



Sustainable intensification of crop-livestock
systems in Northern Ghana: Report on 2012
activities
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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation and impact assessment.



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Executive summary

The U.S. Agency for International Development (USAID) is supporting multi-stakeholder agricultural research projects to sustainably intensify key African farming systems as a pathway to attain food security and to combat poverty in sub-Saharan Africa. In West Africa, this research project focuses primarily on maize-legume and crop/tree/livestock systems in the northern Guinea and Sudan savannah zones of Ghana and Mali but is intended to result in spill-over effects in other similar agro-ecological zones.

ILRI and IITA have agreed to carry out livestock based research activities and scale out research outputs to end users with the objective to sustainably intensify crop livestock systems in Northern Ghana. The present project activities were designed to contribute to the objectives the Africa RISING Initiative by carrying out participatory action research with farmers to demonstrate practical small ruminants, rural poultry and pig production solutions or options for increased system productivity through enhanced feeding systems and better health care interventions. The specific objectives of the present project were: 1. to document constraints and opportunities for intensified livestock production in northern Ghana, 2. to develop and promote feeding and health care strategies for increased productivity in guinea fowl, pigs and small ruminants, 3 to set up or use existing innovation platforms to develop milk, guinea fowl and small ruminant value chains.

Main activities carried out in 2012 included:

1. Organisation of project planning workshops for participatory identification of specific research projects, the development of project partnership mechanisms and implementation strategy;
2. Organisation of a diagnostic workshop to analyse constraints and opportunities of sustainable intensification of crop livestock systems building on existing knowledge and past experiences in livestock and crop research and development projects and programmes in Northern Ghana;
3. The design and implementation of experiments for the testing on station and on-farm of small ruminant, guinea fowl and pig productivity enhancing technologies that address key biophysical constraints of the targeted livestock value chains.
4. The organisation of training workshop to strengthen the capacity of scientists in methodological approach for research on crop-livestock systems
5. The organisation of training courses targeting dairy value chains actors to strengthen their capacity in milk processing and hygiene to improve marketed milk quality for better consumer confidence and reduced risk of transmission of zoonoses.

Prioritized constraints in Crop-Livestock Systems in Northern Ghana include declining soil fertility as a result of soil mining and weak soil fertility management. Although there are environmentally adapted livestock breeds in Northern Ghana, the smaller size of these adapted breeds may not be suitable for use as traction animals pulling heavy implements for work. Breed improvement programs that retain the adaptable traits need to be embarked on. Trypanosomiasis transmitted by tsetse flies still occurs in many pockets in the region thus preventing livestock to be raised except where tolerant breeds are present. Tolerant breeds are not widespread and often not preferred. Major livestock disease in Northern Ghana include Anthrax, ASF, FMD, Blackleg, CBPP, Bovine TB, PPR that cause high mortality rate in small ruminants. High death losses in poultry including guinea fowl keets have been also reported. Low feed supplies and poor quality feeds remain a high priority constraint in

the region. Programs to improve quantity and quality of feeds and availability throughout the year would provide needed support to crop-livestock systems.

For Northern Ghana the prospects for crop-livestock systems development are good over a longer term perspective and intensification of agriculture which is currently going on through many projects in the region favours crop-livestock systems. Demand for livestock products is expected to increase as rapid development of the three regions attracts new residents.

Priority interventions to address identified constraints include:

- *Improvement of soil fertility* through various technologies: use of alternative crops for mulching, introduction soil management techniques such as conservation tillage, bench terracing, stone bunding, Composting and farm yard manure, Community no-bush-burning practices, Local protection and management of tree species, Zai, Ridging, Farm mechanization (smart combination of farm power sources including donkey, bullock, power tillers, tractors for cropping and transport - limited household means of transport is the most critical impediment of the use of existing farm organic matter for soil fertility purposes).
- *Improvement of feed production and quality* to reduce the pressure on grazing areas and improve internal nutrient transfers. Technologies to do so include: (1) Introduction of higher yielding food-feed crop with higher quality residues, (2) Introduction of fodder shrubs and trees and (3) Smart use of existing feed resources through combination of legume and cereal residues and Strategic supplementation for specific classes of animals (lactating animals) to improve the efficiency of limited amounts of available feed.

Key research findings on alternative feed resources have shown that sorghum spent grain, false yam seeds and tuber have a high potential as substitutes to maize which is the main ingredient of poultry and pig diets. The incorporation of these feed resources in guinea fowl and pig diets is likely to impact significantly the guinea fowl and pig industries in Northern Ghana through reduced costs of diets and decreased competition between human and animal needs for the use of maize as food or feed.

Introduction

Background and justification

The three northern regions are the most poverty stricken and hunger spots in Ghana (GLSS, 2000). Low input-output farming systems found in the 3 northern regions of Ghana can only secure cereals for 3-5, 4-5 and 6-7 months in the Northern, Upper West and Upper East regions, respectively (Quaye, 2008). The picture is not significantly different for the legumes production in the 3 northern regions of Ghana (Quaye, 2008). Food insecurity is driven by erratic rainfall distribution and recurrent drought, floods and crop failures leading to poor yields, high post-harvest losses, lack of improved storage structures and market for farm produce, diminishing resource base resulting from environmental degradation related to population growth rates and poor environmental management and farm practices. Limited integration between crop and livestock production systems and continuous monoculture has contributed to decreasing soil organic matter contents, parasitic weed infestation, reduced soil biodiversity, higher risk of erosion, and significant nutrients losses that in turn has resulted in reduced yields per unit per ha. The deterioration of the resource is exacerbated by low levels of mineral and organic fertilizers usage due to high cost and inadequate purchasing power.

In northern Ghana the livestock component assumes greater importance as major source of livelihood and income for many households as well as in food security initiatives of farm families and whole communities. Rural poultry, sheep and goat rearing and small scale dairy, particularly are known to best serve the interests of women and poor households.

Increasing agricultural productivity in this zone hinges on improved crop livestock integration. Improving fodder availability during the dry season could have wider benefits for income generation, especially where market demands for milk, small ruminant and poultry meat are high to respond to increasing demand of livestock products (meat, milk) that have created great opportunities of income generation for smallholder farmers, especially women. Northern Ghana is heavily used by transhumant herders for dry-season grazing. This is resulting in serious conflicts with the local resident farming communities. A key research issue for this region is how to support growing livestock herds temporarily, while increasing crop productivity and maintaining forest cover and diversity.

Practical technological and institutional solutions are required at the smallholder and community levels to minimize or reduce the risk factors and pave the way for the intensification of small scale dairy, small ruminants and rural poultry (guinea fowl) productions in the given farming systems. The risk factors of high mortality in small ruminants and guinea fowl keets as result of disease, inadequate feeding, and poor husbandry practices hamper or account for low livestock system productivity of the smallholder farmer in northern Ghana and need to be addressed. We hypothesize that the development of small ruminant value chains and the small dairy sector in Northern Ghana will drive the sustainable intensification of mixed crop-livestock systems. Indeed, returns from profitable small ruminants and small scale milk production will likely create incentive systems for farmers to invest in the adoption of food-feed crops and better management of

available feed resources for both improved feeding systems and soils health as the availability of quality biomass will improve.

Purpose and objectives

The U.S. Agency for International Development (USAID) is supporting multi-stakeholder agricultural research projects to sustainably intensify key African farming systems as a pathway to attain food security and to combat poverty in sub-Saharan Africa. In West Africa, this research project focuses primarily on maize-legume and crop/tree/livestock systems in the northern Guinea and Sudan savanna zones of Ghana and Mali but is intended to result in spill-over effects in other similar agro-ecological zones. Increasing population growth (3.0%) and severe climate change effects are sufficient drivers calling for the need to put in place tested and proven systems for increased productivity sustainably to address the food and nutrition requirements of families in milk, meat and their products. Specific objectives of the project are to identify, combine and test sustainable farming practices and to effectively deliver and scale out research outputs to end users. The present project was designed to contribute to these objectives by carrying out participatory action research with farmers in three districts to demonstrate practical small ruminants and rural poultry and pig production solutions or options for increased system productivity through enhanced feeding systems and better health care interventions. The specific objectives were:

1. To document constraints and opportunities for intensified livestock production in northern Ghana.
2. To develop and promote feeding and health care strategies for increased productivity in guinea fowl, pigs and small ruminants.
3. To set up or use existing innovation platforms to develop milk, guinea fowl and small ruminant value chains.

Expected outputs

1. Workshop proceedings on constraints and opportunities for intensification of livestock production in northern Ghana.
2. Best-bet feeding, health and reproductive management practices for guinea fowl, pigs and small ruminant production tested and disseminated to at least 200 farmers.
3. At least one women livestock interest group formed in two districts per region.
4. Farmer access to information and education on value chain platforms improved.
5. At least 100 women trained in milk hygiene and processing

Implementation strategy

Main partners that joined their efforts for the design and implementation of the research included the International Livestock Research Institute (ILRI), the CSIR-Animal Research Institute (CSIR-ARI), University of Development Studies (UDS) and Ministry of Agriculture (MoFA). CSIR-ARI is already engaged in collective actions geared towards improved management of small ruminants and village poultry, and dairy value chain development in Northern Ghana. The project built on existing partner interventions thus making use of identified 'low hanging fruits' for possible quick wins in the given project time frame in 2012. An inception workshop was held on 11th and 12th June 2012 to develop the project R4D action plan for the first phase by bringing together all organizations who will partner in this project in order to review their experiences in past projects and to collate best-bet interventions that have been developed and tested over the years. The following Institutions participated in the planning workshop: International Livestock Research Institute, Ministry of Food and Agriculture, University for Development Studies, Kwame Nkrumah University of Science and Technology, Savanna Agricultural Research Institute, Non-governmental organizations, Farmers' organizations, the Women in Agricultural Development unit (WIAD) of MoFA. At the project planning workshop, Regional Teams were constituted, one for each of the three Regions in Northern Ghana. The Regional Teams comprised MoFA staff, a representative of NGO, WIAD member and a representative from Farmers' organization. Their main function was to help the project investigators to implement the project in their respective Regions.

Results

Output 1.1. Integrated crop and livestock production systems developed, evaluated, and effectively delivered to end users.

Activity 1.1.7. Organize workshop to review constraints and opportunities for intensification of ruminant and non-ruminant production systems in northern Ghana

Purpose and objectives

A diagnostic workshop was held in Tamale, Ghana on 27-28 August, 2012 with the objective to analyse constraints and opportunities for the sustainable intensification of mixed crop livestock systems in Northern Ghana. The 44 participants of the workshop represented the CSIR-ARI, ILRI, Universities, development/extension institutions, including the Ministry of Food and Agriculture (MoFA), NGOs, and private services providers and farmers' groups. The Workshop focussed on crop-livestock systems within a broader agriculture-livestock integrated system in the region and attracted value chain actors in the livestock and crops sectors. These included experts in crop and livestock production, health, processing and marketing in public and private sectors. Researchers, extensionists and technicians from national institutions and regional/international centres and non-governmental organisations (NGOs) participated in the workshop. The Workshop brought together these experts to provide inputs into the determination of the path that the development of crop-livestock systems has taken in the three regions, the *status quo* of enterprises in the crop-

livestock domains, what challenges are facing the sector's value chains that may constrain further development and intensification, and what opportunities there are to exploit to hasten development.

A total of 8 invited key papers were presented. Ten shorter technical papers were presented at the two Scientific Sessions. Two Group Sessions took place and three Working Groups were created for each day. The workshop full report is presented in Annexe 1 of the present report. It gives Summaries of presentations at the Plenary and Synthesis of the presentations as well as those from Questions and Answers following the presentations. The Papers presented at Plenary and at the Scientific Session are being published as Proceedings of the Workshop (Dei *et al.*, forthcoming). Main outcomes of the workshop are summarised here.

Baseline and systems' diagnosis

In the context of the Project, Northern Ghana was taken to comprise Northern, Upper East and Upper West Regions of Ghana. The combined size of the Project region is 97.703 km² and represents approximately 40.8 % of Ghana. The area contains 18.2% of Ghana's human population (2010 census). Human population and densities are respectively, 3.346 million persons and 34 persons/ km². The three regions are located in the Guinea and Sudan Savannahs and the area is classified as sub-humid, with mean annual rainfall of 1000-1100 mm. The rainfall mode is single season April/May to October, sometimes erratic in nature. Length of growing season is 150-200 days (dry spells of up to 10days) in major season.

Farming is prime occupation of vast percentage of population. Crop farming is considered a major occupation for subsistence living. Shifting cultivation which was a dominant farming method some decades ago has given way bush-fallow system. However, fallow periods have been declining from 10 years to 2-3 years with continuous cultivation becoming common. Agriculture is mainly rain-fed agriculture with some irrigated farming in areas where horticultural crops are grown. Crops grown are mainly cereals- maize, sorghum, millet; pulses and oil seeds and tubers. Land preparation in many areas is mainly by hand tools, although in some areas bullock drawn implements and tractors are used. Livestock raised in the area include cattle, sheep, goats, donkeys, horses, pigs and poultry. Guinea fowls form a significant part of the poultry sub-sector. About 75% of national cattle herd in the 3 regions, 37% of sheep and 42% of goats and 23% of poultry. Animals in the farming systems have several functions, including, financial security -"walking bank", insurance against food deficit, social functions such as payment of bride prices and in religious activities/rites, draught power - traction in land cultivation, transportation for humans and goods. Livestock management in the Project area differs according to season. In the cropping season, large ruminants are mainly herded by hired Fulanis or fed in kraals. Sheep and goats are often tethered around farms close to compounds.

Surveys conducted in recent times as reported at Workshop (see Bacho's Day 2) confirm the existence of mixed crop-livestock systems at various stages of development as described by Karbo and Agyare. Crop residues use by ruminants and the use of manure for cropping and the use of draught animal power define crop-livestock interactions/integrations in the area. The predominant system is the one whereby crop residues use and the grazing of natural pastures and rangelands are the major source of food for livestock. However, there are several variations, with more than one method going on at the same time with diverse activities, for example, small sized compound farms intensively using manure from tethered or kraaled animals, collection of cattle and pig manure from the range by farmers without livestock, tethered goats often getting fed through "cut and carry". Crop residues and agro-industrial by-products are fed while trampled crop-residues and agro by-products are

recycled with soil for crop production. These modes of production do fit the broader arable crop–livestock systems as seen in similar agro-ecological zones in West Africa.

Various forms of crop-livestock associations are developing in Northern Ghana and are at different stages of development. They range from “opportunistic” collection of manure from the range for home use to fairly systematic, planned nutrient cycling involving manure, urine, crop residues and compost. Livestock numbers, including ruminants and poultry, are increasing but specialized functions such as animal traction for farm work are not that widespread and not developed.

Crop-Livestock farmers may occasionally access rudimentary research based technologies and extension messages but Research and Extension services are generally considered weak in the region.

Human population pressure on land, especially around urban centres and larger towns has been noted and census figures over 3 decades confirm population growth and urbanization although the rates are below National averages.

From the demand sub-component of the systems, there is a growing market development in Northern Ghana. Products from the livestock, and crop-livestock systems sectors are being sold in local, national and international markets. Locally, in densely populated parts (Upper East Region 150-160 persons/ km²) crop residues are sold or traded for other goods. Prices of crop residues more than doubled over a 5-year period. Contractual agreements between herd owners and hired Fulani herders revised for cattle owners to own manure for crop production. Some setbacks in the local markets include high prices for animal drawn carts, a major constraint for many households; Zebu bullocks are imported from Burkina Faso, while maximum use of adapted local animals not achieved.

Prioritized Constraints in Crop-Livestock Systems in Northern Ghana

Biophysical constraints. Declining soil fertility as a result of soil mining and weak soil fertility management is a widespread constraint in large areas within the region and will require a concerted effort to replenish lost nutrients. Integrated Soil Fertility Management (ISFM) approaches are needed in the region. A true ISFM program includes both organic and inorganic fertilizers. Animal manure represents an important source of organic fertilizer. Thus, crop-livestock systems are a part of solution to declining soil fertility.

Livestock-specific constraints. It was mentioned in several presentations that livestock is an essential component for a crop-livestock system to develop. In environments where the livestock species and breeds are not suitable, the development or maturation of the system is impaired. Although there are environmentally adapted livestock breeds in Northern Ghana, the smaller size of these adapted breeds may not be suitable for use as traction animals pulling heavy implements for work. Breed improvement programs that retain the adaptable traits need to be embarked on.

Trypanosomiasis transmitted by tsetse flies still occurs in many pockets in the region thus preventing livestock to be raised except where tolerant breeds are present. Evidence on the ground in Northern Ghana show that tolerant breeds are not widespread and often not preferred. Livestock keepers in Northern Ghana have to face critical animal health constraints including Anthrax, ASF, FMD, Blackleg, CBPP, Bovine TB, PPR that cause high mortality rate in small ruminants. High death losses in poultry including guinea fowl keets have been also reported in many presentations.

Low feed supplies and poor quality feeds remain a high priority constraint. Programs to improve quantity and quality of feeds and availability throughout the year would provide needed support to crop-livestock systems.

Conflicts between pastoralists and crop farmers are now common in most of the regions of Ghana, especially the three northern regions and the Kwahu area. Bloody conflicts are attributable to Fulani herdsmen transgression. However, Ghana is required to respect the ECOWAS protocol for the movement of the pastoralists through designated routes with support services- water, grazing, vet service

Policy and institutional constraints. The agricultural and social-based policies that bring about subsidization of fertilizer, tractors and fuel for farm use are those that negatively impact the development of organic fertilizers and animal traction, are the ones that need most attention. Advocacy is needed to bring policy makers appreciate the link between subsidized inputs and the development of crop-livestock systems. Land tenure system and its attendant challenges in land acquisition is a prioritized constraint to the extent that potential farmers face acquisition problems and risk of losing the land after acquisition. Complicated communal land tenure disfavours women, encourages farm fragmentation and constrains the use of land as collateral security for bank loans in a capital-short poverty-stricken region. Lack of effective extension services to disseminate information on the appropriate crop-livestock system for specific areas, slow response by research and extension institutions to needs of crop-livestock subsectors in terms of service delivery are also seen as an important constrain that need to be attended to through better training and education programs. Finally, international- free trade policy leading to the influx of cheap frozen meat and meat products on the market that act as a disincentive for the domestic meat industry.

Opportunities for intensification of crop-livestock systems in Northern Ghana

Biophysical Opportunities. The three Northern regions fall mainly under “sub-humid zone”, a zone considered to be suitable for the evolving and development of crop-livestock systems. Poor soil fertility, high prices of inorganic fertilizers and labour costs are forcing poor farmers to rely on alternatives such as manure and animal traction. Under climate change scenarios, Northern most areas (Sudan savannah) may turn drier, to become semi-arid, which is still suitable for crop-livestock systems. Thus, for Northern Ghana the prospects for crop-livestock systems development are good over a longer term perspective.

Market and Technology Opportunities. Intensification of agriculture which is currently going on through many projects in the region favours crop-livestock systems. DFID, USAID, AGRA, DANIDA and others have Projects in Northern Ghana which will have spin-offs for crop-livestock integration. Demand for livestock products is expected to increase as rapid development of the three regions attracts new residents, a large percent of products expected from intensified production in peri-urban areas. Rapid development of higher learning and research activities initiated by Government and its Development Partners will increase technology outputs, for example, the development of crop varieties in support of crop-livestock systems.

Institutional and Social Opportunities. Emerging dialogue and discussions on Land tenure arrangements and women participation and on other socio-cultural issues in the three regions may be signalling changes in attitudes on land issues that could favour crop-livestock development as access to land improve. Development Partner funded Projects in the three

regions targeting other approaches to Extension to smallholder farmers through capacity building. The new generation of extension cadres is likely to bring about new ways of extension delivery, which can benefit crop-livestock production systems.

Lessons learned

Working Group analysis of Projects that were judged successful or failure was able to identify key factors that made the difference of success or failure. The criteria set in order to score various activities or attributes should be refined to improve the objectivity of scoring. It however, remains a powerful tool in learning what went well and what went bad. Among the lessons learnt listed were a) Use multi-disciplinary team to assess feasibility of proposal, b) Proper and appropriate engagement of all stakeholders and partners, c) Ensuring that funding agency will not strategically delay disbursement – inflexible, imported technology, employment for nationals, etc., d) Beneficiaries/Farmers should be involved in research and technology development, e) Technology should be responsive to climate change, f) Market-based to achieve sustainability, g) Ensuring proper alignment of policies and time frames, h) Project should have specific focus and not be so broad to lend itself to any interpretation. For a way forward, the following were proposed: a) strengthening formal and informal research, extension, processing and marketing organisations, b) develop and/or extend sustainable and appropriate technologies and c) developing collaboration and partnership models for relevant technology generation, transfer and adoption.

Priority interventions

Priority interventions are needed to overcome the biophysical, policy and institutional constraints. For the biophysical constraints, technology options hold the key to bring lasting solutions. For feeds and livestock health related constraints the following promising interventions are proposed.

- *Improvement of soil fertility* through various technologies: use of alternative crops for mulching, introduction soil management techniques such as conservation tillage, bench terracing, stone bunding, Composting and farm yard manure, Community no-bush-burning practices, Local protection and management of tree species, Zai, Ridging, Farm mechanization (smart combination of farm power sources including donkey, bullock, power tillers, tractors for cropping and transport - limited household means of transport is the most critical impediment of the use of existing farm organic matter for soil fertility purposes).
- *Improvement of feed production and quality* to reduce the pressure on grazing areas and improve internal nutrient transfers. Technologies to do so include:
 - Introduction of higher yielding food-feed crop with higher quality residues
 - Introduction of fodder shrubs and trees.
 - Smart use of existing feed resources through combination of legume and cereal residues and Strategic supplementation for specific classes of animals (lactating animals) to improve the efficiency of limited amounts of available feed.

For policy interventions advocacy actions could be bring to policy makers to slowly phasing out of subsidies on in-organic fertilizer and motorization over time; improved land tenure for mixed farmers, and improved extension to inform and motivate on crop-livestock integration, and stimulating non-farm rural employment.

Workshop Recommendations

Recommendations directed at the Government of Ghana

- In view of intermittent dry spells during wet season and droughts which constrain crop-livestock farming, Government is urged to extend small scale irrigation often targeting rice farmers to crop-livestock farmers in the area.
- It was recommended that the influx of imported frozen meat and meat products must be controlled in order not to kill farmers' enthusiasm to increase livestock production in Ghana.
- In view of the role of livestock in the developing of crop-livestock integrated systems, and the tremendous health issues confronting livestock in Northern Ghana, a full-fledged institution training animal health personnel should be brought closer to farmers. In view of this it was recommended that the Pong-Tamale College on animal health be upgraded to a Veterinary college to service the region.
- In managing conflicts attendant to the use of community owned natural resources it was recommended that demarcation of livestock routes, enforcement of local bye-laws related to livestock movements and the introduction of the "no ownership" concept be implemented in the region.
- It was recommended that Government take positive actions to promote crop-livestock integrated farming by promoting phasing out policies that do not favour crop-livestock integrated farming, such as organic fertilizers in combination with minimum use of inorganic fertilizers benefiting from subsidies on fertilizers. Promotion of appropriate mechanization technologies (animal traction, forage cutters and choppers, transport, etc.) for crop-livestock intensification including with smart combination of draught animal, power tillers and tractor powers and implements for cropping and transport according specific farmer's needs.

Recommendations directed at the USAID

- Consider support to crop-livestock integrated systems in the next phase of Project in view of the importance of the sub-sector as emerged from the first phase of the Project.
- Liaise with other development players in the region during the design of the second phase in order to increase linkages and bringing out synergies.
- Crop-livestock Research Programming is crucial for dealing effectively with technological and institutional innovations for intensification with the value chain perspective. It is therefore recommended that capacities of Savannah Agriculture Research Institute and the Animal Research Institute Station be strengthened to further play key roles in Northern Ghana to handle the complex crop-livestock issues of small, medium and large farm systems towards intensification. Such programmes should be mainstreamed into the curricular of relevant departments of the University for Development Studies
- Attention needs be given to both biophysical and institutional constraints in an integrated research than is currently observed. Participatory action research employing IAR4D principles could speed up development, adoption and scaling up of innovations along livestock value chains.

Activity 1.1.8. Build on existing innovation platforms to promote ruminant and non-ruminant value chains through action research.

During the course of the first phase of the project time did not allow the establishment and operation of innovation platforms. However, the concept of innovation platform was one of the topics of the training course on intensification of crop-livestock systems: *Improving crop-livestock integration system in the value chain system*. The resource person for this topic introduced the concept of Innovations and Innovation Platforms (IP). The innovation and innovation approaches are used within the Integrated Agricultural Research for Development (IAR4D) approach of agricultural research. Other topics covered were effective IPs, what is needed to establish and maintain IPs, local and higher level IPs and challenges in running IPs. In order to bring home more forcefully the new approach of Innovation in comparison with how things were done in the past, working Groups were formed and tasked to work on three projects namely Small ruminant, Poultry (guinea fowl) and Dairy value chains.

In order to impart further skills to course participants on creation and running of IPs, another session of Group Work was organized to discuss the approaches and tools and to analyse the role Innovation Platforms can play in the project, the requirements to establish the innovation platforms (in terms of information, initial activities) and what key activities and resources are needed to keep the innovation platform functioning. Issues for discussion included IP Formation / Methods of formation, what type of innovation platform is appropriate? – Grass roots – largest number of actors are farmers, slow decision making due to long deliberations, bottom up decisions, – Apex body IP –What is the Life of the IP? Are the current IP actors relevant to the IP issue? In addition, various meetings held with key livestock value chain actors during the course of implementation of farm and on-station trials of present project and the numerous training courses that took place, were opportunities to apply IP principles in terms of linking actors, sharing knowledge and information and mutual learning among various actors. For instance the training workshops that targeted milk producers and processors stimulated stronger linkages among small scale dairy value chains actors that could be the basis for the formation of an innovation platform. Next project phases will build on this to establish IPs along targeted livestock value chains.

Activity 1.1.9 Test management feeding, health and reproductive management strategies to promote ruminant and non-ruminant value chains through action research.

A number of livestock productivity enhancing and system intensification interventions have been designed and pilot tested in 2012. The objectives, hypotheses, experimental design and preliminary results of these experiments are summarised here. Their full description and results are presented in separate project reports. For some of the experiments, data collection was not completed by the time of the report writing or data analysis could not be completed. Therefore, for some of the trials, only preliminary results are indicated. The full reports of each experiment are presented in the appendixes of the present report.

Testing the effect of health management and improved feeding strategies for increased intensification of integrated crop-livestock systems and the promotion of small ruminant value chains

Purpose and objectives

Poor small ruminant management during the rainy season is a main cause of sheep and goat productivity losses. Indeed, to limit damages to crop, small ruminants are tethered in the homesteads or in fallows during the cropping seasons. There are fed cut and carry feed

materials in the form of crop residues, tree foliage and grass of variable quantity and quality. For tethered animals (especially lactating females and their kids and lambs), limited grazing time and area is a serious impediment to adequate feed intake. For improved intensification of integrated cereal/legume-small ruminant systems, adequate amounts of manure are needed for the replenishment of soil nutrients. Adequate small ruminant housing is a prerequisite for the production of quality manure in higher quantity. It was hypothesized that rainy season feed supplementation and better health care interventions for small ruminants would result in overall increase in small ruminant productivity with more availability of soil nutrients that will ultimately translate into increased income for resource-poor farmers. The objective of this work was to test the effect of health management and rainy season supplementary feeding strategies on small ruminant productivity and manure production.

Material and methods

Communities recommended by the Africa Rising – Ghana project after a Stakeholders' workshop organized in Tamale, the Northern Regional where IITA crops-related projects are being implemented, were selected to test the small ruminant interventions. The following treatments were applied:

Table 1: Treatments

Treatment	Description
Treatment 1 (control) : Farmers practice	Farmers' usual method of feeding their small ruminants in the wet season
Treatment 2: Recommended health care	Deworming and tick control twice, once PPR vaccination; antibiotic, multivitamin and wound treatment when needed
Treatment 3: Recommended supplementary feeding	Offer 40% of daily requirement of feed in the form of experimental supplementary feed. This was equivalent to about 1.2% of animal body weight.
Treatment 4: Recommended health care and supplementary feeding	Deworming and tick control twice, once PPR vaccination; antibiotic, multivitamin and wound treatment when needed; offer 40% of daily requirement of feed in the form of experimental feed supplement

In total 24 experimental farmers and a total 873 small ruminants were used for the experiment. The following data were collected: live weight, body condition scores, type and cause of exits, births, feed intake, abortions, still births, feed costs, offtake, coordinates of project locations, small ruminant flock structure and management practices of experimental farmers, manure output, Rainfall, temperature, relative humidity. Feed samples are yet to be analysed for dry matter, ash, crude protein, acid detergent fibre, starch and neutral detergent fibre contents.

Preliminary results

As would have been expected, animals receiving both healthcare and supplementary feed displayed best weight gains (1.02kg) ($P < 0.05$) compared with the other treatments. Animals on either healthcare or supplementary feed did not produce statistically significant differences in their weight gains (-91g for healthcare and -244 g for supplementary feed only) but they both performed better ($P < 0.05$) than the control animals which each lost on average 1.57 kg during the period of the experiment. About two to three times more deaths were recorded in the control groups than the other groups. Groups receiving healthcare alone or in combination with supplementary feed recorded the lowest mortalities; about 2% but not more than 4%. Animals receiving supplementary feed only recorded about 11% mortality rate. Even though the supplementary feed was observed to be good, its beneficial effect was hampered in tethered animals. Community members evaluated the feed as suitable for sheep and goats. As most goats were tethered during the period of the experiment, the sheep appeared to be performing better on the supplementary feed.

More manure has been collected from the pens of treatments 3 and 4 animals than from treatments 1 and 2 animals. This may be partly explained by the offer of supplementary feed to treatments 3 and 4 animals. Manure collection was low at Sabegu partly because of poor flooring of the pens and overcrowding of animals in their pens. Upper West Region gave the highest quantity of manure. Close to 3 tonnes of manure was harvested during the experimental period.

Table 2: Amount of manure harvested

	Community	T1	T2	T3	T4	Total	No. of animals	Quantity/animal
NR	Sabegu	34	89.5	144.5	144.5	412.5	393	1.049618321
	Zugu	81.5	54	45	40	220.5	110	2.004545455
UER	Baare-Bapelgo	43	127.5	274.5	110.5	555.5	76	7.309210526
	Winkogo	30.5	64.5	21.5	62	178.5	64	2.7890625
UWR	Loggu	308.5	167	106.5	262	844	163	5.17791411
	Bulenga	130.5	127.5	263.5	261.3	782.8	67	11.68358209
	Total	628	630	855.5	880.3	2993.8	873	3.42932417
	No. of animals	181	310	159	223	873		
	Quantity/animal	3.46961326	2.032258065	5.380503145	3.947533632	3.42932417		

Key Deliverable Deviation: Additional data analysis will be performed to produce a full experiment report with a thorough analysis of health and rainy season feed supplementation on small productivity.

Support of AFRICA RISING: Reduced mortality rates due to better health care will be translated into an increase in small ruminant numbers and therefore an increase in the number of animals households can dispose of to meet pressing needs. Therefore it is expected to contribute to improved livelihood. Furthermore, the introduction of a balanced supplementary feed which was constituted using 62% agro-industrial by-products provides an alternative to scarce rainy season labour allocation for harvesting and feeding of fodder and long hours of grazing. The two targeted interventions have resulted in increased manure output from small ruminant. This confirms the finding that that supplementary feeding with outsourced feed resources is a way of bringing in the farming system additional nutrients for soil health. It could be also expected that the concentrate feed used will improve the nutrient content of the manure and therefore more nutrients to the soils. New knowledge, example balanced feed formulation for small ruminants, has been generated, shared with farmers and development workers, and documented and may be applied and developed to improve livelihoods. Already this knowledge is being used by a University for Development Studies students.

Scalability: So far the formulated feed has been well received by the farmers using it, the Ministry of Agriculture staff, Animal Research Institute staff and staff of the University for Development Studies. The cost is 62 p/kg (about 32 cents/kg). The feed will be introduced to livestock farmers who regularly fatten ruminants for sale. Substitutes will be found for the more expensive ingredients. The feed will be packaged into smaller size packs to increase affordability. Whole cottonseed may be hard to find in the quantities required. New contacts will be made to increase the sources of whole cottonseed for the feed formulation. Links will also be established with Tamale Polytechnic to develop feed pelleting machine to pellet the feed. Farmers suggested that the feed be tried on cattle and pigs. Breed improvement would be pursued for efficient utilization of feeding materials by the small ruminants. A farmer observed that no matter how well the local breed was well fed, its growth would be slow. He therefore recommended the introduction of the Sahelian breed for crossbreeding.

There is the need to improve manure availability and application. Animal housing will be promoted and support will be given to facilitate conveyance of manure to farms for example through the supply of donkey and cart and proper application of manure. Capacities of selected community members will be built to become community animal health workers. These people will administer simple treatments and serve as a link between the vet and the community.

Recommendations: The project should be extended to cover both dry and wet seasons to assess impact of the interventions on small ruminant productivity.

Lessons learnt: When project activity plan was widely shared with stakeholders useful suggestions were obtained from experts to increase success of project. Could vegetable farmers visit livestock farmers to collect manure? Can the livestock farmers also visit vegetable farmers to collect residues to feed their animals? Alternatively the animals may be herded to the vegetable farms after harvest to feed on the remnants. Farmers have raised issues of easier access to veterinary input services as veterinary officers are very few and costs of veterinary inputs and services are seen as high. Breeding males were scarce. Future efforts may include the design and implementation of genetic improvement strategies and plans.

Publicity: Papers will be prepared and submitted for publication

Effect of partial replacement of maize with sorghum spent grain on growth performance of local guinea fowl.

Background, objectives and research protocol

The domestic guinea fowl (*Numida meleagris*) is an important poultry species reared under extensive system of management by almost every farmer including women and children in Northern Ghana. Apart from their function as a source of household income and protein, they also play important social roles. Guinea fowl production has great potential for income generation to reduce poverty, malnutrition and food insecurity among rural and peri-urban farm families in northern Ghana. Previous studies have shown the possibility of rearing guinea fowl under semi-intensive or intensive system of management with resultant improvement in productivity. Brewers' sorghum spent grains commonly referred to as 'pito mash' is available for feeding animals in Northern Ghana with similarities in its nutrient composition to that of wheat bran (Larbier and Leclercq, 1994). Therefore, it can be used as a partial substitute for maize which is used widely in poultry diets in Ghana as maize is often scarce and expensive. Preliminary studies involving broiler chicken have shown that sorghum brewery waste can be used as a feed ingredient in the diet of broiler finishers up to 150 g/kg without adverse effect on their performance (Dei *et al.*, 2011). However, there is paucity of information on its nutritive value for growing guinea fowls. The objectives of this study were to determine effects of pito mash as substitute for maize on growth performance of local guinea fowl and to assess the economics of feeding the pito mash to guinea fowl. The experiment was conducted using 100 local guinea fowls, mainly the pearl variety at 10 weeks of age. Two dietary treatments were applied: pito mash was incorporated in the diets at 0% (Treatment 1, control) and 20% (Treatment 2) as replacement of maize using a completely randomized design.

Results

Mean feed intake of the control birds was similar ($P>0.05$) to that of their counterparts fed diet containing pito mash (Table 3). Also, all the birds recorded similar ($P>0.05$) live weight gains and gain/feed ratios. There were very low mortalities in this experiment. There was slight reduction ($P>0.05$) in feed cost when the pito mash partially replaced maize in the diet (Table 3). Therefore, feed cost per gain was reduced by 13.8% when birds were fed pito mash diet. The macro-nutrient composition of the pito mash used in this study was comparable to those reported in other brewers' spent grains (Morad *et al.*, 1984). The main nutritional concern for use in poultry rations has been its poor protein quality due to low concentration of lysine in particular, as well as high fibre content. However, these nutritional deficiencies can be overcome if diets are properly formulated.

Table 3: Effects of pito mash on performance of local guinea fowl (10-20 weeks of age)

Parameter	Control Diet (mean±sd)	Pito mash Diet (mean±sd)	Probability
Feed intake (g/bird/day)	53.11 ± 2.78	56.73 ± 7.21	0.385
Weight gain (g/bird/day)	5.86±2.49	5.71±0.82	0.916
Gain/feed	0.11±0.04	0.10±0.01	0.673
Final live weight (kg/bird)	1.01±00	1.08±00	-
Mortality (%)	1.50±1.29	1.75±0.96	0.766
Feed cost/kg diet (GHS)	0.82±00	0.73±00	-

Total feed intake (kg/bird)	4.02±0.27	4.16±0.54	0.66
Total feed cost (GHS/bird)	3.29±0.22	3.03±0.39	0.294
Feed cost/kg gain (GHS)	3.26±0.22	2.81±0.36	0.076

sd-Standard deviations

Similar growth performance exhibited by guinea fowls fed diet containing pito mash could be attributed to its favourable nutrient composition in terms of protein. Its protein content and quality are higher than those of maize it replaced in the diet. It has been observed that even broiler chickens fed diets containing pito mash up to 15% responded positively with no adverse effects on growth performance (Dei *et al.*, 2011). Guinea fowls are noted for utilizing fibrous feed materials better than chickens. The pito mash was relatively far cheaper than maize, which accounted for the lower feed cost. At the time of the study, the price per kilogram of maize was 66 Ghana pesewas compared with 4 Ghana pesewas for pito mash. Thus ingredient substitution using cheap locally available non-conventional feedstuffs has been suggested as a way of minimizing feed cost. Therefore, guinea producers should use pito mash as partial substitute for maize in feeds for guinea fowls. Pito mash or sorghum brewers' spent grains can be incorporated in guinea fowl grower diet at 20% as substitute for maize without adverse effects on their growth performance.

Additional deliverable. Farmer learning: Some backyard guinea fowl producers in the Upper East Region (48= 28 males, 20 females) and Northern Region (24= 23 males, 1 female) visited the on-farm study site on learning tour about the potential of rearing guinea fowls intensively and how feed cost can be reduced through use of locally available non-conventional feedstuffs like 'pito mash'. Farmers were highly impressed about the project and asked for USAID-Africa Rising support including training on husbandry practices.

Support of AFRICA RISING: Knowledge generated from this trial will contribute to informed improved feeding management and productivity of guinea fowl production in northern Ghana for income generation, food and nutrition security.

Scalability: Credit support for farmers to expand their poultry business, Capacity building of farmers through training on modern production.

Lessons learnt: Effective collaboration of funding agencies, farmers and researchers is crucial for the success of USAID-AFRICA RISING

Publicity: Results of this study will be disseminated at the biennial conference of Ghana Society of Animal Production in 2013 as well as published in reputable journals.

Effect of replacing maize with processed false yam seed (*Ipomoea pes-caprae*) meals on growth performance of local guinea fowls.

Background, objectives and research protocol

Intensive rearing guinea fowl production requires proper feeding using complete diets. Maize is the main cereal grain used as dietary source of energy and constitutes 40-70% in poultry diets. Attempts to address this feed situation include use of non-conventional feed ingredients including new feed resources such as false yam (*Ipomoea pes-caprae*) tuber and seed. Both products are high in carbohydrates, thus can serve as alternative dietary source of energy for broiler chickens if properly processed to ameliorate adverse effects of anti-nutritional factors such as resins (Dei et al., 2011a, 2011b). Presently there is no information on its usefulness for local guinea fowls. As a result, this study was undertaken to determine effects of processed false yam seed (soaked or boiled) meals as substitutes for maize on growth performance and carcass characteristics of local guinea fowl; as well as to assess the economics of feeding the false yam seed meals to guinea fowls. The study was conducted at the Poultry Unit of the University for Development Studies, Nyankpala Campus, Tamale. For the boiled sample, the crushed seeds were boiled in water (i.e. 1 part seed to 1 part water) and boiled for 2 hours, washed with clean water and sun-dried for 8 days, and the ground into gritty meal using a grinding mill, and labeled BFYSM. In the case of the soaked sample, the crushed seeds were soaked in clean water for 12 days in a ratio of 1part of seeds to 2 parts of water. The soaked seeds were washed with clean water, sun-dried for 8 days and ground into a gritty meal using a grinding mill, and labeled SFYSM. The boiled sample contained on "as fed" basis 87.3% dry matter, 13.5% crude protein, 2.1% crude fibre, 52.0% starch and 3722 Kcal/kg gross energy, whereas the soaked sample contained 85.9% dry matter, 6.9% crude protein, 1.7% crude fibre, 65.6% starch and 3652 Kcal/kg gross energy (Dei, unpublished).

This study involved two experiments using the local Pearl guinea fowl. In Experiment 1, boiled false yam seed meal was fed to 96 ten-week-old guinea fowls. In Experiment 2, soaked false yam seed meal was given to 96 five-week-old guinea fowls. In Experiment 1, ninety six 10-week-old pearl guinea fowls of similar live weights were used. Four dietary treatments containing boiled false yam seed at 0, 5, 10 and 15% as partial substitute for maize were tested using a completely randomized design. Each treatment was replicated thrice with each replicate comprising 8 unsexed guinea fowls. The mean initial live weight per bird per replicate was 340g. The same experimental design was used in Experiment 2; where 5-week-old birds with mean initial live weight of 110g per bird were used. They were fed 4 diets containing soaked false yam seed at the same levels as in Experiment 1.

Results

The use of the processed false yam seed meals as substitutes for maize had no adverse effects on the growth performance of the guinea fowls. This could be as a result of substantial reduction in the anti-nutritional factors in the seeds by the processing methods employed, particularly soaking of the seeds. Therefore, similarity in the consumption of the feed between birds fed control diets and those fed processed seed meal suggested that, processing might have removed the bitter compounds in the seeds which made the products palatable. Moneam (1990) reported that soaking improves the extraction of anti-nutritional factors in some seeds. A previous study involving broiler chickens showed that the nutritive value of soaked seed meal was superior to that of boiled seed meal (Dei et al., 2011b). In that study, growth of broilers was not compromised when maize in the diet was replaced by either 5% boiled seed meal or 10% soaked seed meal. By way of nutrient composition, false yam seed compares favorably with that of maize in terms of starch and crude protein

contents (Fay, 1991; Dei et al., 2011b). Thus the major nutritional concern has been its anti-nutritional factors such as resins (NRI, 1987).

The similarity in the total cost of all the feeds could be attributed to small disparities in their unit costs. The price difference between maize and the seed meals was quite small as a result of the labour and other costs involved in harvesting and processing of the seed meals. Also, the protein quality of the false yam seed has been noted to be poorer than that of maize because of its very low content of methionine. Thus slightly more high quality protein but expensive ingredients such as fishmeal and soybean meal were used. Besides, the metabolizable energy content of false yam seed was about 50% less than that of maize (Dei, unpublished data); hence palm oil was added to increase dietary energy. The use of the soaked seed meal appeared to be more economical than the boiled seed meal from the results obtained in this study. This was an indication that the soaked seed meal could be very useful during periods of maize shortage in the market. Besides, it could spare maize for human consumption. For instance, for every ten tons of feed produced using soaked false yam seed meal, one and half tons of maize would be spared for human use. Based on the results of this study, the soaked false yam seed meal (SFYSM) can replace maize up to 15% in diets for growing guinea fowls without adverse effects on growth performance. Also, the use of the SFYSM was economical in local guinea fowl production. Based on economic considerations, the boiled false yam seed meal can replace maize at 5% in the diet for local guinea fowls.

Effect of replacing maize with false yam tuber meals on growth performance of local pig (Ashanti Black)

Background objectives and research protocol.

In recent times, interest has been generated in indigenous livestock breeds in Ghana, particularly, the Ashanti Black pig in order to produce meat to the increasing protein intake of the population. It has the ability to survive under stressful environmental conditions like poor nutrition, disease challenges and high ambient temperatures. It is the main pig breed reared under the traditional system and commonly found in northern Ghana, particularly the Upper West Region; where pig production contributes about 34% of household income generated from livestock and fishery (Otchere et al., 1999). Thus pig production has a high potential of contributing to job creation and poverty reduction in this part of the country. Attempts to improve productivity of the Ashanti Black pig include improved housing, nutrition and health-care under intensive management system. Thus high feeding cost comes into focus as a major constraint that must be dealt with through the use of non-conventional feedstuffs. The supply of conventional energy feed ingredients such as maize has been dwindling as a result of competition for this commodity by humans for food and other industrial uses as well as low yields due to rampant drought conditions. Thus a need for alternative feed resources to spare maize for human consumption. False yam (*Icacina oliviformis*) tuber has a potential as alternative to maize in pig diets due to its comparable content of soluble carbohydrates.

The plant is presently not cultivated for its products due to a toxic principle called 'gum resins' (National Research Institute, 1987) identified as terpenes (Vanhaelen *et al.*, 1986). However, it is envisaged that with proper methods of detoxification, the nutritive value of the tuber can be substantially improved for feeding monogastric animals (Dei et al., 2011). Therefore, this study was undertaken to determine the usefulness of false yam tuber as a feed ingredient for local pigs. The specific objectives were: (1) to determine the effects of raw, boiled and soaked false yam tuber meals as substitutes for maize on growth

performance of Ashanti Black pigs and (2) to assess the economics of feeding these false yam meals to the local pigs.

The study was conducted at the Babile Pig Breeding Station in the Lawra district of the Upper West Region of Ghana. It is a state owned farm with the mandate to improve the Ashanti Black Pig (ABP) as an indigenous Ghanaian breed. The Station also produces the local pigs for sale to pig farmers. For the preparation of each sample, the fresh tubers were peeled and chopped into tiny pieces (about 2 cm).

- The raw false yam tuber meal (RFYTM) was prepared as follows: The chopped tubers were sun-dried for 8 days on a cement floor and then ground into gritty meal using a grinding mill.
- The boiled false yam tuber meal (BFYTM) was prepared as follows: The chopped tubers were cooked in water (i.e. tuber added to boiling water in the ratio 1:1 w/v) for 2 h, the cooking water was discarded, boiled tuber chips sun-dried for 8 d and ground into gritty meal.
- The soaked false yam tuber meal (SFYTM) was prepared as follows: The chopped tubers were soaked (1 part SFYTM to 2 parts of water) for 12 days with water changed every 3 days, sun-dried for 8 days and ground into gritty meal.

Sixty (60) Ashanti Black pig weaners (30 males and 30 females) at 12 weeks of age and of similar live weights were used for the study. The factorial design comprised 3 false yam tuber meals (raw, boiled and soaked) at 3 dietary levels (5, 10 and 15%) with control diet containing no false yam meal (i.e. 0% dietary level). Each treatment was replicated 3 times in a completely randomized design.

Results

There were linear reductions in mean total feed intakes ($P=0.002$) and live weight gains ($P<0.001$) of the pigs as the level of the false yam tuber meals increased in the diets. Also, there were significant differences ($P<0.001$) in these parameters between the false yam tuber samples and dietary levels. There were interactions ($P<0.05$) between the samples and dietary levels. However, there were no significant differences ($P>0.05$) between the control pigs and their counterparts fed 10% soaked false yam tuber meal in terms of total feed intake, total live weight gain, final live weight at 20 weeks of age and feed/gain ratio. Although feed intake of the pigs fed 5% boiled false yam was lower ($P<0.001$) than that of control pigs, their weight gain was not significantly different ($P>0.05$) from that of the control group (Table 2). Generally, the pigs fed the soaked samples tended to perform better than their counterparts fed the raw and boiled samples at all dietary levels. Generally, feed cost decreased ($P=0.002$) with increasing level of the samples in the diets. Also, there were significant differences ($P<0.001$) between the samples. However, there were no differences ($P>0.05$) between feed cost per gain between the control pigs and those fed 5% boiled sample and 5% or 10% soaked sample.

The nutrient compositions of the false yam tuber samples determined in previous studies on "as fed basis" have been found to be fairly comparable, particularly in terms of crude protein (3.2-7.0%), crude fibre (4.8-6.5%), starch (54.6-59.5%) and gross energy (14.5-14.7 MJ/kg) (Dei, unpublished data). This was an indication that boiling or soaking had no major effect on the nutrient content due to leaching. Although, the overall nutrient density of these materials was somewhat less than that of maize (Larbier and Leclercq, 1994), soaked sample tended to give similar growth performance of weaner pigs when it replaced maize up to 100 g/kg in the diet. The boiled sample, also, gave good performance at 50 g/kg diet. Although the chemical composition of the anti-nutritive factors in tuber samples were not determined

in this study, the results suggest that soaking might have leached out most of the bitter compounds; or modified the chemical structure of the terpenes making them inactive. Soaking has been used traditionally to make the tuber safe for human consumption (NRI, 1987). Also, feeding of soaked false yam tuber meal in broiler chicken diet at 10% as substitute for maize had no adverse effects on their growth performance (Dei et al., 2010). Therefore, by ameliorating the toxic components in this material by soaking, it could become a new commodity for feeding pigs as well as promote production of the crop. The high tuberous root yield (Fay, 1993) of this plant coupled with its drought resistance could ensure ready availability all year-round for feeding pigs.

In this study, all growth variables appeared not to be adversely affected by increasing dietary level of the soaked false yam tuber meal up to 10%. However, there were numerical non-significant ($P>0.05$) slight reductions in all growth variables when the material was substituted for maize in the diet at 100 g/kg. This suggests presence of residual concentrations of anti-nutritive factors. The observed improvement in growth performance of all the pigs fed the soaked or boiled tuber meal could be attributed to reduction in the concentrations of the anti-nutritive factors in them, which affected feed intake (Table 2). Feed intake is important in the growth of pigs. According to Forbes (1995), feed intake is affected by factors including toxins in feed.

Generally, feeding of the false yam tuber meals posed no health challenges for the pigs. This suggests that toxic components in the false yam tuber samples might not have health-related consequences. Previous studies involving broiler chickens showed no health related problems when the raw false yam tuber was used (Dei et al., 2011).

Soaked false yam tuber meal could be a good replacement for maize up to 100 g/kg in pig weaner diets. Although the false yam at present has no economic value, the major concerns are labour involved in harvesting and processing. Thus its use in pig diets will stem more from its use as alternative feedstuff for maize than as a cheaper feed ingredient. Maize is a staple food for most Ghanaians, therefore sparing it by using false yam tuber is very important for ensuring food security.

Additional deliverable. Some backyard pig producers in the Upper West Region (45= 24 males, 21 females) visited the on-farm study site on learning tour about the potential of rearing local pigs intensively and how feed cost can be reduced through use of locally available non-conventional feedstuffs like 'false yam tuber'. Farmers were highly impressed about the project and asked for USAID-Africa Rising support including training on husbandry practices. A farmer described the false yam tuber as "nuisance turned into gold". False yam is a notorious weed on crop farmlands.

Output 4.3 Increased availability, utilization and consumption of highly nutritious foods (fruits, vegetables, legumes, meat and milk)

Activity 4.3.1 Introduce and disseminate best-bet technologies and practices to improve milk processing and consumption. Training of producers and processors in safe milk, Wagashi (Soft cheese) and yoghurt production in Northern Ghana.

Purpose and objectives

The poor hygienic environment in which milk was extracted, processed and marketed was a major constraint for the consumption of quality milk and milk products in Ghana. This activity was designed to create awareness among milk producers, processors and consumers on safe handling and processing of milk and milk products so as to increase consumer confidence in locally produced milk as safe food. Specific objectives were:

- To train herdsmen and wives on improved hygiene at the kraal and handling of milk
- To train milk processors in hygienic production of 'wagashi', yoghurt and other fermented products
- Increase consumer confidence in consumption of fresh milk, 'wagashi' and yoghurt

Implementation strategy

At least three hundred milk producers and processors were targeted to be trained on hygienic handling and processing of local milk and milk products in six communities in Northern Ghana. CSIR-ARI and KNUST which have experience in milk production and processors were involved in the initial stakeholders meeting and were identified to lead the dairy programme. The focal persons, mainly Ministry of Food and Agriculture (MOFA) staff assisted with community mobilization and facilitated the training activities. The training was done in two phases. Phase one involved training mainly herdsmen, cattle owners and some women in milk hygiene and phase two involved mainly women in milk processing and sale.

Implemented work programme and results/deliverables

Table 5. Planned activities and achievements

	Planned	Achieved
1	To organize nine training and demonstration sessions for 120 herdsmen and women in milk hygiene in 3 districts of northern Ghana	Six training and demonstration session organized for 173 herdsmen, women and cattle owners in milk hygiene practices in 3 districts of northern Ghana.
2	To organize nine training sessions and demonstration on milk hygiene, safety in value chain for 300 'wagashi' processors and retailers in the 3 districts	Six training sessions organized for 325 'wagashi' processors in the 3 districts
3	To organize training and demonstration of safe yoghurt processing for 36 processors in 3 districts	Forty processors introduced to rudiments of yoghurt processing in one district.

4	Radio presentation and development of 60 sec jingle on milk hygiene for airing on radio	This was not achieved.
5	Development and design six messages on milk hygiene and safety and 3000 posters and revision of manual for training	Six concepts on safe milk and milk products developed and 3000 posters printed and distributed. Training manual reviewed awaiting printing

It was planned to do nine sessions in training 120 herdsmen and their wives and 300 women milk processors and market agents as well as introduce yoghurt processing to 36 women. Training in milk hygiene involved 173 participants and that on 'wagashi' processing involved 325 participants. Yoghurt processing was introduced to forty women. These figures exceeded the projected figures to be trained, but it also might suffer from inadequate 'hands-on' experience. Even though the training in milk processing targeted only women, some men (herdsmen and cattle owners) came for the training. We accepted to train them as well as this might let the men in some households understand what changes in practices in milk handling by the women might mean. Participant was given posters and the class was taken through the steps in each poster. Discussions were then held on the best practices that would make them have a safe product.

Key Deliverable Deviation:

The main deviations that occurred in the planned activities and as delivered was in the number of sessions planned for the training and also the late start of the project. However, the number trained exceeded that planned. A new strategy was devised in which more people were invited for the milk processing sessions. The discussion on issues of milk hygiene on radio which would have assured consumer confidence in milk consumption and therefore helped increase consumption of local milk and milk products was not done.

Support of AFRICA RISING:

It is expected that as the hygiene is improved in the production and marketing chain of milk, consumer confidence would improve and consumption of local milk and milk products would increase. It is expected that as a result of the increased consumption, milk producers, processors as well as market agents would have increased income and improve their livelihoods. It is also expected that the wide adoption of milk processing practices will reduce the risks of public health hazards associated with zoonoses.

Scalability:

Given the rapidly growing urban population in the three regions of northern Ghana, there will certainly be an increased demand for milk and milk products. To meet this challenge, it is proposed that the people involved in the milk trade be encouraged to form identifiable interest groups so that they could be assisted in their trade through labelling and certification systems. Also, it would be useful to map out the extent of milk production in the regions as well as the prices and marketing channels for the milk and the products.

Further training in milk hygiene and processing particularly yoghurt production would be necessary. Herdsmen and cattle owners need to be trained on use of production techniques that could improve milk yield e.g. use of supplemental feeding. Furthermore, a milk collection scheme could be explored. In the long term, selection of high milk producing local cattle could be implemented and also dual purpose improved breeds could be introduced from other tropical areas.

Lessons learnt: what lessons, including about the partnership you had within the project, have been learnt during the implementation of the project that will help Africa RISING to succeed in future?

The wide consultations that were made before the inception of the project have been useful. There is an improved communication between MOFA staff and producers. MOFA personnel very supportive of the milk component of the project.

Publicity:

Posters on milk hygiene and processing have been sighted on walls in some communities that we did not work in. Training materials, developed from a previous programme (DFID funded, R7321 and ZC 0285) and implemented mainly in southern Ghana were revised and used for training in this project. Six posters were developed and used in the training. The captions of the posters were;

- Milk hygiene: sources of contamination of milk and remedies
- Simple milk platform improves milk quality
- Preparing good 'wagashi' with *Calotropis procera* -step by step
- Preparing Quesco blanco semi-hard cheese with lemon – step by step
- Salt preserves 'wagashi' longer
- Making yoghurt – step by step

The posters were illustrated such that participants could follow the messages even if they could not read the English text. An accompanying manual for use by Extension agents has been revised but not printed.



Processors encouraged to store 'wagashi' in brine overnight to increase shelf life

Output 5.3 Strengthen capacities of partners

Activity 5.3.1 Organize a course on integrated crop-livestock production for research and extension staff.

Background and purpose

A 4-day Training Course on crop-livestock farming systems was convened for personnel from Agricultural and Livestock research and development institutions, universities and private sector staff mostly from the three regions in Northern Ghana. The objectives of the training course were to (1) equip the participants with the “state-of-the-art” knowledge on the subject of crop-livestock farming systems and (2) to sharpen the skills of participants in handling issues in the crop-livestock integration domain by providing them with analytical tools used in designing and implementing crop-livestock integrated research projects. Twenty eight (28) persons participated in the “Crop-Livestock Farming Systems” Training Course in Tamale, Ghana, 19-22 September, 2012. Subject matters and resource persons included:

- Crop-livestock Integration: Concepts, Principles and Practice. Dr. Kwaku Agyemang gave a 3-Part Presentation on Concepts, Principles and Practice of crop-livestock systems; Situation analysis of crop-livestock Systems in Northern Ghana and on experience sharing from Course Participants.
- Methodologies in analysing crop-livestock systems/modelling of systems. Dr. Augustine Naazie made a 2-part presentation that dwelt with concept of crop-livestock systems and “Modelling of systems”.
- Integration of crop-livestock systems for improved soil management program. Dr. A. Opoku gave a 4-part Presentation. In Part 1 he touched on the assessment of nutrient flows and balances in Crop-livestock systems, assessment of tradeoffs in alternative uses of Crop residues, and evaluation of agricultural sustainability. In Part 2 he gave the general objective as to identifying hot spots for research intervention in cereal-legume-livestock (C-L-L) systems. Specifically the Presentation sought: to audit the flow of nutrient resources in small-scale C-L-L systems; to quantify the nutrient balances in these C-L-L system and, to identify alternative management scenarios to redress the nutrient imbalances.
- Improving crop-livestock integration system in the value chain system. Dr. Pamela Pali. (see in activity

A total of 10 Lectures, 6 Working Group Sessions and 2 Experience Sharing Sessions were delivered during the four days. The Lectures delivered and questions and answers provided are compiled in a separate Volume “CSIR-ARI-USAID FEED THE FUTURE COURSE ON CROP-LIVESTOCK FARMING SYSTEMS” is attached to this present report.

This training course has been an opportunity for sharing of knowledge and information and mutual learning among research scientists on a number of key concepts, principles, tools of crop livestock integration that will have a bearing on the design and implementation of research projects under the Africa RISING Initiative on sustainable intensification of crop livestock systems.

- The need to have an integral systems approach addressing the whole crop-livestock systems and not only components cannot be overemphasized. The need to gain better understanding of factors that drive farmers and influence their decision was stressed. Participants appreciated discussions on concepts of models and modelling.

- The exposure to the concept of Integrated Agricultural Research for Development (IAR4D) and the better understanding of concepts of innovations and innovation platforms (IPs) mechanisms will likely be useful in the design of future project activities including scaling up and out processes. The sharing of past experiences on the formation and operationalization of innovation platforms with concrete examples of the development of technological, institutional and commercial innovations was beneficial to participants. As a result, they anticipated the role such processes and mechanisms (IAR4D, IPs) could play for the development of selected livestock value chains in Northern Ghana, namely, small ruminant, dairy and guinea fowl value chains under the Africa RISING project.
- One key implication of knowledge gained through the training workshop was how it would inform the design of field experiments and the development of monitoring and evaluation strategies to track systems changes brought about by the project interventions. The knowledge gained through presentations and discussion on nutrients flows and balances in crop livestock systems, the assessments of trade-offs in alternative uses of crop residues and the evaluation of agricultural sustainability will be valuable to inform project experimental designs.