



**Faculty of Agriculture
Makerere University
&
Swedish University of Agricultural
Sciences**

Research Abstracts

Sida/SAREC funded Projects

Phase I: 2001 - 2005

Edited by: J.S. Tenywa

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FORWARD

The Faculty of Agriculture is a beneficiary of the Sida/SAREC support extended to Makerere University towards Ph.D. training, research and dissemination of results. The support towards research has greatly invigorated the research culture of the Faculty as well as bolstered professional growth among the Academia. A spectrum of research projects has been implemented and others are on-going under the direct funding of Sida/SAREC. This booklet presents abstracts of these projects along with substantive as well as interim results obtained. The abstracts are sequenced in the untitled order of socio-economics, soil and water management, crop production, livestock production, and statistics/biometrics. The Faculty is heartily grateful to Sida/SAREC for the continued support.



Professor M. Bekunda
DEAN

Knowledge and perception of agriculture by youths in Makerere University Agricultural Research Institute Kabanyolo vicinity: Implications for Agricultural Extension/Education Programming

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Abstract

The outreach programmes in the Faculty of Agriculture mainly target adult farmers, most of whom are elderly. The Faculty seems to miss out on the youth that are the custodians of tomorrow's agriculture. This study was designed to establish the level of agricultural knowledge among the youth in communities around the Makerere University Agricultural Research Institute, Kabanyolo (MUARIK); attitudes towards/perceptions about agriculture; farming activities undertaken by the youths, as well as knowledge gaps hindering their productivity. The study was conducted in four parishes of Nangabo sub county that are in the immediate vicinity of MUARIK, namely, Kabubbu, Bulamu, Nangabo and Gayaza. A descriptive survey was conducted in three phases: (a) discussions with local government and youth leaders; (b) focus group discussions (FGDs) at village level and; (c) a house-to-house survey using questionnaires and individual interviews. The study involved 316 youths aged 15-30 years. The findings from FGDs indicated that all the youth ranked farming as their preferred occupation compared to carpentry, tailoring, *boda-boda* (motorcycle transport), and beer selling. More than half of the respondents (40 out of 60) were involved in farming related activities either as individuals or as members of a household. Many male youth were engaged in horticultural market gardening of crops such as *Nakati*, tomatoes, *Amaranthus* (Dodo), and cabbages. Lack of agro-inputs, especially good seeds and pesticides hindered their gainful involvement in farming. Other hindrances were: lack of markets, limited capital for increased investment, transportation costs for produce to markets, lack of technical knowledge especially

on crop pests and diseases, animal diseases and low soil fertility. The extension system and MUARIK outreach programme were applauded for the good job, though both systems did not benefited farmers in their locality. Survey findings indicated that youths were fairly knowledgeable about agriculture but relied mostly on personal experiences, neighbours and newspapers for farming information. MUARIK, Extension, Schools and NGOs in the area played only a secondary role in promoting agricultural knowledge. There were no systematic programmes to popularise agriculture among the youths. One third of the youths had farming enterprises of their own, while more than half (58%) had no projects at all. Majority of youths were poor and vulnerable to crime. Training needs among the youths of the area were about basic production skills for both crops and livestock. The driving force behind youth involvement in Agriculture was income generation rather than food security. MUARIK has a high potential for influencing youths towards farming since a majority of them rated the Institute as a model farm for nearby communities.

Handling of used plastics in urban and peri-urban areas of Uganda: A socio-economic perspective

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Abstract

The continuous accumulation of solid wastes in urban and peri-urban areas and lack of safe waste handling creates environmental and public health problems, consequently, reducing quality of life for the communities. Some wastes have been utilised mainly in compost making and livestock feeding, while others have, due to favourable conditions, been reduced naturally by decomposition. In either case, the pattern of non-biodegradable plastic and polythene materials in the generated waste greatly limits value addition and natural decomposition, hence, the ever increasing accumulation of waste. Plastics get into households mainly in form of packaging materials. Of particular concern in Uganda are polythene bags, locally known as 'buveera'. Despite the fact that they are cheap and light, they are hazardous to agriculture, environment, health and sanitation. It is, therefore, important that, in finding out the most appropriate urban waste management alternatives, the socio-economic handling of plastic and polythene waste should be clearly understood. On this basis, a study was conducted to estimate the quantity of plastic and polythene waste generated at household level and establish the relationship between households socio-economic characteristics and handling nature of used plastics. The study was carried out in urban and peri-urban areas of three districts within the Lake Victoria crescent region, namely, Kampala, Masaka and Iganga. Data were collected from 240 households (120 from Kampala, 60 from Iganga and 60 from Masaka urban and peri-urban areas). These were selected purposively to cater for the low and high income earners, and randomly from the categories. In addition, data were collected from three recycling

firms, 10 waste pickers at garbage collection places and seedling nursery attendants who use the plastics and polythene materials. These are the units that find plastic waste useful after initial utilisation. Descriptive statistics and correlation results were obtained. An average urban low income household uses 2,114 bags, 139 plastic containers and 14 nylon-fibre sacks annually. This is equivalent to 8.7, 3.0 and 3.7 kg, respectively. The high income households use 2,018 polythene bags (8.3 kg), 14.0 kg of plastic containers and 23 nylon-fibre sacks (6.4 kg) per year. The most popular practice of handling plastic wastes among households was throwing away with limited reuse, which was more common among the low income households. From the garbage bins, skips and landfills, scavengers mainly extracted paper (boxes), plastics, sacks and polythene bags, which they usually sold Shs. 100-250 per kilogramme. Those who bought the scavengers' sorted wastes sold them either to tree/nursery attendants and recycling firms. The former bought mainly plastics and polythene materials (mostly milk packs) at Shs. 200-300 per kilogramme, which they used for potting the plants before sell. Recycling firms bought at Shs. 300-500 per kilogram and used the plastics and polythene materials to reproduce polythene bags, tubings, water pipes and polythene rolls. Negative relationships existed between income class and number of nylon-fibre sacks consumed ($-0.273, P \leq 0.01$); income class and quantity of plastic containers used ($P \leq 0.05$) and education status of the household head and quantity of polythene bags consumed ($-0.146, P \leq 0.05$). Similarly, quantity of plastic and polythene materials consumed and sex of the household head being female, and household size were positively related. Factors which the households attributed to popularity of plastic materials included convenience, being given for free after purchases, non-bulky and reusability. Negative attributes included danger to human and domestic animal health, non-degradability and littering everywhere. Households, therefore, suggested banning their manufacturing, burning, manufacturing organics, recycling and educating the public about the dangers and proper disposal practices as solutions to reducing the negative effects. However, very few respondents were willing to participate in reducing the problem. Only 24% of the households expressed willingness to dispose the wastes in the right places, while 35% were willing to burn them. Regarding stopping use or paying a fee for

waste disposal, only 2.5 and 1.7% of the high and low income households, respectively, were willing to pay for disposal services. It is, therefore, through improving income and education status, checking urban households sizes and sensitising the masses on appropriate waste handling that can reduce on the dangers of plastic and polythene wastes.

Socio-economic implications of waste utilisation in urban and peri-urban areas of the Lake Victoria Crescent

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Abstract

The rapid rate of uncontrolled and unplanned urbanisation has brought about an environmental problem of urban waste management. Effective waste management is required but in many developing nations, this is constrained by lack of the required funds. In urban and peri-urban areas of the Lake Victoria crescent of Uganda, waste generation stands at 1,000 t in Kampala, 112 t in Iganga and 150 t per day in Masaka. The collection rates have remained below 40% in of the urban centres. The high generation rates coupled with poor collection rates and less reuse poses serious environmental and health problems for urban populations. The organic portions form 50- 80% of the wastes and could be sorted, composted and reused. However, the reuse is still limited. Waste disposal, which now consumes approximately 20 % of the urban budgets, is largely funded by taxes levied on households. This does not encourage any source reduction. Large quantities of organic wastes which form the biggest portion of wastes remain underutilised, are buried in land fills, illegally dumped or left to rot leading to serious environmental and human health risks. There is, therefore, need for alternative ways of reutilising the organic wastes. The objective of this study was to explore potential alternatives (technologies) of waste utilisation in urban and peri-urban Uganda that are economically viable and socially acceptable. The project was based in the districts of Kampala, Mukono, Wakiso, Iganga and Masaka, all located in the Lake Victoria crescent region. Interviews were held with market administrators, vendors, urban officials, waste sellers and selected households. Results so far indicate that the ten biggest markets in Kampala City

generate approximately 1800 tonnes monthly. A monthly saving of up to Shs. 19 million in disposal costs could be realised, if 80% of the biodegradable market waste stream was composted instead of being land filled. At the household level, waste generation is about 1.2 kg per head per day in Kampala and even higher in other urban centres. Households are willing to pay Shs. 100- 3000 weekly for proper waste management provided waste bags or bins are available and the frequency of collection increased. The current trend to privatise waste collection and disposal has increased the rate of collection, but the service is limited to only two divisions in Kampala City where households provide their own garbage bags. The common ways in which wastes are utilised in the surveyed districts are as a feed for livestock, biogas production, soil amendment in form of compost and as mulch. A profitability assessment of using banana peels as a feed supplement for dairy cattle showed that incorporation of 40% of the peels in the feed, gives a positive net benefit of Shs. 1.15 million compared to Shs. 0.8 million without banana peels. Preliminary results also show that compost applied at a rate of 5 t per ha in combination with nitrogen at 40 kg per ha and phosphorus at 9 kg per ha gives a positive net benefit of Shs. 0.734 million. No waste recycling is currently undertaken by Kampala City Council or other municipal authorities. However, two Non-Governmental Organisations, namely Talent Calls Club in Mukono district and Uganda Environmental Protection Forum (UEPF) in conjunction with Kalerwe Vendors Association in Kampala, compost garbage and sell at Shs. 10,000 per 100 kg bag. Demand for compost is high among vanilla farmers. Nearly 50% of farmers surveyed in peri-urban areas turn their household wastes into compost but face constraints such as lack of labour and equipment. They generally had a positive attitude towards compost from municipal wastes. A market for crop wastes has emerged in the urban centres primarily for banana peels, potato vines, cabbage leaves and bean pods. These are sold to livestock farmers. The prices vary with the season but average Shs. 300 per bag in the wet season and Shs. 1500 per bag in the dry season when pasture is scarce. At landfills, waste pickers or scavengers collect approximately 1 tonne of recyclable materials per day which is resold. Plastics and paper are resold at Shs. 200 and Shs. 100 per kg, respectively. Many have made a livelihood out of this activity and, thus, been kept

out of various vices. In conclusion, wastes are resources which can be profitably used as a feed supplement and soil amendment. The high quantities of biodegradable wastes generated means they are readily available as composting material. The rising demand for compost among vanilla farmers in nutrient depleted areas of the crescent offers an important alternative solution to the waste problem because of the benefits it brings to the environment and the subsequent increase in agricultural productivity. Recycling and the reuse of wastes is environmentally friendly as it reduces waste transport costs, prolongs the life of landfills and reduces pollution from leacheates. Waste pickers or scavengers are an important part of the solution to waste management given the income they earn from their informal employment and the reduction in waste dumped in the land fill. What remains of the project is to complete the estimation of the econometric models, write up of the complete thesis and three journal papers for publication.

Identifying the limiting nutrients in coffee plantations at Makerere University Agricultural Research Institution, Kabanyolo

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Abstract

Coffee is a leading traditional cash crop in Uganda, earning more than 50% of foreign exchange. Coffee is one of the main revenue sources at MUARIK, from plantations established more than 40 years ago, and only fertilised intermittently. Nutrients removed in harvest at MUARIK average 33, 2.5 and 30 kg ha⁻¹ yr⁻¹ for N, P and K, respectively. The basis for the fertiliser application in these plantations (type, rate, method of application, residual effects) has not been documented. We considered that the basic information required for the planning for nutrient management in coffee plantations at MUARIK would be the identification of the most limiting nutrient(s) to productivity; this was the basis for formulation of this research concept. The study was conducted in the existing coffee plantations. Four blocks were used in which each of the following primary-nutrient treatments was applied as follows:

1. Nitrogen as urea (150 kg N ha⁻¹ yr⁻¹);
2. Phosphorus as superphosphate (100 kg P ha⁻¹ yr⁻¹); and
3. Potassium as Muriate of Potash (100 kg K ha⁻¹ yr⁻¹).

In addition, treatment combinations of N and P; P and K; N and K; and N, P and K were applied and all were compared with a control. Ripe coffee beans were harvested through 15 months starting one month after treatment application, and dried to constant weight at 60°C before weighing. Soil analytical characteristics showed nitrogen and potassium were well below the critical level (Table 1) at which addition of N and K containing fertilisers is necessary for a good crop. This was reflected in the coffee

yield response within the 16 months after fertiliser application (Table 2). None of the nutrient combinations performed better than N and K applied individually.

Table 1. Selected characteristics of soil from MUARIK coffee site.

| Depth | pH | Total N (%) (mg kg ⁻¹) | Available P (mg kg ⁻¹) | Exchangeable K ⁺ (cmol kg ⁻¹) |
|----------------|-----|---------------------------------------|---------------------------------------|---------------------------------------------------------|
| 0-15 cm | 5.5 | 0.08 | 18.9 | 1.64 |
| 15-30 cm | 5.4 | 0.05 | 6.9 | 1.28 |
| Critical value | 5.5 | 0.20 | 15.0 | 0.22 |

Table 2. Cumulative coffee berry yield under different nutrient treatments

| Nutrient treatment | Control | N | P | K | Lsd |
|-----------------------------|---------|-----|-----|-----|-----|
| Yield (t ha ⁻¹) | 1.6 | 2.3 | 1.8 | 2.2 | 0.5 |

Nitrogen and potassium appear to be the most limiting nutrients. However, the highest yield values obtained were still below expected peak yields of about 6 t ha⁻¹ cited elsewhere, indicating existence of potentially other limiting factors. There was an unexpected extended draught period during the study, but the age of the coffee trees may also have contributed to the inefficient use of fertilisers.

Establishment of the agronomic value and supply potential of urban market crop waste for soil fertility management

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Abstract

Massive movement of unprocessed crop and livestock produce from remote producing areas to urban centres characterises Uganda's domestic food marketing and consumption structures. This scenario is fuelled by the dramatic rise in urban dweller communities resulting from the growing rural-to-urban migration patterns. Consequently, huge piles of wastes or garbage are dumped beyond the capacity of municipalities to manage. However, crop wastes being endowed with nutrients, could be used to revitalise the productivity of urban and peri-urban soils, which are nutrient impoverished due to continuous crop removal unreciprocated by nutrient addition. This project was designed to improve food security and urban/peri-urban sanitation through utilisation of urban market crop wastes for soil fertility management. Project objectives include (i) determination of garbage quantity and nutrient composition changes in Kampala markets annually (survey); (ii) characterisation of garbage composting process in windrows; (iii) establishment of the point of synchrony between maximum nutrient release from garbage compost and maximum crop nutrient demand; and (iv) evaluation of agronomic effectiveness of composted urban crop wastes. From the urban market waste survey, plant and to a limited extent, animal based garbage was >80% of the overall mass, with banana residues (leaves, bunch stalks and pseudostems) dominating. Other major residues included vegetables, maize, beans and sweet potato vines. Major non-plant or animal wastes include plastics, tyres and broken glass. Garbage quantity and quality varied insignificantly ($P < 0.05$) among markets, though seasonal differences were apparent. In the composting

windrows, temperature was from 72 and 30 °C at the composting peak and maturity point, respectively, while the pH remained virtually constant at 10. A phenomenal quantity of nitrogen (34%) was lost during open windrow composting; this devalued the final product. Phosphorus concentration did not change significantly ($P>0.05$). Data from the nutrient release (mineralisation) are still unavailable; samples are still being analysed. From the agronomic evaluation standpoint, the four seasons pooled data showed that application of compost on-station and on-farm significantly ($P<0.05$) increases maize plant height, leaf area index, total dry plant and grain weight. Up to 15% grain yield increase was recorded on both locations and for the two compost rates used, namely, 5 and 10 t ha⁻¹, implying that the former is the most appropriate rate. Superior results were obtained with compost and N (0, 40 and 80 kg ha⁻¹) interactions. The best combination, which increased grain yield by 43% over the control, was 80 and 9 kg ha⁻¹ N and P, respectively. Overall, application of P interactively with garbage compost and N did not significantly influence grain yield. All studies including a greenhouse experiment (to back up the field studies) are still underway till June 2005 when the PhD. student will be ready to submit her thesis.

Surface irrigation design and management on-station in Central Uganda

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Abstract

Uganda's agriculture increasingly suffers from extended dry seasons, unreliable and poorly distributed rainfall. Irrigation is, therefore, desirable for most parts of the country. Furrow irrigation is one of the cheapest and most common irrigation methods. Makerere University Agricultural Research Institute (MUARIK) should be an exemplary demonstration and training facility for this aspect. For effective design and management of a furrow irrigation system, information is required on optimum stream size, optimum furrow length, and optimum duration of water application corresponding to particular type of soils and slopes. These constituted the objective of this study. A contour map of the MUARIK was established using survey, climatic data from MUARIK weather station to establish crop water requirement, soil texture, infiltration data and soil profiles. Furrows were established on slopes of 0.2, 0.4, 0.7, 1 and 1.67% and discharges of 0.08 to 0.705 litres where run for the different furrows and slopes. Spinach yield was evaluated under irrigated and rain-fed growing conditions. Major furrow design variables established include the stream size, furrow length for various slopes by field trials. Field application efficiency was found to be 57%. There was no yield under rain-fed conditions due to severe drought. The estimated profit for spinach grown under irrigation was 2.5 million shillings per hectare. A negative relationship occurred between stream size and slope magnitude. In contrast, furrow length increased with increase in slope magnitude. The irrigation water application time for spinach at peak water demand was 95 minutes, while the advance time was 24 minutes. These results can be used to select for a given slope the appropriate furrow length and stream size. More research on yield improvement under irrigation using different treatments should be done to build a database.

Utilisation of market crop wastes as soil fertility amendments in integrated pest management in farming systems in Uganda

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Abstract

Beans, *Phaseolus vulgaris* L and cabbage, *Brassica oleracea* var. *capitata* are important vegetable crops in urban and peri-urban areas of Uganda. Despite the great value of these crops with respect to food security and income, yields on-farm are way below the potential, sometimes as low as 300 kg ha⁻¹ in the case of beans. This has been attributed to soil nutrient depletion and crop losses due to insect pests and diseases. Ironically, fertiliser application may reduce the impact of insect pests and diseases on yield. There is growing evidence that organic fertilisers can decrease insect pest populations. This potential, however, has not been exploited. In Uganda, urban and peri-urban areas are burdened with piles of market crop wastes (MCW) and also low crop productivity due to nutrient depletion. An opportunity of solving the two problems, therefore, exists whereby growers could utilise market crop wastes as organic fertilisers. This study was conducted to quantify the effect of different forms of MCW organic amendments on insect pests and natural enemy occurrence, and yield of beans and cabbage. Field experiments (cabbage and beans) were conducted on-station (Makerere University Agricultural Research Institute, Kabanyolo) during 2003 and 2004 for three consecutive seasons. For both crops, the treatments included (1) MCW compost incorporated in the soil, (2) Un-composted MCW incorporated in the soil, (3) Un-composted MCW applied as a surface mulch, (4) a conventional chemical fertiliser (NPK) incorporated in the soil, and (5) the untreated control. The amendments were applied at the rate of 12 t ha⁻¹, whereas NPK was applied at a rate of 70 kg N, 50 kg P, and 50 kg K ha⁻¹. Both cabbage and beans responded positively and

similarly to the amendments in terms of plant growth attributes, namely width, height, and leaf area. The bean aphid (*Aphis fabae*) consistently preferred the surface applied un-composted MCW amended plants, whereas cabbage aphids performed best on composted MCW amended plants. Generally, MCW plots sustained higher insect pest infestations. Natural enemy occurrence followed the trend of host insect pests infestation. As such, for both crops, MCW plots generally had a higher natural enemy occurrence than NPK and untreated plots. Yield performance and profit margins from the two crops were quite distinct. Cabbage responded to the organic (MCW) amendments in the first season of amendment application; beans, on the other hand, responded significantly ($P < 0.05$) only after two seasons of amendments application. For beans, yields from MCW plots were comparable with those from NPK plots (Figure 1 a), even though higher economic returns accrued from the use of NPK. For cabbage, MCW plots surpassed NPK plots both in yield (Figure 1b) and economic returns. Soil had a higher pH, organic matter content, levels of K, Ca, and Mg, after beans than cabbage, except for the level of P where the reverse was true.

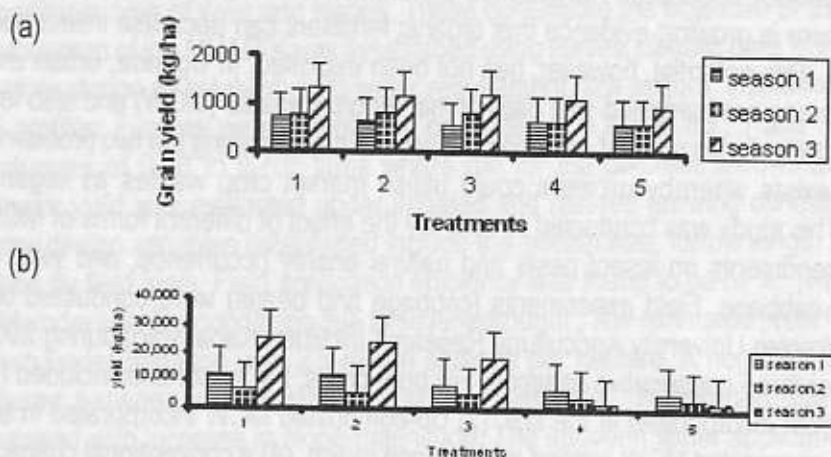


Figure 1. Yield from differently amended plots over a period of three seasons: (a) beans; (b) cabbage. (1=MCW compost incorporated; 2=MCW un-composted incorporated; 3=MCW un-composted on surface; 4=NPK incorporated; and 5=untreated).

In general, yields from MCW amended plots were higher or comparable to those from NPK despite higher pest infestations in MCW plots. This, in addition to an improvement in soil quality, demonstrated that organic soil fertility amendments could be a valuable tool in integrated insect pest and soil fertility depletion management in crop production. One season of on-farm trials will be conducted to verify on-station results. Further research is required to assess ways of augmenting this technology with other environmentally friendly pest management strategies.

Performance of lactating dairy cows fed urban market crop wastes in smallholder dairy production systems

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Abstract

Urban and peri-urban agriculture is important in sustaining livelihoods of the increasing population in this farming system. Farmers in these areas are faced with problems of fodder scarcity which is worse in the dry season when pasture productivity in terms of quality and quantity are greatly lowered. Moreover, the major agricultural produce lead to increased accumulation of crop wastes such as banana leaves and peels, sweet potato peels and vines, sugarcane tops, cassava leaves, bean haulms, maize stover and vegetable remains in Uganda's markets. Of these crop wastes, banana peelings constitute the largest proportion in markets of central Uganda. About 1000 tonnes of market crop wastes are generated daily in Kampala yet only 35% are disposed off. These materials viewed as garbage can be utilised as major animal feed resources. Most crop wastes are low in most of the nutrients, therefore, need to be fed at certain levels and strategically if optimal performance is to be achieved. This study was conducted to evaluate the performance (milk production and live weight changes) of lactating dairy cows fed urban market crop wastes in the Lake Victoria crescent region of Uganda. Four lactating Friesian animals weighing 496 kg on average were used in a Latin Square design, at Makerere University Agricultural Research Institute, Kabanyolo. A basal diet consisted of banana peelings at 0, 20, 40 and 60% of the total ration in addition to elephant grass. Each diet was supplemented with maize bran, cotton seed cake and *Gliricidia sepium* to contain above 11-12% crude protein required for moderate levels of production. Animals were housed in individual stalls and were dewormed and treated against external

parasites before commencement of the experiment. The animals had free access to clean drinking water and mineral licks. Milking was done twice daily and the total daily yields were recorded. Milk samples were collected from animals on each diet and analysed for protein, butterfat, total solids and ash. Daily dry matter intakes, live weight changes, milk yields and composition were determined. Feeds were sampled fortnightly for determination of crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF), acid insoluble ash (AIA), ash, dry matter (DM), organic matter (OM), calcium (Ca) and phosphorus (P). Banana peelings were collected from markets over four months from central, eastern and western regions. The BP were also analysed for CP, ADF, NDF, DM, Ca and P. For *invitro* fermentation, rumen liquor was collected from a fistulated animal into pre-warmed CO₂ filled thermos flasks and strained through a cheese cloth. Samples were weighed into 125 ml flasks and 40ml of prepared medium was added to each flask. *Invitro* fermentation was then conducted using 10 ml inoculum for 48 hours. The DM digestibility was then determined. DM, CP, ADF, NDF, Ca and P in the feeds were determined as above. Dry matter intake on diets with 40 and 60% BP were 21.5 and 21.4 kg dry matter/cow/day, respectively, and were significantly ($P<0.05$) higher than intake of 16.2 and 18.0 kg dry matter/cow/day on diets with 0 and 20% BP, respectively. Live weight changes were similar for animals on all treatments. Milk yields ranged from 10.2-11.4 kg per day, with no significant ($P>0.05$) differences between treatments. The nutritive value of banana peelings of the different banana varieties was higher in banana varieties from the eastern region than for varieties from other regions. Phosphorus and Ca were higher in varieties from the western and central than in those from the eastern region. Crude protein, ADF, NDF and INDMD values did not differ among the varieties. Evaluation of feeding different levels of banana peelings and elephant grass each supplemented with cotton seed cake, maize bran and *Gliricidia sepium* on rumen environment, degradability and digesta kinetics of feeds and, manure evaluation are on-going. Effect of feeding the optimum level of banana peelings from experiment one with other crop wastes on performance of lactating Friesian cows are to commence soon.

Restricted suckling and split weaning for improving sow and progeny performance under smallholder farm conditions in Uganda

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Abstract

In Uganda, early weaning is not a recommended management practice due to high costs of rearing the piglets. Long lactations are associated with a reduction in the sow's reproductive performance as a result of a long wean to service interval and fewer litters per year. In a management system where the recommended lactation length is up to 8 weeks, a reduction in the wean- to -service interval would increase the number of litters per sow per year, and providing the other determinants of sow efficiency remained unchanged, would improve sow output. Management practices, which would reduce the intensity of suckling, are known to reduce lactational weight loss and wean-to -estrus period. This study aimed at assessing the effect of restricted suckling and split weaning as management strategy for reducing suckling intensity and lactational weight loss, on the performance of sows and their litters. Forty eight sows of second or third parity from two different farms, Kabanyolo and Seeta in central Uganda, were used. The sows were of the Landrace x Large white breed. During lactation, the sows were kept outdoors on pastures. Individual pens partially open were used from 4 to 8 days before farrowing until the litters were weaned. The sow meal was mixed on-farm using maize bran, fishmeal, and cottonseed cake. Each sow was given 3 kg daily during pregnancy. The sows were recruited to the experiment when they became pregnant. They were allocated to the four treatments as follows. Beginning 4 weeks after farrowing sows were separated from their litters and the piglets allowed either one period of suckling lasting 30 minutes, or two periods of suckling (morning and afternoon) each lasting 30 minutes. For the third group, piglets that attained 6 kg body weight after 4 weeks of lactation were weaned.

All piglets were weaned at 8 weeks of age irrespective of body weight attained. A control treatment where piglets were left with their mother for the entire eight-week lactation period was included for comparison. Suckling regime of piglets significantly ($P < 0.05$) affected their creep feed intake and live weight at all pre-weaning ages. Feed intake increased with age and averaged 1.0, 1.8, 2.5 and 3.3 kg for week 4, 5, 6 and 7, respectively. Piglets suckled once a day had the highest total intake (8.76 kg) which was significantly higher ($P < 0.05$) than those suckling twice a day (8.35 kg) and *ad libitum* (8.49 kg) (Table 1). Piglets that suckled twice a day were significantly heavier ($P < 0.05$) than those suckling once, and the control group (Table 2). The total weight gain of the piglets over the 4-week trial period was 2.48, 3.45 and 3.32 kg when suckled once, twice a day and *ad libitum* (control), respectively. Piglets that were split weaned gained 2.73 kg but did not significantly differ from all the other categories.

Table 1. Average creep feed intake of piglets.

| Treatment | Feed intake (kg) during week | | | | Total |
|---------------------|------------------------------|-------------------|-------------------|-------------------|-------------------|
| | 5 | 6 | 7 | 8 | |
| Once a day | 1.06 ^a | 1.73 ^a | 2.53 ^a | 3.44 ^a | 8.76 ^a |
| Twice a day | 1.01 ^b | 1.71 ^b | 2.34 ^b | 3.29 ^b | 8.35 ^b |
| Split weaning | 0.89 ^c | 1.79 ^c | 2.60 ^a | 3.20 ^c | 8.49 ^c |
| Control | - | - | - | - | - |
| LSD _{0.05} | 0.02 | 0.03 | 0.09 | 0.01 | 0.09 |

Table 2. Average live weight and survival rate of piglets.

| Treatment | Body weight (kg) at week | | | | Total gain | Piglet mortality |
|---------------------|--------------------------|-------------------|-------------------|-------------------|--------------------|------------------|
| | 5 | 6 | 7 | 8 | | |
| Once a day | 6.09 ^a | 6.68 ^a | 7.74 ^a | 8.19 ^a | 2.48 ^a | 0.3 ^a |
| Twice a day | 6.40 ^a | 7.82 ^b | 8.61 ^b | 9.22 ^b | 3.45 ^b | 0.0 ^b |
| Split weaning | 5.52 ^b | 5.56 ^c | 6.17 ^c | 6.42 ^c | 2.73 ^{ab} | 0.0 ^b |
| Control | 6.24 ^a | 6.90 ^a | 7.75 ^a | 9.30 ^b | 3.32 ^{ab} | 0.0 ^b |
| LSD _{0.05} | 0.405 | 0.381 | 0.740 | 0.895 | 0.895 | 0.08 |

Means with different superscripts differ significantly ($P < 0.05$)

Table 3 shows the weaning to estrus period, body condition score at weaning, and subsequent litter size of sows in the respective suckling restriction and split weaning treatments. Sows whose litters were restricted to suckling twice a day came to estrus before weaning, while those, which suckled *ad libitum*, came to estrus after a fortnight. Body condition of the sows significantly ($P < 0.05$) varied across all treatments with the highest recorded for split weaning. Sows that suckled their litters once a day had the highest subsequent litter size while split weaning gave the lowest size (Table 3).

Table 3. Sow reproductive performance.

| Treatment | Days from weaning to estrus | Body condition score at weaning | Litter size at subsequent farrowing |
|---------------------|-----------------------------|---------------------------------|-------------------------------------|
| Once a day | 3.2 ^a | 7.1 ^a | 11.8 ^a |
| Twice a day | -2.8 ^b | 6.4 ^b | 8.0 ^b |
| Split weaning | 1.2 ^a | 8.8 ^c | 7.9 ^c |
| Control | 17.0 ^c | 3.7 ^d | 9.5 ^d |
| LSD _{0.05} | 2.4 | 0.46 | 0.1 |

Means with different superscripts differ significantly ($P < 0.05$)

Quality assessment and monitoring of raw cow milk produced by Makerere University Agricultural Research Institute, Kabanyolo

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Abstract

Milk production in Uganda has risen from 446 million litres per *annum* in 1994 to the current level of over 700 million litres. The dairy enterprise has become the biggest income earner in Uganda. Makerere University Agricultural Research Institute (MUARIK) is among the leading agricultural research centres in dairy production in Uganda. The Institute produces one of the best consumer-rated quality milk in central Uganda. It also has great potential for being among the biggest milk producers in the central region. However, MUARIK milk has not yet been evaluated for the commercial quality as required by premium price markets. Milk is a vehicle for human disease causing micro-organisms, including zoonotic micro-organisms such as the causative agents of tuberculosis and brucellosis. The number of bacteria contaminating milk at farm varies from about 10^3 /ml when hygiene is very good to 10^5 /ml when it is poor. Milk handling utensils such as jerry cans and plastic cans are difficult to clean due to hidden surfaces and the formation of biofilms which leads to build up of large numbers of microorganisms. Conditions such as inadequate water supplies, lack of refrigeration facilities, long delivery time and warm environmental conditions are all responsible for the fast rate of milk spoilage. Owing to the setting of MUARIK, and lack of personnel training in general principles food hygiene, contamination of milk is inevitable. Immediate solutions should be sought to maintain the quality of MUARIK milk as safe as possible. This project was set to study the quality parameters of MUARIK milk and generating scientific information about MUARIK milk to promote its marketability. The pH value of morning and evening milk was found to be 6.58 ± 0.02 and 6.61 ± 0.03 ,

respectively. The values were within the recommended pH range standard of 6.5-6.7. Milk pH is affected by presence of microorganisms, buffering power and the temperature of the milk. Titratable acidity values of the morning and evening milk were 0.19 ± 0.01 and $0.2 \pm 0.01\%$, respectively. The values are within the recommended range of $< 0.2\%$. High titratable acidity in milk is indicative of high microbial activity. Titratable acidity of fresh milk is typically 0.14 to 0.16% expressed as lactic acid. The density of the both milk regimes was 1.031 ± 0.001 and within the recommended range of 1.026-1.032g ml⁻¹. These density values suggest that the milk from MUARIK is not adulterated. Protein content of both milk regimes were 3.81 ± 0.151 and $3.77 \pm 0.152\%$, respectively. Fat content was 3.62 ± 0.09 and $3.92 \pm 0.08\%$ for both morning and evening milk, respectively. These are above 3%, the recommended grade. Total plate count values of the morning and evening milk were 7.02 ± 0.31 and 6.15 ± 0.43 log cfu ml⁻¹, respectively. These values are higher than the recommended standard of less than 5.3 log cfu ml⁻¹. Coliform counts for milk forms were 5.42 ± 0.37 and 4.45 ± 0.62 log cfu ml⁻¹, respectively. Again, these values were higher than the recommended standard of < 1.3 log cfu ml⁻¹. Presence of high coliforms numbers in excess of 100 cfu ml⁻¹ is evidence of the unsatisfactory production hygiene. The cans had TPC value range of 3.23-3.31 log cfu ml⁻¹, which was a clear indication of poor sanitation of the cans. This can be a major source of contamination of the raw milk. The coliform counts were in the range of 2.86-2.93 log cfu ml⁻¹, which is a direct explanation of the high numbers of coliforms in the raw milk. In conclusion, microbial load is a major factor undermining the keeping quality of MUARIK cattle milk. This situation calls for strict hygienic practices from the time of milking to the final consumer. The strategy should be training of workers of the dairy section in general principles of food handling, proper sanitation and cleaning procedures, food hygiene and personal hygiene.

Establishing the status of passion fruit woodiness in Uganda

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Abstract

Passion fruit is among eight priority fruit crops being promoted to enhance foreign exchange earnings from horticultural export in Uganda. Incomes of up to US\$ 5m are realised from this crop annually. However, the crop's production potential has not been fully realised due to several factors, the most significant of which are viruses that heavily infest the crop. Damage attributed to these pathogens has been absolute in some parts of the country. Disease symptoms observed mainly consist of woodiness of the fruit, a condition named the passion fruit woodiness disease (PWD). PWD is caused by the passion fruit woodiness *Potyvirus* (PWV). This virus belongs to the *Potyvirus* genus, a category into which most passion fruit viruses are classified. PWV may occur in isolation or in mixed infection with other viruses such as the cucumber mosaic virus (CMV). This study was, therefore, initiated as a preliminary investigation to establish the prevalence of passion fruit woodiness virus on passion fruit in Uganda. A survey was conducted in 3 districts (Masaka, Mpigi and Mukono) in central Uganda. A hundred disease samples were propagated by mechanical inoculation of the indicator plants, *Solanum demissum*, *Chenopodium quinoa* and *Nicotiana benthamiana*, at Makerere University Agricultural Research Institute Kabanyolo. Two enzyme-linked immunosorbent assay (ELISA) techniques, Antigen Coated Plate and Double Antibody Sandwich ELISA were used for serological analysis of 80 field and indicator plant samples. ELISA utilised a general antiserum to detect *Potyvirus* presence. A specific antiserum was also used for the cowpea aphid-borne

mosaic virus (CABMV), CMV, Sri-Lankan passion fruit mottle virus (SrMV) and Tomato ring spot virus (ToRSV). These are viruses that infect passion fruit worldwide and for which commercial diagnostics were available. Forty five percent of the samples tested with ELISA were positive for *Potyvirus* presence. Of these, 17% were CABMV-positive, leaving 83% unknown. All samples tested negative for SrMV, ToRSV and CMV presence. Further identification utilised Reverse Transcription-Polymerase Chain Reaction (RT-PCR) with *Moloney murine leukemia virus* reverse transcriptase and specific primers for PWV and CABMV. Preliminary results from this analysis highlight the possible occurrence of PWV. Further analysis is underway to confirm these findings. More diagnostics have also been accessed for comprehensive diagnosis of pathogen genera not identified in the preliminary study. In addition, the sampling area will be increased in a subsequent countrywide survey to cover 15 passion fruit growing districts.

BIO-EARN Programme achievements from 1999 and the way forward

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Abstract

The East African Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development (BIO-EARN) is a long standing regional initiative for biotechnology capacity development in East Africa. The programme includes research for development activities involving partner institutes from Ethiopia, Kenya, Uganda and Tanzania, and Sweden. The programme was initiated in 1997, when the Department for Research Co-operation (SAREC) of the Swedish International Development Cooperation Agency (Sida) assigned the Biotechnology Advisory Centre (BAC) of the Stockholm Environment Institute (SEI) to develop a proposal for building capacity in biotechnology in the region. In March 1999, BIO-EARN was awarded a three year grant by Sida/SAREC to start its programme activities. The programme was envisaged to have three phases. Phase I (1999-2001) and phase II (2002-2004) activities centred on capacity building through postgraduate training at MSc and PhD levels, and laboratory infrastructure support. The programme also initiated biotechnology policy development processes and to develop a foundation for regional collaboration. Thus, over the last five years, this programme has enhanced capacity in biotechnology in the four Eastern Africa countries through collaborative research for development, human resource development and policy advocacy that will enable to broaden options for sustainable development in the region. The key accomplishments of the BIO-EARN Programme include: (1). Training of 3 MSc and 17 PhD students in agricultural, environmental and industrial biotechnology. Seven PhDs have already graduated (of which 3 are from Uganda. The remaining students will graduate in 2005; (2). Several articles, arising from the work

under the BIO-EARN programme, have been published in international journals and as popular science; (3). Establishment of basic infrastructure, human capacity, policy and networking support for biotechnology research for development in 11 institutes of Ethiopia, Kenya, Uganda and Tanzania. This includes training of other academic and technical staff, and establishment of a Biotech Laboratory at the Department of Crop Science; (4). Pioneered development of competencies for biosafety risk assessment; (5). Developed, in collaboration with the biosafety regulatory officials in the region, common risk assessment/management decision support material, a BIO-EARN biosafety resource book to facilitate biosafety implementation and information sharing in the region; (6). Enhanced biotechnology policy development/awareness in the region by exposing policy makers and scientists to new policy areas not covered by traditional institutions of higher learning and on which information and guidance were lacking; (7). Facilitated development of a platform for increased regional collaboration and information sharing between policy institutions (e.g. Science and Technology Councils) on key policy issues (e.g. biosafety implementation, public-private partnerships, Intellectual Property Rights policies); and (8). Supported the formulation and implementation of policies related biotechnology research for development. The BIO-EARN phase III was initiated with the view to promote ownership, sustainability and relevance to development aspirations of the network partner countries. Through a competitive scheme 4-5 interdisciplinary and collaborative research projects will be selected to constitute the phase III programme that is envisaged to start 2006 and end 2009. The new projects will include BIO-EARN network institutions from at least two East African countries, and the projects will be of regional significance and address problems of regional character (e.g. specific aspects of food security, environmental problems etc). For more details see www.bio-earn.org

Rationalisation of some aspects of experimental layout based on field heterogeneity

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Abstract

Experimental layouts dictate upon inferences made from a study. Yet often limited time and effort are put into the planning of experiments. A properly designed field experiment separates the effects of natural field variability from those of the treatments and provides reliable information upon which the researcher can base sound decisions. The success or efficiency of a field experiment depends on how much of the underlying variability has been estimated. In on-station experiments, the effect of this variability under field conditions is normally minimised, for instance by blocking at the design stage. Increasing replication tends to minimise random variability in terms of heterogeneity of the field and, thus, increase precision. Plot size is another fundamental aspect of an experimental layout, where rationalisation has hitherto been neglected. Therefore, to achieve a suitable experimental design requires investigation of the interaction between the design itself, the number of replicates and plot size. This has evidently been lacking even in classical research endeavours. This study was conducted to determine the interaction of these design aspects. Specifically, the objectives of this study were to (i) determine optimum experimental plot size of a maize crop grown on-station in Uganda, and (ii) establish the relative effectiveness and efficiency of alternative block designs. A maize uniformity trial was grown in the second season of 2003. Longe 4 maize was planted at 30 cm x 75 cm in plots where soil samples had been collected for analysis to establish soil heterogeneity. At harvesting, the experimental field was demarcated into basic units (unit plots)

measuring 1 m x 1 m. Each of these units was harvested separately. Yield data collected included number of maize cobs, total weight and grain weight. At analysis stage, adjacent basic plots were combined in different directions to generate different plot sizes and number of replicates. The optimum plot size and layout was determined using a functional relationship between precision as measured by variance and plot size. The optimum plot size was established as the one that minimised the computed coefficient of variation (CV). Results show that for fixed number of replicates ranging between 4 - 6, a plot size of 6 m x 4 m had the minimum coefficient of variation. However, further analysis showed that its CV was not significantly different from those of 5 m x 5 m, 6 m x 6 m and 7 m x 5 m. Results slightly differed among the four blocks. Data analysis is still underway. Based on observed heterogeneity as measured by the variance and soil analysis, suitable blocks will be constructed. The study should be conducted for at least another cropping season to get conclusive results.

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