

POVERTY ANALYSES IN INTEGRATED AGRICULTURAL RESEARCH FOR DEVELOPMENT

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It is essential for integrated agricultural research for development (IARD) to relate research on agricultural innovations to the demands of farmers with different livelihoods and farming systems, especially according to poverty and gender differentiation. Uganda has a relatively long experience with poverty monitoring at the level of the national and regional economy. The Uganda National Household Survey (UNHS) and Uganda Participatory Poverty Assessment Programme (UPPAP). However ARD has done little to adapt innovations to demands of males and females or poverty groups. With support from DANIDA, the external monitoring unit (EMU) of DANIDA's Agricultural Sector Programme Support (ASPS), has developed a gender and poverty analysis methodology, which supplements poverty analyses based on the UNHS and UPPAP. This approach measures poverty statistically using a multidimensional set of indicators developed from rural men's and women's own perceptions. In addition the approach can be used at the household level to analyse demands for, adoption of, and impact of innovations as expressed and experienced by male and female farmers and different poverty groups. The paper describes briefly how multidimensional and participatory poverty and gender well-being indicators were identified. A well-being ranking methodology was used to obtain the indicators. They were then extrapolated and tested statistically for representativeness and aggregated in a quantitative index. Based on a conventional questionnaire survey, poverty analyses are presented for five ASPS pilot districts in Uganda. Among other things, the analysis shows how different faces of poverty are expressed through different indicators, such as landholding, sources of non-agricultural incomes, food security, and standard of housing. Due to limitations of space, related analyses of gender inequality are not included in this paper. In the ASPS study as well as studies undertaken in other districts, The poverty analyses have also been used to assess the extent to which agricultural practices are adopted by farmers of varying well being categories, and how different agricultural interventions reach these categories. Finally the paper discusses the need to base poverty targeted IARD on similar approaches.

Key words: Agricultural research, impact local, perceptions, poverty index poverty monitoring

FACTORS AFFECTING EFFECTIVE PERFORMANCE OF RURAL PRODUCERS' ORGANIZATIONS IN THE TESO FARMING SYSTEM, UGANDA

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Rural Producers' Organizations (RPOs) have a vital role to play in Uganda's efforts to improve the peoples' standard of living. Recent developments like the launching of the Plan for Modernization of Agriculture (PMA) and policy reforms notably decentralization, privatization and liberalization reinforce this role. In the PMA, RPOs are prioritised as the main avenues through which farmers, as rural producers will be empowered to access and control services. However, despite their existence in Uganda for long, experience shows that RPOs have been largely unsuccessful in enhancing development of the rural people. This study was conducted in the Teso Farming System of (Eastern) Uganda covering the districts of Pallisa, Kumi and Soroti. The objective(s) of the study were to (i) characterize the existing RPOs and determining their respective capacities for achieving objectives (ii) examine linkage mechanisms existing between the RPOs and other players in rural development. Thirty RPOs, ten per district, were selected based on existing apex bodies. The study used focus group discussions guided by a rapid appraisal checklist. Findings indicated that a variety of functions, seventeen (17), are served by the different categories of RPOs. The main ones included provision of training in agriculture and other related fields (76.7%), procurement of inputs for members (56.7%), provision of market information (46.7%) and marketing (40%) and credit (40%). Linkages are vital for effective achievement of purposes and most RPOs (80%), had established them with extension and local policy making institutions. Many RPOs lacked linkages with credit (83.3%) and marketing institutions (56.7%), yet they are perceived as key players in development efforts. Main constraints affecting their performance included inadequate access to resources (96.7%), lack of technical knowledge/ skills in running RPOs (66.7%), lack of own income sources (70%), insecurity (63.3%) and lack of adequate markets (60%). A prediction of main issues that potentially impact on improvement of quality service provision included having plans in addition to establishment of adequate and effective market linkages. On the basis of these findings, recommendations aimed at enabling RPOs play their enhanced role in development become necessary. These include, among others, emphasis on development of appropriate policies, bye-laws and plans to guide their management, establishing income generating activities and establishing market linkages as well as linkages with other RPOs.

Key words: Impact, linkages, policy reforms rural development

**COMPARING THE PROCESSES USED FOR ASSESSING FARMERS'
DEMAND FOR RESEARCH AND ADVISORY SERVICES**

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The public extension system in Uganda is currently undergoing a transition towards a demand-driven one, with private sector involvement in service delivery, and in the future possibly funding as well. There is a concern that poor farmers' needs are not sufficiently addressed by NAADS, because (1) they are not adequately represented in farmer groups and fora, (2) even if represented, they do not influence priority setting, and (3) the need identification criteria indirectly discriminate against the poor. The NAADS approach is dynamic and lessons are still being learnt which might be relevant for NARS. A study carried out in eight villages (four sub-counties) in Arua and Tororo districts analysed the demand assessment procedures used by NAADS and emerging farmer demands for advisory services for inclusion of the poor, participation, transparency, alignment of farmers' criteria with NAADS criteria, and extent to which cross-cutting issues are addressed. Wealth grouping was used to stratify village households along villager-defined wealth groups. Initial findings show that in the two districts participation in NAADS groups is skewed towards the better-off households. Reasons for this appear to be (1) membership fees from one to five thousand shillings per household, which are difficult to mobilise by the poor, and (2) insufficient information about NAADS and doubts about benefits among poor households. Extension link farmers and cadre of farmers facilitator facilitated group level enterprise selection; NGOs facilitated at parish level. Some farmers did not understand the procedures and criteria used for selection, limiting their participation. The terms of reference for advisory services developed by the technical teams emphasised commodities, rather than cross-cutting issues such as gender, soil fertility and markets that equally affect productivity. The differences between NAADS criteria and those used by NARO is leading to a dichotomy of farmer needs, as identified by the two agencies.

Key words: Demand assessment, farmer needs NAADS, NARO, research priorities, processes institutions

CHALLENGES AND PROSPECTS OF DISSEMINATING TECHNOLOGIES THROUGH FARMER FIELD SCHOOLS: LESSONS LEARNT BASED ON EXPERIENCE FROM UGANDA

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The agricultural extension service in Uganda has in the last 40 years used a variety of approaches to disseminate technologies developed by researchers and other partners. These included regulatory, advisory and educational approaches. The regulatory and advisory approaches were top-bottom and non-participatory in nature. The educational approach, on the other hand, was a one-way system based on teacher-learner model in which the learner knew nothing while the teacher knew it all and did not need a feed back. Farmer participation in problem identification and solving was inadequate. Consequently, the technology and innovations uptake were compromised. In order to improve the situation, a number of participatory approaches, including the use of “farmer field schools” (FFS), evolved. A farmer field school approach was initiated and applied in Uganda by SIDA-funded Farmer Regional Program in 1996. In subsequent years various integrated pest management (IPM) pilot projects were supported by International Fund for Agricultural Development (IFAD) and Food and Agriculture Organisation (FAO) in an effort to train farmers in understanding principles and concepts related to the application of technologies through practical training. A group of 25-30 farmers constituted a farmer field school and they met weekly through an entire growing season to learn through practical experience about integrated crop production and pest control. The crops used in these exercises included cotton, cowpeas, groundnuts, *Solanum* potatoes, sunflower, cassava, sweet potatoes and beans. FFS-educated farmers have been observed to be more confident in running their own and other community activities. Farmers have had a better understanding of biological control measures and increased use of non-chemical control measures in addition to reduced level of pesticide usage. Whereas the FFS approach has concentrated on IPM-based technologies, it also lends itself well to being applied to the promotion of various agricultural technologies including micro-finance delivery. However, scaling-up and institutionalisation of FFS have continued to be elusive. The paper discusses the challenges and prospects related to the FFS approach in Uganda.

Key words: Approach, discovery learning, farmer participation, integrated pest management, technology dissemination

**INTEGRATING INDIGENOUS AND SCIENTIFIC KNOWLEDGE ON SOILS:
RECENT EXPERIENCES IN UGANDA AND TANZANIA AND THEIR
RELEVANCE TO PARTICIPATORY LAND USE PLANNING**

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The last decade has seen a reappraisal of the process of agricultural innovation and a convergence on participatory approaches to development planning and research. Recognising that practitioners face scarcity of information on how to operationalise the new paradigm, the project reported here aimed to develop a methodology for integrating scientific soil survey products with indigenous knowledge surveys. In principle, these methods offer complementary strengths. Scientific survey provides valuable insight into key soil properties and their spatial variability, but such mapping is generally not available at sufficiently detailed scale. On the other hand, indigenous knowledge is fine-tuned to locality and represents an assembly of accumulated local experience. Field research over 3 years on sites in Uganda and Tanzania aimed to test the hypothesis that indigenous knowledge and scientific soil assessment can both be represented within a common spatial frame and can therefore be usefully integrated. The research highlighted the importance of a systematic and iterative exploration of indigenous knowledge, which must extend beyond the level of rapid rural appraisal and include several different techniques of cross-validation of interpretations of indigenous soil classification systems. We conclude that there is much to be gained by combining elements of broad-scale scientific survey with a localised assessment of indigenous knowledge. The remaining challenge is to develop best practice guidelines that will allow agricultural researchers and planners to understand and use local knowledge combined with scientific understanding of soil and land resources.

Key words: Ethnopedology, indigenous knowledge, land use, participatory approach, soil survey

**DIFFICULTIES IN ASSESSING OUTCOMES OF SOIL AND WATER
CONSERVATION EXTENSION MESSAGES IN BANANA BASED CROPPING
SYSTEMS: A CASE STUDY OF STUDENT PROJECTS AT MAKERERE
UNIVERSITY, UGANDA**

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Observations made on students following a BSc degree program for mid-career extension professionals at Makerere University show a tendency to promote soil and water conservation as a matter of course without regard to realistic opportunities for successful application by farmers. In addition, recommendations on soil and water conservation techniques in banana based cropping systems seem unclear making it difficult to assess effectiveness of extension and application by farmers. This study was designed to identify potential for extension impact in soil and water conservation and to identify objective ways of teaching and assessing farmers' application of the different techniques. The study was done through a case study of three student projects involving 135 farmers. Key recommendations for each technology were identified and objective ways of assessing farmer application were agreed with the students. A questionnaire for assessing application and associated problems was designed which the three students used in evaluating their projects. Critical issues arising from the assessment were presented to a seminar of soil scientists and extension experts for discussion. The study revealed the need for addressing the scarcity of mulching and compost materials and labour if the most commonly recommended techniques, mulching, compost manure and contour bunds, are to be more widely applied. The study also revealed difficulties in using specifications for soil and water techniques as an objective way of assessing effectiveness and outcomes of extension, firstly because of lack of clarity of the specifications and, secondly because of the multipurpose nature of the soil and water conservation techniques. The specifications are designed to control soil erosion whilst the farmers' main concern in applying them is water/moisture conservation and soil fertility improvement as soil erosion does not seem to be a big problem in banana based cropping systems.

Key words: Application, conservation technique, soil fertility

**SMALLHOLDER AGRICULTURAL TECHNOLOGY DEVELOPMENT IN
SOROTI DISTRICT: SYNERGY BETWEEN NAADS AND FARMER FIELD
SCHOOLS**

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Greater involvement of farmers in development and dissemination of agricultural technology is a key component in current reforms of agricultural services in Uganda. Successful demand-driven agricultural services, however, require that farmers are able to identify and effectively articulate their needs. Experience shows that the capabilities required to analyse causes and effects of their problems and to be active in adapting technologies to their local-specific condition of production is not widely available among all farmers. Experiential farmer learning approach used by Farmer Field School (FFS) has enabled its members to engage in demand-driven agricultural services in Soroti district and thereby contributed to the success of National Agricultural Advisory and Development Services (NAADS) in Soroti district. The study shows that members of FFS and NAADS groups have significantly higher levels of technology adoption and use than non-members. However, the study also reveals that FFS and NAADS groups are not inclusive of poor farmers and that adoption and use of technologies are significantly higher among better-off farmers. The paper is based on fieldwork carried out in 2001 and 2004 that includes a comprehensive qualitative well-being ranking exercise and a large household questionnaire.

Key words: Demand-driven advisory services, farmer field school, poverty assessment.

**INFORMATION SOURCES AND CONSTRAINTS UNDER NATIONAL
AGRICULTURAL ADVISORY SERVICES PROGRAMME, OF SERVICE
PROVIDERS IN UGANDA**

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National Agricultural Advisory Services (NAADS), one of the seven pillars of the Plan for the Modernization of Agriculture (PMA) started operating in Uganda in 2001. Under NAADS, public sector funded private service providers (PSPs) deliver advisory services to farmers for profitable agriculture. However, where and how PSPs access information, their constraints and possible remedies are still unclear. A descriptive cross sectional study using both qualitative and quantitative approaches was therefore conducted in two sub-counties in each of Arua and Tororo districts to find out where and how PSPs access agricultural information, the problems faced in accessing and processing the information the existing and potential quality assurance mechanisms for such information. Data was collected through individual discussions with NAADS coordinators; focus group discussions and self-administered questionnaires to PSPs. Almost all the 43 PSPs who participated in the study were males, educated up to diploma level but with minimal working experience. The study revealed that PSPs obtain information from school/college notes, books, radios, manuals, newspapers, district departments, research institutes (NARO), with manuals perceived to be the most important in both districts. There seems to be no deliberate efforts by information sources to target to PSPs while information quality assurance is lacking and/or haphazard. Problems in information access and use included lack of resources, inadequate information, expensive/availability internet resources, and limited information sharing amongst PSPs and with public extension staff, and translating the information.

Key words: Informationsources, NAADS, private agricultural extension

**ASSESSING APPROACHES FOR DISSEMINATION OF RESEARCH
INFORMATION TO FARMERS WITHIN THEIR LIVELIHOOD SITUATIONS
IN TORORO DISTRICT, UGANDA**

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This study sought to, identify and describe the approaches used by research and service providers in technology dissemination to target different wealth categories of farmers, identify the information that is required by these farmers and their preferences regarding channels and formats for information presentation. Three villages were used as study sites. The case organizations, namely NAADS, Africa 2000 Network, and Sasakawa Global 2000, were selected based on their avowed principle of involving grass root farmers in all stages of the project cycle. This study employed a cross-sectional survey design involving face-to-face individual and group interviews. Findings indicate that the approaches used by the three organizations have only reached a small proportion of the targeted households: NAADS (12%), SG2 (8%) and A2N (33%) in the village. The farmers' groups have limited useful information in such areas as, availability and use of improved crop varieties and livestock breeds, post-harvest processes and virtually nothing on value addition. Service providers used trained extension staff for information dissemination and practical training sessions. Farmers preferred this method of training but called for more of, trainings, availability of improved seed, and implementation of all practical trainings by projects. While SG2 and A2N disseminated technologies targeted to soil improvement, NAADS had a wide scope that included animal husbandry. Farmers supplemented this information with information from other sources. The households in the project areas were ranked by key informants as poor (52%), very poor (30%) and average (18%) and although the registered group membership is mainly female most of them come from male-headed households (82%). Farmers' information needs were limited to technologies that they had been taught. Pests and disease control, and lack of practical training in some projects were the major problems faced by farmers.

Key words: Agricultural service providers, farmer groups, household.

**EVALUATION OF FARMERS' BEST PRACTICES FOR ON-FARM
CONSERVATION OF RARE BANANA CULTIVARS IN THE SEMI-ARID
REGION OF LWENGO SUB-COUNTY, UGANDA**

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Farmers have since humanity nurtured the plant genetic diversity from which they derive their livelihood and as a basis for social transformation. In the process they have been able to continually develop and improve management practices for the conservation of their genetic resources. The socio-economic transformations, however, come with negative impacts to the biological as well as to the cultural environment. These have irreversible effects on the genetic diversity in terms of genetic erosion and even total loss of populations. The farmers are in most cases overwhelmed by these impacts that they solely may not be able to continue with the critical practices for the conservation of the diversity. Institutional and policy support ought to join hands with farmers if these resources are to be sustainably utilised and enjoyed by the future generations. Support, however can only be mobilised after there is a clear understanding of which practices are important for the conservation of the resources. This study was to identify and understand the best practices for conservation of rare banana landraces in Uganda's semi-arid area of Lwengo sub-county, with an ultimate objective of promoting and supporting the practices through the relevant policy channels. Using the Four Square Analysis methodology a total of 66 banana cultivars were recorded in the sub-county. Out of these 19 were considered by the farmers to be rare cultivars. A total of 21 management practices were identified. The Principal Component Analysis (PCA) showed that out of the 21 practices 9 were very critical for the survival of rare landraces. The correlations indicate that only 8 of the 19 rare cultivars seem to have a direct relationship with the 9 practices, meaning that the 8 rare cultivars rely on particular practices out of the 9 for their survival and continued existence.

Key words: Farmers, Genetic diversity, management practices, *Musa* spp

AN INTEGRATED APPROACH TO SUSTAINABLE UTILISATION OF LAND RESOURCES FOR A BETTER ENVIRONMENT

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The drive to increase food production for the growing population in Uganda is undermined by high levels of environmental degradation which has arisen through increased population pressure, nutrient mining, deforestation, poorly managed hillsides, and inappropriate use of wetlands. The environmental degradation has led to soil erosion, siltation, and pollution of water resources. Agricultural productivity is further exacerbated by the very low efficiency in the capture and utilisation of rainfall in smallholder agricultural systems. This paper highlights some of the research and pilot activities that have been undertaken to develop and promote technologies to mitigate further natural resource degradation. These include a catchment approach to evaluate the effects of landuse on agricultural productivity and the environment. Participatory approaches were used to identify problems and manage land resources for increased crop production and to reverse the land degradation trends. These approaches have led to a better appreciation of land degradation and development of appropriate land management packages/ tools that can be adapted to other agro-ecological zones.

Key words: Environmental degradation, farmer experimentation, integrated soil management, participatory learning,

**MERGING BIOTECHNOLOGY WITH BIOLOGICAL CONTROL: BANANA
Musa TISSUE CULTURE PLANTS ENHANCED BY ENDOPHYTIC FUNGI**

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Among the major constraints to highland cooking banana (*Musa* spp. AAA-EA) production in Uganda is the high pests infestation levels. Most important are the banana weevil *Cosmopolites sordidus* and a complex of plant parasitic root nematodes of which *Radopholus similis* is the most important. Clean planting material, such as tissue culture derived plants, is now being promoted in Uganda for establishments of new fields, although pest re-infestation remains a vital concern. Fungal endophytes are microorganisms that colonize plant tissue internally for at least part of their life cycle to form mutualistic relationships with their host plants, including antagonism to pests and diseases. These endophytes can be artificially inoculated into tissue culture plants and thus reduce banana weevil and nematode pressure. A survey for endophytes in highland cooking banana revealed that most strains belong to *Fusarium* spp. *In vitro* bioassays against *C. sordidus* eggs and *R. similis* juvenile and adult stages showed that, depending on the endophytic strain, mortality can reach up to 100.0%. *In vivo* screenhouse experiments using tissue culture plants revealed that the endophytic strain V5w2 decrease *R. similis* reproduction by 22.9 and 60.6% in the banana cultivars Enyeru and Kibuzi (AAA-EA), respectively, compared to control plants. The use of endophytic fungi is a novel yet promising biological control strategy that can be used against the banana weevil and parasitic nematodes.

Key words: *Cosmopolites sordidus*, fungal endophytes, *Fusarium*, *Radopholus similis*,

**RESTORATION OF DEGRADED NATURAL GRASSLANDS TO ENHANCE
SOIL FERTILITY, PASTURE AND ANIMAL PRODUCTIVITY**

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The natural grasslands of Uganda are regarded as a natural asset due to multiple uses in terms of providing cheap natural feeds/pasture to the over 5 million heads of cattle and about 6 million sheep and goats and in addition, support wild life and provide natural cover to the soils. Unfortunately, the grazing resources are facing serious degradation due to mismanagement, natural causes such as drought, weed invasion, frequent uncontrolled burning and overgrazing by cattle and wild life. There has been limited research to address the above constraints and the situation is becoming more serious because of reduced overall ecosystem productivity- animal productivity, reduced pasture productivity and loss of biodiversity. This downward trend is likely to affect the livelihoods of the majority of the people especially pastoralists who depend on these grasslands for animal production and herbal medicine. Limited research using forage/fodder legumes to restore or halt the declining trends indicate promising results over a period of six years on different farms in Mbarara District, Uganda. Introducing several improved legumes and grasses into these grasslands improved soil fertility, pasture and animal productivity with subsequent increase in food (milk) production and incomes. This paper presents data that has been generated from several studies on grassland research and other studies in the country that have developed appropriate technologies that have been adopted or are being adopted by the farmers to solve the problems of declining natural resources, food security and hence reduced poverty.

Key words: Ecosystem productivity, Legumes, Natural grassland,

A GREENHOUSE EXPERIMENT TO EVALUATE COMPOST DERIVED FROM HOUSEHOLD AND MARKET CROP WASTES

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Urban peasants in Uganda frequently cultivate soils with low intrinsic fertility status (low pH, low organic matter and nutrient contents), which restricts high crop production. A greenhouse study was conducted at Kabanyolo Research Station, Makerere University to evaluate how compost (CO) compares with commercial fertilizers as a soil fertility amendment. The aims included improvement of crop productivity, while reducing environmental pollution with the wastes. The treatments, each of which had two replicates, comprised a control, 5 and 10 t CO ha⁻¹ applied singly or in combination with 40 and 80 kg urea-N ha⁻¹ and 9 and 18 kg triple superphosphate-P (TSP) ha⁻¹. The test crop maize (*Zea mays* L.) plants were harvested, 39 days after sowing, and dry matter (DM) yields were recorded and analyzed for plant tissue contents of nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). In the single applications, effectiveness measured in terms of average DM yields increased in the order: Control < N < P < CO. Also in the single applications, DM yields increased along with increasing compost application rates. The combined applications produced significantly higher DM yields than the control and single applications. Of the amendments, CO5 + N40 + P18 was the best treatment, increasing DM yields over control by 629%. Notwithstanding that best performance, however, the CO5 + N40 + P9 treatment, which increased DM yields by 571%, seemed to be more affordable for the peasants concerned. The combined applications generally enhanced uptake of N, P, K and S. The average utilization efficiency (UE) of compost-N, -P, -K and -S was about 11, 3, 11 and 3%, respectively. When the compost was applied together with fertilizers, UE varied from 13 to 98% for N; 2 to 40% for P; 11 to 30% for K and 3 to 11% for S.

Key words: Maize, soil fertility, urban peasants, utilization efficiency, waste

**POPULATION SCREENING FOR SELECTION OF BUCKS AND DOES OF
THE MUBENDE GOAT IN UGANDA**

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Sixty goats of Mubende breed were categorized in the field into large and ordinary size animals on the basis of heart girth. Subsequently, two large and five ordinary bucks as well as 53 does were purchased from the farmers and assembled at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK). Four experimental groups were formed and random within-group mating was undertaken of large bucks x large does, large bucks x ordinary does, ordinary bucks x large does and ordinary bucks x ordinary does. The progenies were evaluated for birth and weaning weights. Of the original 53 mated does, 39 kidded. Only one of the ordinary bucks produced progenies and thereby the intention of having a balanced sample of ordinary and large sized bucks was not achieved. Consequently, a comparison of the genetic difference between the two categories was not feasible. The kids from large dams were 0.27 kg heavier at birth than kids of ordinary dams ($p < 0.001$). The overall development strongly indicated that doe size has lasting effect from birth to yearling weights. However, the differences could not be separated into direct genetic, maternal genetic and non-genetic maternal effects for birth weight.

Key words: Buck size, dam size, kid weights, maternal effects

INOCULATION, COLONIZATION AND DISTRIBUTION OF FUNGAL ENDOPHYTES IN *Musa* TISSUE CULTURE PLANTS

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The use of mutualistic fungal endophytes to control the banana weevil (*Cosmopolites sordidus*) and banana parasitic nematodes (*Radopholus similis*, *Pratylenchus goodeyi* and *Helicotylenchus multicinctus*) is currently being investigated at the International Institute of Tropical Agriculture. Fungal endophytes are microorganisms that colonize the plant through the root system and for a part or whole of their life cycle live symptomlessly within the plant. Such organisms in some instances have been known to act as antagonists against pests and diseases. For an endophyte strain to be a good antagonist against target pests, it must be present in the plant tissues at the time the plants are attacked by the pests. They therefore need to be artificially inoculated in tissue culture banana plants, must occur at high frequencies in the plant and be able to persist in the plant after inoculation. It is also critical that an endophyte successfully colonizes and persists from the time of inoculation onwards. Screen house studies where two *Fusarium oxysporum* strains, V2w2 and III4w1, were artificially inoculated into two banana cultivars, Nabusa and Kibuzi (*Musa*, AAA-EA), using different inoculation methods revealed that tissue colonization depended on the method of endophyte inoculation and differed for the different tissues investigated. Studies using the same two strains and same banana cultivars showed that colonization persistence also depended on inoculation methods and was different among the types of tissue within the banana plant. Plant tissue colonization varied by cultivar and strain combinations, indicating the need for identifying suitable cultivar-strain combinations.

Key words: Antagonistics, artificial inoculation, banana pests and diseases

**THE USE OF STARTER CULTURES IN THE FERMENTATION OF *BUSHERA*:
A UGANDAN TRADITIONAL FERMENTED SORGHUM BEVERAGE**

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Weissella (W) confusa MINF8, *Lactobacillus (Lb) plantarum* MINF227, *Lb. paracasei* subsp. *paracasei* MINF98, *Lb. fermentum* MINF99 and *Lb. brevis* MINF226, all previously isolated from *bushera* were evaluated as single strain starters for sorghum *bushera* production. Production of *bushera* was according to the traditional procedure except that the raw materials were steamed at 98°C for 45 minutes before inoculation. Fermentation was carried out at 30°C and analyses for pH, sugars, organic acids, volatile organic compounds and viable counts were made after 0, 4, 8, 12, 48, 72 and 96 h. Traditional *bushera* was also prepared using germinated sorghum flour as inoculum. The starter cultures increased during the fermentation of *bushera* from about 7 log cfu ml⁻¹ to 8.5 - 9 log cfu ml⁻¹, while in spontaneously fermented *bushera* LAB increased from 6 to 9 log cfu ml⁻¹. No yeasts or coliforms were detected in starter fermentations due to the steaming step. However, in spontaneously fermented *bushera*, coliforms increased from about 6 to 8.4 log cfu ml⁻¹ within 12 h, but thereafter decreased to <2 log cfu ml⁻¹ after 48 h. Yeast numbers gradually increased during spontaneous fermentation from 4.5 to 7.1 log cfu ml⁻¹. Compared to the other starter strains, *W. confusa* MINF8 possessed a superior ability to utilise sugars. In addition, an increase in maltose and glucose levels due to starch degradation was observed after 48 h. All strains reduced the pH from 6.5 to below 4.0, except for *Lb. fermentum* MINF99 (pH 4.07 after 96 h). *W. confusa* MINF8 produced the lowest pH (3.6) which was similar to that of spontaneously fermented *bushera* (pH 3.6). The lactate content of spontaneously fermented *bushera* was 0.89 % while that produced by different starter cultures was in the range 0.34 - 0.66%. The added starters produced 0.002- 0.14 % ethanol whereas spontaneously fermented *bushera* contained 1.04 %. The rapid acidification, superior utilisation of sugars, and hydrolysis of starch with increasing sugar level by *W. confusa* MINF8 during fermentation indicated its potential for use as a starter culture.

Key words: Sorghum, fermented *bushera*, *Lactobacillus*, *Weissella*

KAIROMONE TRAPPING SYSTEM FOR DELIVERY OF *BEAUVERIA BASSIANA* TO CONTROL THE BANANA WEEVIL

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Field studies were conducted to determine banana weevil attraction to processed banana tissues that could then be used at delivery sites for the entomopathogen *Beauveria bassiana*. Tested materials included pounded corm or pseudostem and chopped corm or pseudostem of (cv Mpologoma, AAA-EA and Kayinja, AAB), which were placed on top of the soil and buried 5 cm below the soil surface. Processed banana materials placed at the soil surface captured 2.0 – 2.7 weevils/trap, with no significant differences among the traps, and were more attractive than split pseudostem traps. By contrast, material buried 5 cm below the soil surface captured only 0.1 – 0.5 weevils/trap, and were less attractive than the split pseudostem traps. Kayinja chopped tissues captured significantly more weevils than the rest of the processed banana tissues. There were no significant differences between the two test cultivars or the test plant parts. Although buried banana materials had been reported elsewhere as highly attractive to banana weevils, our results suggest that burying processed banana tissues actually lowers their ability to attract banana weevils. Moreover, the realized attraction levels of the processed tissues placed at the soil surface may not be sufficient for their recommendation as appropriate for the delivery of entomopathogens, given the extra labor required in comparison to conventional pseudostem trapping. However, efforts to improve attractivity of the banana tissues, such as integration with other weevil trapping strategies (e.g. use of pheromones) should focus on placement of the tissues at the soil surface, instead of burying them. This might result in synergistic effects thus improving their ability to aggregate adult banana weevils under field conditions.

Key words: *Cosmopolites sordidus*, *Musa* spp., pseudostem traps

ASSESSING THE POTENTIAL OF MUSHROOM CULTIVATION IN IMPROVING HOUSEHOLD INCOMES OF SMALLHOLDER FARMERS

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Mushroom cultivation technology was introduced in Kyanamira sub-county, Kabale District as a strategy to relieve pressure on land, increase farmers' incomes and food security. This is because mushroom growing utilizes agricultural residues as substrate and requires little land as it is done intensively indoors. This study, therefore, aimed at introducing, promoting and assessing the impact of mushroom growing technology on household incomes of small scale farmers in Kabale. The study was carried out in Nyabushabe and Kyanamira parishes in Kyanamira sub-county, Kabale district. Sixty farmers from the two parishes were interviewed twice: at the beginning and at the end of the project. Thirty of these were selected, trained and provided all inputs for mushroom production. The study concluded that mushroom growing, which ranked favourably among major income sources, has a potential to be a leading alternative income source besides the traditional crops. There is widespread knowledgeable and appreciation for edible wild mushrooms. There was ready market for mushrooms which could increase with awareness creation. The technology had some impact on gender relations. Mushroom growing requires less and has therefore not added to their labour requirements. Women were the main mushroom growers so could easily influence the decision to grow mushrooms. Income from farm was controlled by women. The study recommends the continued promotion of mushroom growing as an alternative income source to reduce the devastating effects of land shortage and soil exhaustion.

Key words: Agricultural technology, Market for mushrooms, Uganda.

**EFFECT OF MARKET-ORIENTED AGRICULTURE ON SELECTED
AGROBIODIVERSITY, HOUSEHOLD INCOME AND FOOD SECURITY
COMPONENTS**

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Commercialization of agriculture as a government strategy to eradicate poverty at household level has been envisaged in market oriented agricultural production as a way to negate efforts concerning agro-biodiversity and pose a threat to an insurance for household food security. The research question was whether it is possible to meet the goals and objectives of Plan for Modernization of Agriculture (PMA) through integrated agricultural research for development. The paper discusses aspects of conservation promoting market-oriented production as opposed to conventional subsistence oriented and diversification system. This is an issue subject to investigation through research for development, achievement, and lessons learnt and best practices to establish a reality of policy's possible impacts on agro-biodiversity, food security and improved income. The study was carried out in the districts of Bushenyi and Mbarara, in western Uganda. Methods focused group discussions and household interviews. The selected effect components of the study were number of crops / animal species grown for agro-biodiversity, on farm cash income per annum, as well as number and quality of meals per house hold. Results revealed that market-oriented agriculture increases income, improves quality of meals and accessibility to food, but reduces agro-biodiversity at household level. The study recommends diversification of commercial crops /livestock and popularizing farm enterprises with product that can be utilized locally rather than depending on external market for food security.

Key words: Diversification, farm enterprises, markets, subsistence oriented.

**PROFITABILITY OF SORGHUM-LEGUME CROPPING PRACTICES
AMONG HOUSEHOLDS IN EASTERN UGANDA**

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Sorghum (*Sorghum bicolor* L.moench) is a staple food in Uganda and is particularly intercropped with legumes like groundnut (*Arachis hypogea*) and cowpea (*Vigna unguiculata*) in the eastern and northern parts of Uganda. A lot of research has been carried out on the agronomic and productivity aspects of sorghum-groundnut and sorghum-cowpea intercropping, leaving little to refer to in terms of the profitability of these intercropping systems. This study was aimed at determining the profitability of sorghum-cowpea and sorghum-groundnut intercropping practices and comparing the profitability of the intercrops and their component sole crops. A household survey on 150 randomly selected households which practiced sorghum-legume intercropping in the districts of Soroti and Kumi was conducted. Data collected was entered in SPSS and Excel computer software for analysis. Gross margin was computed to determine the profitability of the intercrops and sole component crops. Gross margin was subjected to analysis of variance using SPSS and results showed that the gross margin of sorghum-cowpea and sorghum-groundnut intercropping systems were not different (LSD at $P < 0.05$, not significant). Gross margin of the two intercrops were significantly higher than those of the component crops. It was concluded that, sorghum-cowpea and sorghum-groundnut were equally profitable and advantageous.

Key words: Gross margin, intercropping, sole crops

MOLECULAR DIVERSITY IN SWEET POTATO INFECTING VIRUSES IN AFRICA: WITH EMPHASIS ON SWEET POTATO CHLOROTIC FLECK VIRUS

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Among the biological factors reduce sweet potato yields, virus-induced diseases rank second to sweet potato weevils. Seven viruses including *Sweet potato feathery mottle potyvirus* (SPFMV), *Sweet potato chlorotic stunt crinivirus* (SPCSV), *Sweet potato mild mottle ipomovirus* (SPMMV), *Sweet potato chlorotic fleck virus* (SPCFV), *Sweet potato virus II* (SPVII) (*sensu* Sweet potato virus Y), *Sweet potato caulimo-like virus* (SPCaL-V) and *Sweet potato virus G* (SPVG) have been detected naturally infecting sweet potato plants Africa. Whereas, SPFMV, SPCFV, SPMMV and SPCSV appear to be widely distributed, SPCaL-V has only been reported from Uganda, SPVII from South Africa and SPVG from Ethiopia and Egypt. However, despite the diversity only a few studies have generated data on molecular variability these viruses. Available data indicates that SPCSV has a limited variability while SPFMV, SPCFV and SPMMV isolates are diverse. Analysis of capsid protein (CP) gene sequences indicated the presence of both common andrusset crack strain groups of SPFMV in Africa. When compared with previously reported SPFMV isolates from other continents, East African isolates formed a single cluster, whereas the other isolates clustered according to geographic origin. Comparison of about 2000 nts of the 3' terminal genome part of SPCFV isolates from Kenya and Uganda revealed 94-99% CP amino acid-aa sequences similarity. These isolates differed from a range of geographically diverse isolates by up to 12% in the CP. Sequence variability of SPMMV in the 3'-end of the genome of eight SPMMV isolates from Uganda indicated 92.8-100% aa sequence similarity for CP encoding region. Comparison of HSP70h and CP genes indicated limited sequence diversity among East African isolates of SPCSV. Phylogenetic analysis separated the East African SPCSV isolates into two groups, differing from each other by 2% and 3% in the HSP70h and CP, respectively. A more distant relationship (89 to 92% in CP-aa), however, was observed between the HSP70h sequences of isolates from East Africa and those from Egypt, Nigeria, Spain, Portugal and USA that were also highly conserved among themselves. In this paper, we report studies undertaken to elucidate the molecular characteristics of SPCFV.

Key words: Molecular detection, phylogenetic analysis, sweet potato diseases

YIELD STABILITY AND ACCEPTABILITY OF TWO NEW *Solanum* POTATO VARIETIES IN UGANDA

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Stability analysis is a popular statistical procedure in testing and selection of new crop varieties. In this procedure, emphasis is often put on stable and high yield often with less regard to users' perspectives. The success of any breeding agenda is how much its products are adapted, adopted and utilised. High yields are sometimes obtained at the cost of acceptable user attributes often resulting in limited variety adoption. Consequently, in addition to routine yield stability analysis, two candidate potato varieties, CIP 387121.4 and CIP 381471.18, other advanced clones from population A and B and older potato varieties in Uganda were subjected to user acceptability during agronomic evaluation for the candidate varieties before official release. Yield stability analysis in the highlands over four seasons showed that CIP 381471.18 was quite stable with a non-significant ($P < 0.05$) gradient (b) close to unity ($R^2 = 0.972$). On the other hand CIP 387121.4 was less stable ($b = 1.3$, $R^2 = 0.88$). The two clones contrasted with older cultivars, Victoria and Kisoro with slopes at 0.19 ($R^2 = 0.014$) and 0.085 ($R^2 = 0.88$), respectively. In multi-site testing, the b -value for CIP 381471.18 was 0.94 ($R^2 = 0.997$) and 1.66 ($R^2 = 0.95$) for CIP 387121.4. Farmer acceptability assessment using qualitative variables indicated that CIP 381471.18 had a higher acceptability index (84.6%) than Victoria (55.6%) and NAKPOT1 (69.8%) however; both were lower than Uganda 11 (91.9%). When the test clones were assessed for palatability and consumer acceptability, CIP 381471.18 had an index of 78.8% while CIP 387121.4 had 72.2%. This contrasted with values for Victoria (64.4%) and Uganda 11 (52.5%). Such information can be used to support candidate variety agronomic and yield stability as an additional basis for superiority of candidate varieties. This approach is likely to enhance adoption and utilisation of new crop varieties and profitably thus transforming the breeders' effort into farmers' cash income.

Keywords: Potato qualitative variables, stability analysis user-acceptability index

**PERFORMANCE OF FARMERS-LED EXTENSION SYSTEM IN
AGRICULTURAL TECHNOLOGY TRANSFER AND ADOPTION**

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The farmers' Organisation component is one of the seven components of Agricultural Sector Programme Support (ASPS), which has been operating in 41 districts of Uganda to increase farmers' welfare through activities of their own organisations. In each district, the component has established an extension system comprising of district-based staff, Parish Executive Committees (PEC), Extension Link Farmers (ELF), Special Interest Groups (SIGs) and farmers. Through the PEC, farmers initiate their training needs and the district technical staff train the Extension Link Farmers who in turn transfer the acquired knowledge and skills to other member farmers. By end of 2002, over 100,000 farmers had been trained in different agricultural technologies. However, the performance of the extension system in terms of technology transfer to and adoption by farmers was not known, hence the need for an adoption assessment study. The study, conducted in 12 districts, estimated adoption rates attained through transferring knowledge and skills using the established extension system as the performance indicator. With focus on four priority enterprises in each district, 12 Extension Link Farmers and 60 member farmers were randomly selected and interviewed from each district. Defining adoption as repeated application of acquired knowledge, adoption rate was computed as a ratio of practices a farmer applied to the number of practices in an enterprise-technology package. Adoption rate was estimated at 35%, meaning that farmers applied about 35% of the practices in which they were trained. The rate was lower (30%) among women than male farmers (37%) due to a combination of economic and cultural reasons. Higher yields and income expectations were the major reasons for adoption. In some enterprises, household size, formal education, number of district Farmers' Organisation staff visits to farmers and training methods used had positive and significant association with adoption, while distance to the market and farmers' sex (farmer being a woman) had negative association. Regular farmer visits by the technical staff, emphasis on training especially using demonstrations and availing inputs closer to farmers were therefore recommended.

Key words: Adoption, agricultural technology, farmers' Organisations

**MARKET OPPORTUNITIES FOR UGANDAN BANANA PRODUCTS:
NATIONAL, REGIONAL AND GLOBAL PERSPECTIVES**

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Banana (*Musa* spp.) is the most important food crop in Uganda, and it is also the most important income source for the majority of the Ugandan farmers, especially in the Western Ugandan Regions. Besides pests, diseases and declining soil fertility, marketing seems to be a major constraint to production and income generation in the banana sector. To address these problems, the project on Improvement of Banana Marketing and Utilization in Uganda, a joint venture of NARO/NBRP, Makerere University and International Institute of Tropical Agriculture (ITTA), seeks new ways of marketing bananas nationally, regionally and globally. The paper discusses the findings of initial surveys on the status quo of banana marketing in Uganda. During a farm and household survey, data on banana supply, marketing and demand have been collected and analysed. In a survey of secondary data, international banana markets have been evaluated. It is clear that, although the second biggest banana producer in the world, Uganda lags far behind in terms of trade shares. However, global markets are of high competition, high dynamics and a high diversification in terms of banana varieties and products. Conclusions are that, the domestic markets, for the fresh product of *matooke*, price and income elasticities are low, and productivity increases are not likely to yield revenue increases for farmers. What could be feasible, is re-organising the marketing chain, in favour of the farmers. Processing has various promising perspectives especially in the high elasticity juice and alcoholic beverages sector. Concerning international trade, Uganda faces high competition on saturated markets. Key factors are the re-organisation of domestic production to obtain quantities and qualities required on global markets. Niches like seasonal highs of prices, and organic fruit markets can be exploited.

Key words: Domestic markets, market chain, *Musa* spp., revenue

EFFICACY OF *Beauveria bassiana* SUBSTRATES AND FORMULATIONS FOR THE CONTROL OF BANANA WEEVIL

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For effective use of the entomopathogen *Beauveria bassiana* in the management of the banana weevil, high inoculum levels and appropriate formulations are mandatory. Evaluations of *B. bassiana* formulations were carried out under laboratory conditions at Kawanda, Uganda with specific objectives of determining conidial yield, efficacy of different formulations against the banana weevil, and their persistence over time. The entomopathogen was produced using a diphasic method. Substrates evaluated for conidial yield were: cracked maize, maize bran, "machicha" bagasse, cotton husks, maize bran + bagasse, maize bran + cotton husks, and bagasse + spent yeast, formulated with clay or loam soils. Data on conidia counts was done using the improved haemocytometer. Cracked maize grains and maize bran were the best substrates with 3.2×10^9 conidia per gram and 3.1×10^9 conidia per gram, respectively. Evaluation of the *B. bassiana* formulations against the banana weevil again showed cracked maize to be best with over 80% weevil mortality in 30 days. Following laboratory storage conditions for three months, recorded weevil mortality after exposure to the cracked maize grains formulation was > 85% in 30 days, but this declined to 20% following 180 days of storage. Further studies are being undertaken on fungal formulation and storage, to improve fungus viability and infectivity over longer periods.

Key words: Banana weevil, *Beauveria bassiana*, conidia, formulations, substrates

TESTING FORAGE LEGUME TECHNOLOGIES WITH SMALLHOLDER DAIRY FARMERS: A CASE STUDY OF MASAKA DISTRICT, UGANDA

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In a farmer participatory process, farmers in Masaka district identified intensive dairy farming using improved cattle breeds as potentially viable enterprise to improve household income and nutrition. The realization of potential economic benefits is however impeded by inadequate feeds during the dry season leading to low animal productivity. Findings from on-station research, suggest the possibility of incorporating forage legumes in farming systems that could solve feed shortages during the dry season. Participatory on-farm trials were therefore conducted on 24 dairy farms to demonstrate the effects of leguminous fodder on feed availability and response of dairy cows fed forages from cereal or elephant grass intercropped with forage legumes and supplemented with lablab hay and/or calliandra leaf hay. The study lasted 18 months. This paper presents benefits and constraints identified by farmers as a result of integrating forage legumes in farming systems and lessons learnt from working with resource poor farmers. Major benefits were improved feed and household food security and increased milk yield. Major constraints were high cost of resources; low yield of legumes in mixtures and land shortage. Lessons learnt from the study were: the performance of promising technologies developed on-station can be tested under “real-life” agro-ecological and management conditions; farmers’ capacity and expertise for conducting collaborative research is built up and becomes a valuable resource for future research programmes; cross-visits and feedback workshops are very effective in sustaining and keeping farmers’ interest and improving their skills; working with farmer groups enhance adoption of forage technologies as farmers share experiences and resources required for the technology to succeed and; development of positive rapport among stakeholders is a key to success of on-farm trials. In conclusion, the key to adoption of forage technologies is to allow farmers experiment, identify the constraints versus the benefits associated with the technology, adapt and expand.

Key words: Benefits; constraints; forage technologies; participatory, smallholder dairy farmers

LONG-TERM STORAGE OF SWEETPOTATO BY SMALL-SCALE FARMERS THROUGH IMPROVED POST HARVEST TECHNOLOGIES

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Sweetpotato (SP) small-scale farmers of Luweero and Mpigi districts were introduced to improved long-term storage methods (pit and clamp) as a way of improving their livelihood. Based on a participatory approach, farmers were involved in a storage study where dry matter, beta-carotene and sugar content parameters were monitored over a 60 day period in Mpigi and 75 days in Luweero district. Pit and clamp stores were constructed by farmers in selected sites of each district. Improved SP varieties (*Ejumula*, *Naspot 1*, *Naspot 2*, *New Kawogo*, *Semanda* and *SPK004*) were used for the storage study. Dry matter contents of SP were exceptionally high, particularly for roots from Mpigi district, with *Semanda* variety having the highest dry matter (41%). High beta-carotene concentrations were recorded for the orange-fleshed varieties, *SPK004* and *Ejumula*, 68 and 125 mg/100 g, respectively. Total sugar contents of the roots were generally low (1.6-3.7 g/100 g), with exception of *Naspot 2* (5.7 g/100 g). Changes in dry matter, beta-carotene and sugar contents of SP depended on location, and differed for both districts. No consistent trends in dry matter, reducing and sucrose contents were noted for SP in Luweero district. The decrease in sugar contents noted for Mpigi SP was due to a general decrease in dry matter for these SP. Although beta-carotene generally decreased with storage period for SP in both districts, the residual beta-carotene (2.6-3.4 mg/100 g) in the orange-fleshed SP varieties could be sufficient as the recommended daily allowance intake of vitamin A. Monitoring temperature, relative humidity and atmospheric compositions of the long-term stores is needed to assess the performance of individual SP varieties.

Key words: Long-term storage, small-scale farmer, sweetpotato, post harvest technologies