche of the earwig (*D. luteipes*).

Keywords: *Chilo partellus*, *Doru luteipes*, *Sesamia calamistis*, *Spodoptera frugiperda*.

RESEARCH INTO SUSTAINABLE MANAGEMENT METHODS OF THE FALL ARMYWORM, *Spodoptera frugiperda* IN FOUR REGIONS OF MOZAMBIQUE

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Maize is the main food crop in Mozambique, and in recent years it has been attacked by the fall armyworm, *Spodoptera frugiperda*. The fall armyworm is a pest native to South America and had its entry into our country at the end of 2017. As maize is a highly important crop in Mozambique, management trials were carried out in order to ensure alternatives to control this pest because, when not controlled, it can cause damage to the crop of up to 100%. During the period from 2017 to 2023, management trials of the fall armyworm were carried out in four IIAM stations, respectively Lichinga, Nampula, Sussundenga and Umbeluzi, which are places with different agroecological characteristics. The trials were on variety effect, conservation agriculture, botanical pesticides, synthetic pesticides and sowing dates. The experiments were set up in a randomized complete block design where the levels of infestation, crop damage and yield were evaluated. The first trials clearly showed no effect of the varieties on the levels of infestation and damage to the maize crop. In relation to conservation agriculture, it was found that intercropping and crop rotation reduces fall armyworm attack levels. This result shows the importance of continuing with some practices that the small farmers already uses with numerous advantages. Several botanical pesticides were tested, and the combination of castor and neem, bio and tephrosia stood out with a significant effect on the control of the pest. Regarding synthetic pesticides, more than 10 active ingredients have been tested, and flubendiamide and emamectin + lufenuron have shown a significant effect. Sowing early (with the first rains) significantly reduces infestation levels and consequently increases yield. There are several caterpillar management alternatives available to the producer, and they should be used in an integrated way to ensure their sustainability. Synthetic pesticides should be a last resort.

Keywords: Corn, management, pests, pesticides, *Spodoptera frugiperda*.

WOOD ASH RECYCLING FOR RESTAURATION OF ACIDIC SOIL FERTILITY IN MOZAMBIQUE: a geochemist's workbench (gwb) predictive model use

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Wood ash recycling is a valuable and economic strategy for restoring and ameliorating the acidic soil fertility. However, the chemical complexity of wood ash, dependent on the plant and carbonization process, limits its reuse for agriculture and requires appropriate management to obtain better environmentally accepted benefits. Thus, the study aimed to develop a geochemical model to use in wood ash recycling for the sustainable restoration of acidic soils fertility. For this purpose, the complexation and adsorption kinetic model was used through the Geochemistry Workbench (GWB12) software to predict the application dose of wood ash from Vanduzi in the Manica province-Mozambique, reaction time of wood ash in acidic soil, changes in soil pH and availability of ions in two acidic soils, one from Vanduzi and the other from the experimental field at Saga University in Japan. Followed by a laboratory experiment in pots with five doses of wood ash predicted in the software (GWB) and applied to the two acidic soils and incubated at a constant field capacity humidity and controlled room temperature of 24 - 25°C for 90 days at Saga University in Japan. The predictions soil pH change and chemical species in the software fit well ($R^2 > 0.9$) with the concentrations of soluble species measured during the incubation time. The wood ash dose and reaction time varied with the soil organic matter content and significantly and non-linearly increased the soil pH, the availability of K^+ , Ca^{2+} , PO_4^- ions and completely precipitated aluminium (Al^{3+}) in the used soils. The GWB12 approach is useful for predicting the environmentally acceptable dose and reaction period of wood ash and restoring fertility in acidic soil. However, for better prediction, use of accurate partial carbon dioxide (pCO_2) and bicarbonate (HCO_3^-) in the soil, field experiments and inclusion of correction factor (crop effect) in the model would be able to make a more effective and accurate prediction.

Keywords: Ash, acidic soils, prediction, restauration.

EFFICIENCY AND SELECTIVITY OF INSECTICIDES AND SOME BIOPESTICIDES FREQUENTLY USED IN THE CONTROL OF *Spodoptera frugiperda* IN THE PROVINCE OF MANICA

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Spodoptera frugiperda (corn fall armyworm) is currently one of the main pests of maize cultivation in Mozambique. The use of insecticides is one of the main control strategies for *Spodoptera frugiperda*. However, in Mozambique there are few studies that clarify the influence of certain insecticides on the biological imbalance of ecosystems caused by their abusive use, as well as their efficiency in controlling these insects. In this context, insecticides with the following active principles were tested: Flubendiamide (Belt® 480 SC) 70 mL.ha⁻¹), Chlorantraniliprole (Ampligo® 150 SC, 75 mL.ha⁻¹), Acephate (EC 40%, 1.13 kg.ha⁻¹), Emamectin benzoate (Imperator® 5% SG), Cypermethrin (Cipercel® 250 SC, 60ml ha⁻¹), biopesticides based on *Azadirachta indica* leaf extract (Margosa), *Tephrosia vogelli* and by a control (treatment without application). The randomized complete block (DBCC) design was used, with four (4) replications. The parameters evaluated were: the incidence of plants with leaf damage, severity of damage, the number of live caterpillars, number of dead funnel and the presence of natural enemies (ladybugs and earwigs). The applications of the treatments were made at 20 and 35 days after maize emergence and three evaluations were carried out, one before the first application of the treatments at 20, 35 and 50 days after maize emergence. The sample consisted of 5 plants previously randomly selected in each row of the 3 central rows of the plot. There was a significant difference between the treatments in the analyses of the effects on mortality of natural enemies and *Spodoptera frugiperda*. The insecticides with the active ingredient Emamectin benzoate (Imperator), Chlorantranilipronlie (Ampligo) and Flubendiamide (Belt® 480 SC, 70 mL.ha⁻¹), depending on the period of application, can achieve an efficiency ranging from 62.5 to 100% in the control of *Spodoptera frugiperda*. On the other hand, regarding their selectivity to the natural enemy earwig, the most selective were biopesticides based on leaf extract and the least selective were the insecticides with the active ingredients Chlorantraniliprole (Ampligo® 150 SC) and Cypermethrin (Cipercel® 250 SC, 60ml ha⁻¹) with 91.7 and 75% mortality respectively.

Keywords: Biopesticides, funnel caterpillar, insecticides, natural enemies.

SYNTROPIC AGROFORESTRY SYSTEMS AS AN ALTERNATIVE TO CLIMATE CHANGE MITIGATION AND ADAPTATION

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Mozambique has a dependence on agricultural practices that are no longer suitable for the context of climate change. Hence, identifying and promoting agricultural practices that communities with greater resilience to the various phenomena of climate change is an urgent need. The Institute for Agrarian Research of Mozambique (IIAM) introduced the first models of syntropic agroforestry systems in the central part of the country in 2020 in the districts of Angonia and Tsangano (Tete Province) and Sussundenga (Manica Province). From 2020 to the present day, comparisons have been made of this model with that of conventional agriculture with regard to the following variables: diversity of gains, improvement of soil properties, soil moisture and agricultural yield. For this purpose, from on-site observation, an evaluation of the quantity/diversity of gains obtained in the two models was made; for the case of soil properties, the infiltration rate was evaluated based on the simple ring as an indicator; soil moisture was measured using the TDR equipment, having evaluated 10 points randomly in each model (agroforestry and conventional); also, the maize yield of the ZM523 variety in the 2023/2024 agricultural season. In general, the results achieved or that have been recorded indicate that in a syntropic agroforestry model several products are harvested in the same area compared to a conventional field. In the case of this experience, bananas, cabbage, gliricidia seeds, umbaua, gliricidia cuttings, coffee, tomatoes, buckbeans, beans, etc. The diversity of products in this model can vary from 5 to 10 species/crops, obeying a temporal arrangement and aided by pruning; In the conventional model, it rarely reaches 5 species/crops. Soil moisture in the on station (22.98%) was significantly higher $P < 0.05$ ($p = 0.00049$) than the control field (14.54%); in the on farm (11.13%) there were no significant differences $P > 0.05$ ($p = 0.16$) in the control field (9.48%). The corn yield in the agroforestry model was estimated to be more than 200% higher than the conventional model (0.347 ton/ha). In order to provide communities with more income diversity and therefore resilience to the negative effects of climate change, more than 30000 seedlings of various species were distributed to more than 150 producers in the buffer zone of the Chimanimani National Park

Keywords: Agroforestry system, agriculture.

INCREASING RESILIENCE OF SMALLHOLDER FARMERS TO CLIMATE CHANGE THROUGH ADOPTION OF CLIMATE SMART AGRICULTURE PRACTICES IN MOZAMBIQUE

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Mozambique is witnessing severe degradation of its farmlands. Much of this degradation can be attributed to farming practices – ploughing that destroys the soil structure and degrade organic matter, burning or removing crop residues and mono-cropping. To change this situation, improved sorghum and legume cropping systems design under better resource allocation and management conditions in Climate Smart Agriculture systems were tested across environments of Nhacoongo – Inhambane. This was done through on-station experiments research aiming to identify best bet resource allocation strategies that can make cropping systems more attractive to poor resourced farmers involved in Climate Smart Agriculture. The response functions for sorghum intercropped with cowpea and pigeon pea were determined. The objective of the study was to contribute to increased household food security of smallholder farmers in Inhambane and enhance their livelihoods. Two fertilizer treatments and two legume intercrop options were applied in a RCBD design with four replications. Results were subjected to ANOVA and the least significant differences (LSD) was used to separate the means. This study demonstrates that the intercropping legumes or combining with inorganic fertilizer has potential to address the low soil fertility problem in farmers' fields and raise yields of sorghum production.

Keywords: Intercropping and yields, legume, rotation, sorghum, tillage.