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FEED THE FUTURE INNOVATION LAB FOR LIVESTOCK SYSTEMS

Report on the Assessment of Forage and Non-Forage Laboratories in Niger

December 2019

by the Human and Institutional Capacity Development team
of the Management Entity at the University of Florida

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Sustainably intensifying smallholder livestock systems to improve human nutrition, health, and incomes.

Disclaimer

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Abbreviations

ADF	Acid detergent fiber
ADL	Acid detergent lignin
ASF	Animal-source foods
CERRA	Centre Regional de la Recherche Agronomique (translated into English as «The Regional Centre for Agricultural Research»)
DM	Dry matter
HICD	Human and institutional capacity development
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IFAS	Institute of Food and Agricultural Sciences
ILRI	International Livestock Research Institute
INRAN	Institut National de la Recherche Agronomique du Niger (translated into English as «The National Institute for Agronomic Research in Niger»)
IVOMD	In vitro organic matter digestibility
LABOCEL	Laboratoire Central de l'Elevage (translated into English as «The Central Laboratory for Livestock»)
LANA	Laboratoire d'Alimentation et de Nutrition Animale (translated into English as "The Laboratory for Animal Nutrition and Feeds")
N	Nitrogen
NDF	Neutral detergent fiber
NIRS	Near infrared spectrophotometry
OM	Organic matter
PPE	Personal protective equipment
SOPs	Standard operating procedures
UAM	Universite Abdou Moumouni de Niamey
UF	University of Florida
USAID	United States Agency for International Development

Executive summary

This report summarizes the findings from the rapid assessment of forage and non-forage laboratories in Niger to determine their strengths and weaknesses in relation to how they can support research, extension, and education activities of the livestock sector. The assessment (conducted in September 2019) targeted laboratories that are operated by public universities and international or government research entities in Niger that partner with the Feed the Future Innovation Lab for Livestock Systems. The assessment included meetings with forage and non-forage lab personnel and users of lab facilities, such as researchers, academics, and students. During this assessment the forage research sites near Niamey and Maradi were also visited. The research at these sites is being conducted through field experiments and feeding trials by research organizations and universities that are partners of the Livestock Systems Innovation Lab.

The primary objective for this assessment was to determine the professional development training needs of the laboratory personnel and users in Niger. The assessment team was comprised of the University of Florida laboratory specialist from the Department of Agronomy, Mr. Richard Fethiere, who manages the forage lab and forage research activities, and the Livestock Systems Innovation Lab's country coordinator, Dr. Moctar Karimou, who developed the assessment itinerary as well as provided context to visiting labs and institutions.

The labs face challenges such as lack of reliable power supply, broken/malfunctioning equipment and instruments, lack of personal protective equipment. And there is also considerable need for training in lab management, lab operations and lab safety. Such training should be offered at each lab for any new users as well as refresher training for lab personnel. At Abdou Moumouni University (AMU), the professors and administrators expressed that training in lab management is crucial to the operation of the labs. AMU is considering including a lab management course as a graduation requirement or offering such a course as a week-long certificate program.

Introduction

The U.S. Agency for International Development (USAID) awarded the University of Florida (UF) Institute of Food and Agricultural Sciences (IFAS) funds to establish the Feed the Future Innovation Lab for Livestock Systems. This five-year initiative (October 2015 to September 2020) supports USAID's agricultural research and capacity building work under Feed the Future, the U.S. Government's global hunger and food security initiative. The International Livestock Research Institute (ILRI) is the UF/IFAS partner in implementation of the Livestock Systems Innovation Lab. The eight target countries for this Lab are Burkina Faso and Niger in West Africa, Ethiopia, Kenya, Rwanda, and Uganda in East Africa, and Nepal and Cambodia in Asia.

The Livestock Systems Innovation Lab aims to improve the nutrition, health and incomes of the poor by sustainably increasing livestock productivity and marketing, and consumption of animal-source foods (ASF). This aim will be achieved by introducing new location-appropriate technologies, by improving management practices, skills, knowledge, capacity and access to and quality of inputs across livestock value chains, and by supporting the development of a policy environment that fosters sustainable intensification and increased profitability of smallholder livestock systems.

One of the crosscutting themes of the Livestock Systems Innovation Lab is the Human and Institutional Capacity Development (HICD) component, which emphasizes the connection between strengthening the capacity of an individual and organizations, and systematic change at the institutional and enabling

environment levels in target countries. HICD works with partner organizations of the Livestock Systems Innovation Lab to build their technical and scientific capacities through various direct and indirect activities. This assessment to evaluate the current status of research laboratories was requested by the HICD team and is an integral part/component of the HICD activities in Niger

This report summarizes the findings from the rapid assessment of forage and non-forage laboratories in Niger to determine their strengths and weaknesses in relation to how they can support research, extension, and education activities of the livestock sector. The assessment included meetings with forage and non-forage lab personnel and users of lab facilities, such as researchers, academics, and students. During this assessment the forage research sites near Niamey and Maradi were also visited. The research at these sites is being conducted through field experiments and feeding trials by research organizations and universities that are partners of the Livestock Systems Innovation Lab.

The interviews and visits to labs helped assess the operational strengths and weaknesses of the forage and non-forage labs at the individual (lab personnel), organizational (lab management, infrastructure, and equipment), and enabling environment (lab policies and regulations that guide lab services) level. The interviews were intended to determine how labs function and operate as well as the training needs of lab personnel and users, and other collaborative arrangements for strengthening the livestock research, extension, and teaching capacities through improved laboratory services. The Livestock Systems Innovation Lab's country coordinator, Dr. Moctar Karimou, was instrumental in developing the assessment itinerary and organizing numerous meetings and visits to the labs and forage research sites, clarifying the context of laboratory activities in Niger and accompanying lab specialist Mr. Richard Fethiere from the University of Florida during the assessment visits.

This report provides the findings of the rapid assessment, the needs identified during the assessment, and the recommendations made to address the needs.

Assessment objectives

The primary objective for this assessment was to determine the professional development training needs of the laboratory personnel and the lab users in Niger. Additional objectives included an assessment of current challenges and needs in the existing labs to conduct lab experiments and research aimed at improving ASF production in Niger. Specifically, this entailed an assessment of laboratory management's technical proficiency, capacity-related deficiencies among lab technicians, scientists, academics and students, and operational policies guiding lab work (i.e., manuals or Standard Operating Procedures (SOPs)).

Methodology

The assessment methodology involved visiting actual labs for forage and non-forage work and meeting with lab administrators and technicians, as well as with users (academics, researchers, and students) to inquire about their lab experiences and their views on how labs could be improved. The interviews were conducted using a semi-structured format supported by visual observations of lab facilities and equipment.

The assessment was conducted by the University of Florida laboratory specialist from the Department of Agronomy, IFAS, who manages the forage lab and forage research activities – Mr. Richard P. Fethiere. Mr. Fethiere worked with the HICD team member who oversaw the assessment and the Livestock Systems

Innovation Lab's country coordinator who developed the assessment itinerary as well as provided context to visiting labs and institutions.

The methodology was designed in a way that it would help identify gaps in professional development that can be addressed through short-term trainings. The assessment plan involved visiting forage sites from where forage samples are produced in the fields and following their path to the laboratory, where they are analyzed and shared with researchers or clients in the form of results reports. Due to Mr. Fethiere's technical expertise in forage lab operation and forage trials in the field, only forage sites were visited to map the path of forage samples to the lab. Where available, the lab protocols, including SOPs, were reviewed during lab visits to determine the scope and extent of various procedures and how they are followed by lab personnel and users during their lab work.

The work was guided by the identification of certain key component factors that contribute to effective lab service delivery. These were systematically assessed in each of the facilities visited. These included:

- Policies regulating laboratory operations
- Human resource capacity (total number and qualifications of personnel)
- Availability of continued professional education, operational research and training
- Structure, operations and management of laboratories
- Health and safety procedures in place
- State of the physical infrastructure
- State/availability of equipment, reagents and lab consumables
- Lab procurement procedures
- Quality assurance
- Laboratory information management
- Financing status of the laboratories

Where available, background information on the laboratories was obtained through a desk review of relevant literature (e.g., reports) and in consultation with the country coordinator.

Limitations of the assessment

The assessment encountered some limitations. First, due to the lab specialist's expertise, the primary focus of the assessment was on forage labs. Non-forage labs were also visited and assessed but mostly from the perspective of the state of physical infrastructure, equipment and general lab management aspects. Second, hardly any background literature on laboratory facilities in Niger was available. Finally, policy or regulatory documents were not readily available and the familiarity of some interviewees with the content of such documents was limited. No laboratories outside of Maradi and Niamey areas were visited due to time limitations, safety and logistical constraints. Gaps resulting from these limitations were filled based on the information provided by the country coordinator.

Types of laboratories visited

The assessment targeted labs that belonged to public universities and international or government research entities in Niger that partner with the Feed the Future Innovation Lab for Livestock Systems.

Research laboratories

- Institut National de la Recherche Agricole du Niger (INRAN). The following research sites and lab facilities were visited:
    - Programme de Selection du Mais, translated as the Program for Maize Selection. This lab is located in Maradi, Niger.
    - Laboratoires Genetique et Amelioration des Plantes (Mil-Sorgho-Niebe; translated as the Genetic and Plant Improvement Lab). This lab is also located in Maradi, Niger.
    - INRAN CERRA-Maradi, Laboratoire d'Entomologie (translated as an Entomology Lab). Located in Maradi, Niger.
    - Laboratoire d'Alimentation et de Nutritition Animale (LANA; translated as the Animal Feed and Nutrition Laboratory), which is located in Niamey, Niger.
- Laboratoire Central d'Elevage du Niger (LABOCEL). This lab is located in Niamey, Niger.
- International Livestock Research Institute (ILRI)'s lab, Niamey, Niger.
- International Crop Research Institute for the Semi-Arid Tropics (ICRISAT)'s lab, Niamey, Niger.

University laboratory

- University of Abdou Moumouni (UAM), which is located in Niamey, Niger.

General findings

Many HICD-related needs and gaps became obvious during the assessment. It should be noted that all buildings housing lab facilities were adequate for the purposes of lab work. Most laboratories were also adequately equipped to conduct lab experiments and tests. Generally, the equipment appeared fairly new or recently acquired. However, most of this new equipment was idle because of minor malfunctions. Almost every lab visited had a complaint about unreliable power supply. During visits, the power fluctuated continuously and confirmed it as a real concern slowing down the lab tests and, in some cases, compromising quality assurance of the lab tests. There is, therefore, an immediate need to install a backup power supply at all lab facilities to ensure that equipment functions properly and analyses can be completed in a reliable manner.

During the visit the team couldn't determine how lab facilities were funded and how purchasing equipment, reagents and supplies was handled. According to some lab managers, prior to purchase some information was gathered for expensive equipment – although they couldn't explain if there is an amount of money that defined "expensive equipment." The management and the directors needed to secure three (3) separate quotes. It was not clear if the same procurement process was involved for lab supplies and reagents. The major complaint about the procurement process was that it was very time consuming and usually resulted into eventually buying from the local distributor that offered the lowest bid , instead of buying from the manufacturer directly. In Niger, distributors can install the equipment but do not usually provide training for lab personnel nor service and maintenance on the equipment sold to the organization. Therefore, the technical support for the equipment in all the labs was lacking. That in combination with some other unfortunate circumstances that will be described below resulted in generally poor maintenance and equipment quickly degenerating into an item that can no longer serve the needs of the laboratory to support research for ASF production in Niger.

In almost all cases explored, operations manuals for the equipment available had been thrown away with the original packing boxes that contained the equipment. As a resulted the only potential support item provided to the lab to maintain the equipment had disappeared. That is a deficiency that requires immediate attention from lab administration to ensure that equipment can function. No evidence of laboratory inventory for supplies or reagents was determined during the visit nor was there evidence of a product catalogue in any of the labs visited. There is an urgent need for re-establishing a solid continuous supply chain for equipment, reagents and supplies in all these laboratories that is supported with technical maintenance efforts. Operations manuals for existing equipment need to be retrieved and/ or training on how to maintain the lab equipment must be conducted. In all laboratories a considerable amount of the equipment for forage analyses appeared to have been ordered from Germany. At LABOCEL, the freeze dryer and the incinerators came from China. The non-functioning UV fume hoods probably came from the European branch of Thermo Fisher. In all cases, there is a need to improve the communication between the manufacturers and the users in the laboratories to receive service, maintenance, and replacement parts.

While a lot of questions from lab personnel and professors about quality control for the laboratories revolved around correct lab procedures, yet the assessment team did not find SOPs posted in the open in any of the labs. That is a deficiency they are acutely aware of and want training on in order to improve the reliability of their labs and the confidence in the institutions. No evidence of a paper trail nor archives were found at these facilities. These concerns become dire when this relates to nutritional lab analysis of forage samples, as it is important to address the collection, drying and processing of samples to be sent to laboratories as well as the packaging and labelling during lab tests, and subsequent results reports preparation and archiving. This gap will also need to be addressed once the equipment is returned to working order. The issue of safety of lab personnel and handling and disposal of hazardous waste was also present in most labs. Personal protective equipment (PPE) was absent in most labs.

At LABOCEL, it is of primary importance to address HICD at the level of different universities and research institutions. **The need for lab management, lab operations and lab safety training is sorely needed in all these institutions.** At Abdou Moumouni University, they expressed the concern that training in lab management was very crucial to their operation. Two options were brought up (but not decided upon) during a recent meeting the professors and administrators, namely, to include such a course in a graduation requirement track or offering such a course as a week-long certificate program.

- In meetings with LABOCEL personnel and administrators it became clear that while the lab users (administrators and researchers) had often been trained in lab work yet over time had had little actual experience working in a laboratory. The refresher training can, therefore, be very helpful.
- Professional lab training is needed for university users (faculty, students) as well as lab personnel (management and technicians). Students are usually new to the laboratories and need all the training they can get in order to complete their research and publish findings. Laboratory managers are those who are in charge of the day to day lab operation and they will benefit the most from additional training. These individuals would constitute the target audience for trainings when offered. This professional training should focus on lab administration and management aspects, including sample intake, processing, supplies purchase, storage and use, equipment maintenance, manuals and procedures, inventory management, workflow, safety, and disposal of hazardous waste.
- Forage labs expressed interest in special training related to in-vitro organic matter digestibility (IVOMD) for ruminants, as well as in learning the protocols for nitrogen (N), dry matter (dm), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin

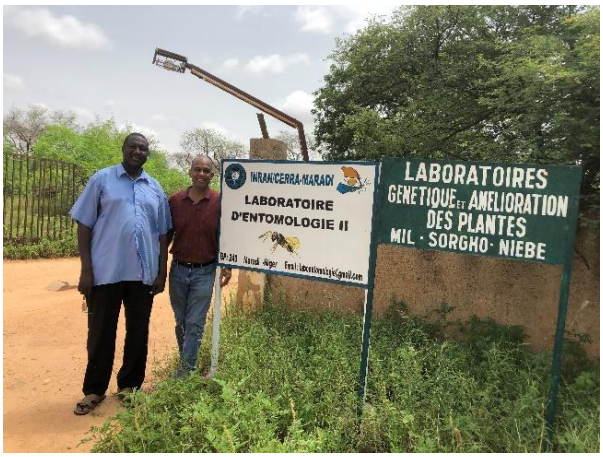
(ADL), energy, fat testing procedures and near infrared spectrophotometry (NIRS). They are interested to run the IVOMD analysis. Some of the laboratories need the equipment to conduct fiber analyses (NDF, ADF, ADL) or spare parts to get their instruments back in working order to conduct the analyses.

- In all labs there is a need to promote good lab practices, to improve the quality and reliability of test data, to generate final reports and to archive data and reports. There is also a need to promote conditions where analyses are well-planned, performed successfully, recorded, reported, archived, and monitored. All labs also require improvements to function in a safe manner for lab personnel and in an environmentally conscious manner for both lab personnel and the environment. Therefore, training is needed in good lab practices and laboratory safety parameters.
- Kollo (in southwestern Niger) has considerable potential to conduct feeding trials for small ruminants. Lab facilities have some never used equipment, animal crates, barns, and drying space for forage samples. With refresher trainings in lab management this lab can re-launch the use of idle equipment and expand its lab operations and services.
- Most laboratories have the equipment to conduct nitrogen analyses but in most of those locations the titrators are not in working order, or the equipment that was purchased do not match and do not allow the personnel to conduct the analyses from start to finish. Labs do have drying ovens for the determination of dry matter and organic matter. In some locations, minor repair or maintenance work is needed to allow the personnel to conduct the experiments. Therefore, the training offered should incorporate aspects of how to troubleshoot and fix minor problems in the labs.

LABOCEL as well as the other labs in Niger suffer from a high turnover rate due to their lab managers and technicians being recruited by the private sector with salaries that sometimes are up to 10X what the public sector can offer. With such competition from the energy, solar and petroleum companies in Niger it becomes imperative to train more lab managers to anticipate such losses. This demand on the job market in Niger is one of the factors that led to the meeting of participants at UAM to consider a lab management specialty as a separate major at the University.

Facilities

In Maradi, the lab facilities exist but they may not have the trained personnel to operate labs in an efficient manner. The labs are fairly well equipped but some major instruments and equipment lack some parts. For example, the defective oven dryer (Figure 2) is still in use with no door lock or temperature indicator.



Figure[1] 1. In front of the lab in Maradi

Figure 2. The oven dryer

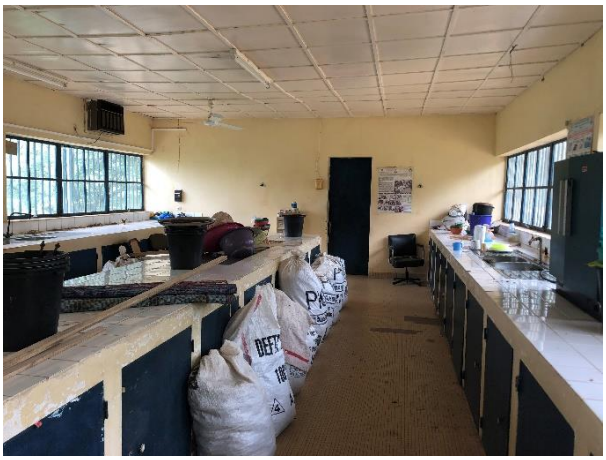


Figure 3. Forage lab in Maradi

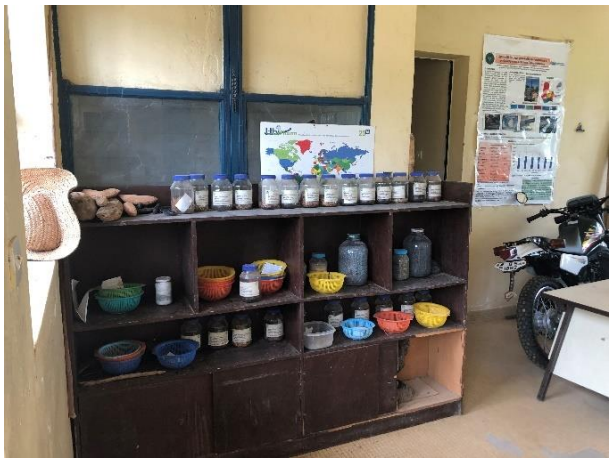


Figure 4. Storage of seeds in the forage lab

However, the forage lab in Maradi is spacious and well utilized for seed preparation and storage. A training program on lab management practices can be of help to this lab to improve the lab technicians' technical skills.

A lab facility in Kollo houses a research lab, an office and a barn where forage research can easily be conducted by a team of researchers. However, this lab has equipment and supplies that remained untouched and dusty. This facility that can benefit from training a new generation of researchers, lab managers, technicians and students in forage research in a short term turnaround. The fields where the research is conducted are near the lab and it would not take much but leadership and vision to restart this facility.

[1] All images presented in this report were taken by Dr. Fethiere during the September 2019 assessment trip to Niger.

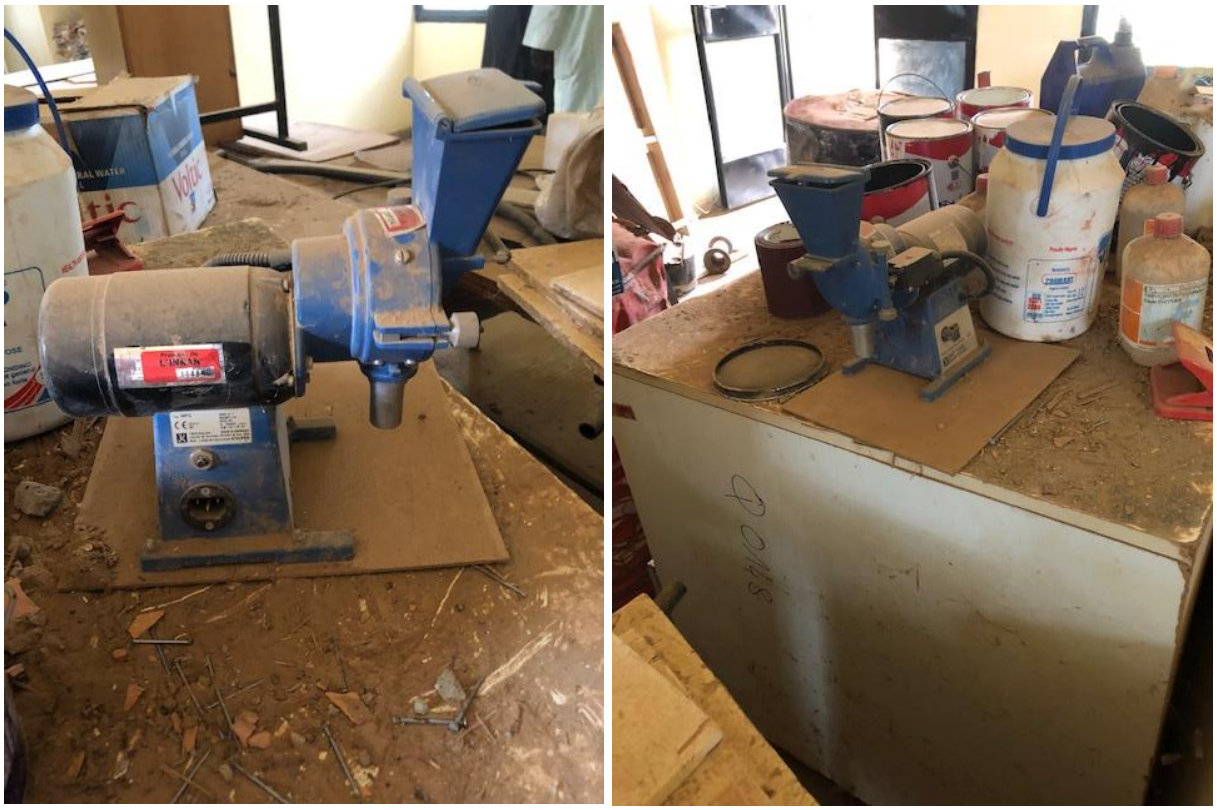


Figure 5 (a & b). A new grinder left in an old laboratory facility in Kollo.

Figure 6. A new autoclave at Kollo which is not in use.

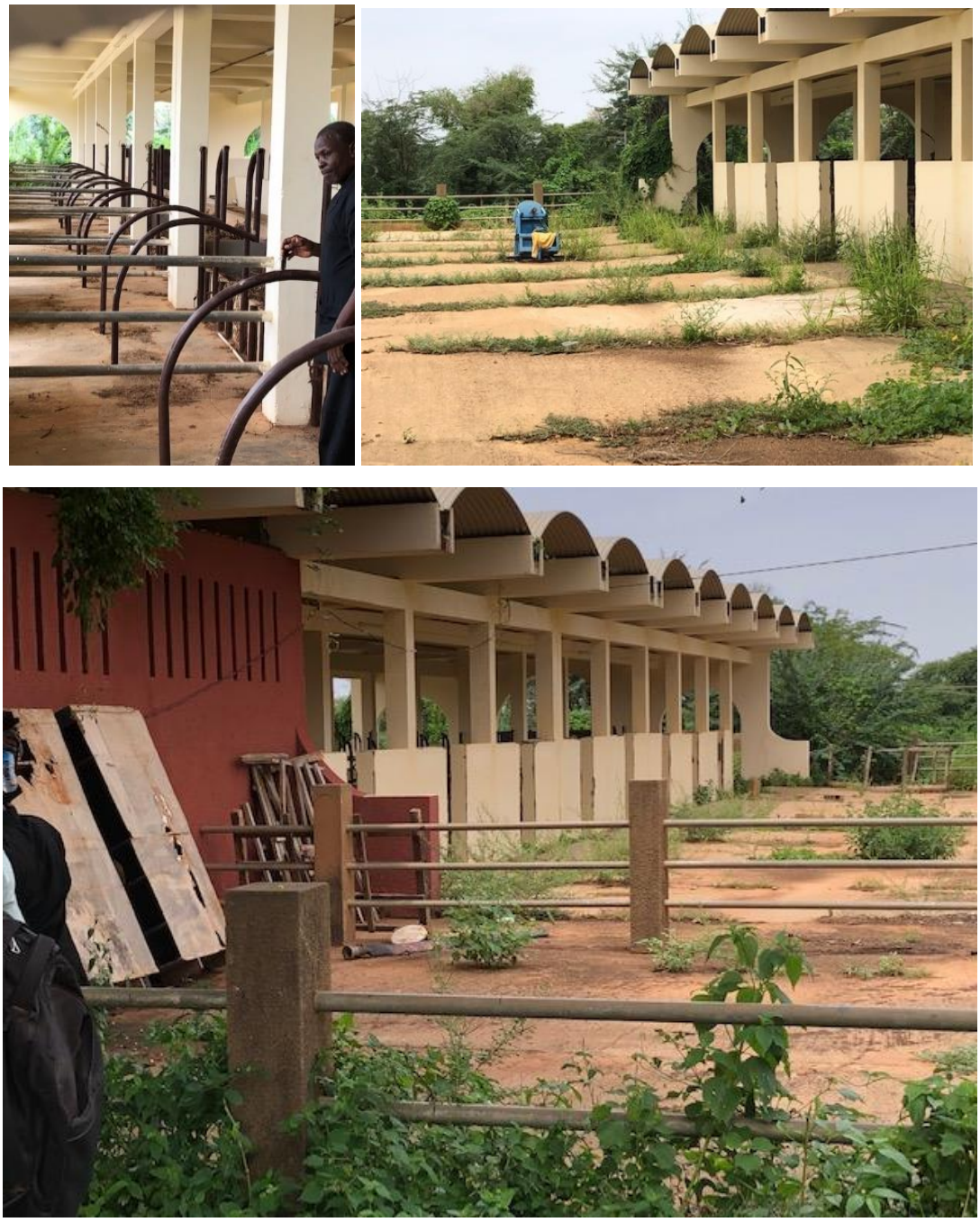


Figure 7 (a, b & c). Unused 48-stall facility for small ruminant feeding trials in Kollo.

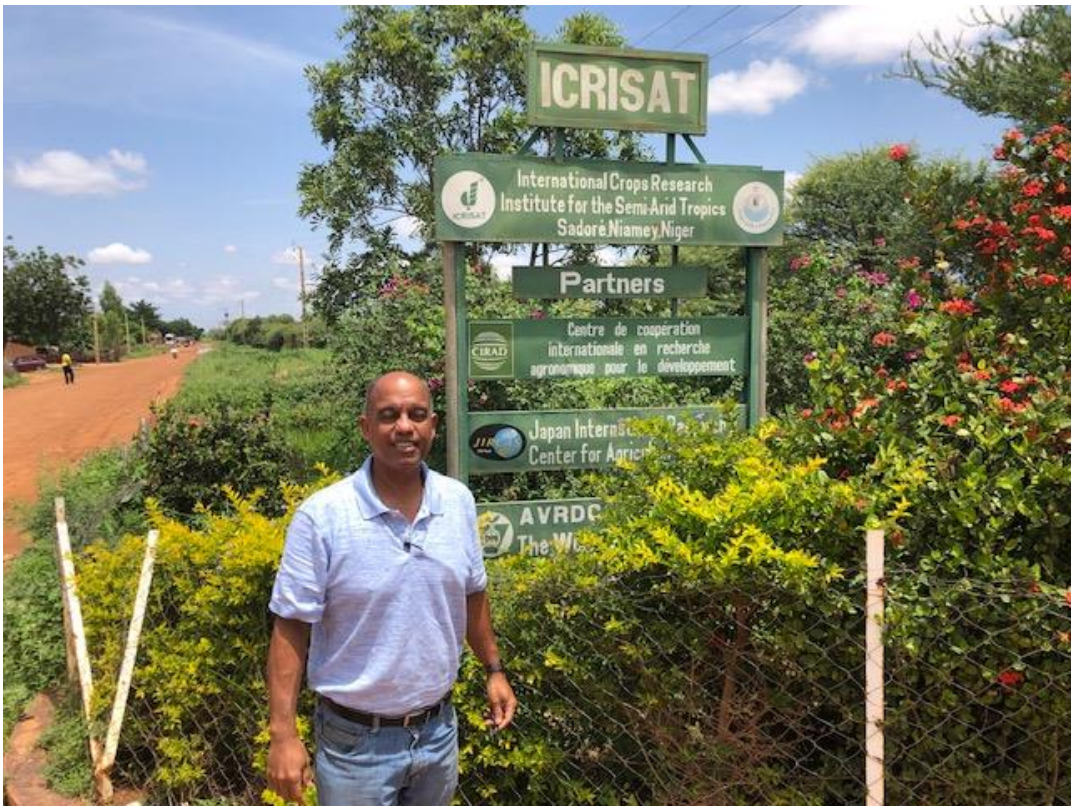


Figure 8. Mr. Fethiere, visiting ICRISAT's lab in Niamey, Niger

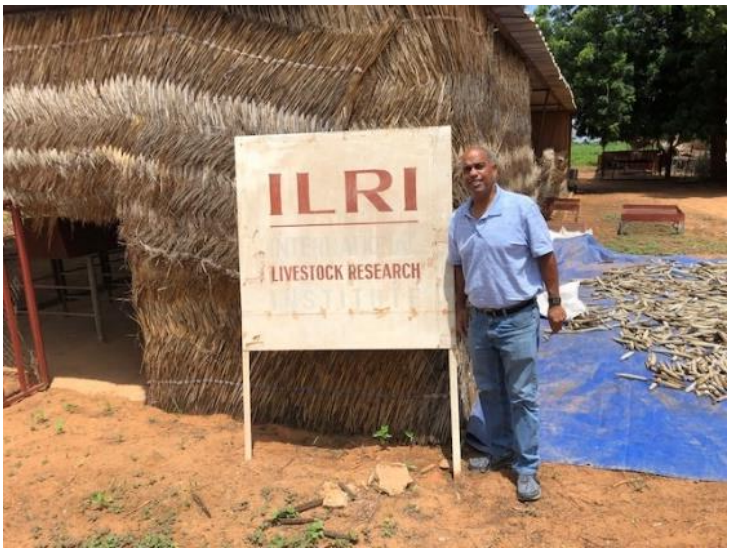


Figure 9. Mr. Fethiere, visiting ILRI's research station

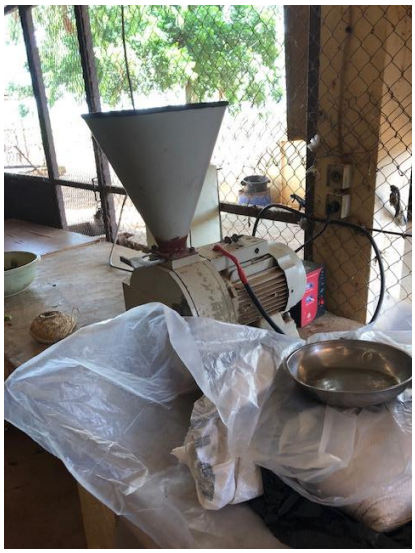


Figure 10. A grinder ILRI

There is a grinder at the ILRI facility that can be used to prepare samples for the research laboratories for analyses. However, the different sieves needed for the grinder should be available in order to be able to prepare samples of the right particle size of 4mm or 1mm. Samples were being cut with machetes instead of using a grinder.

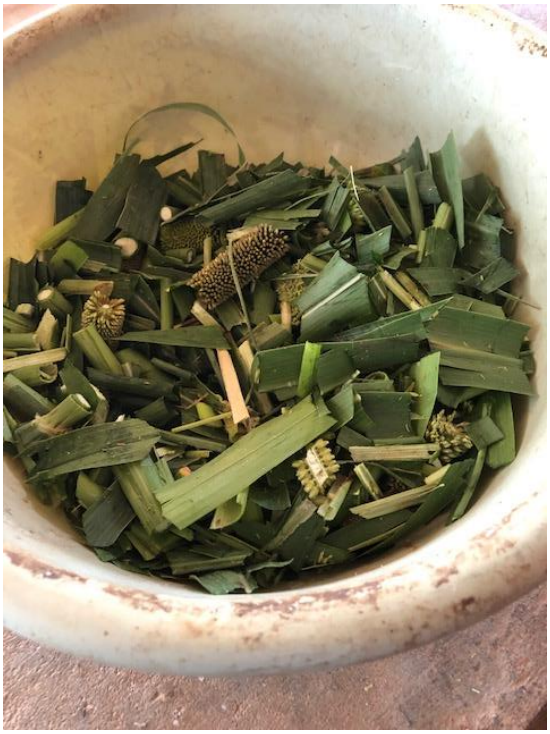
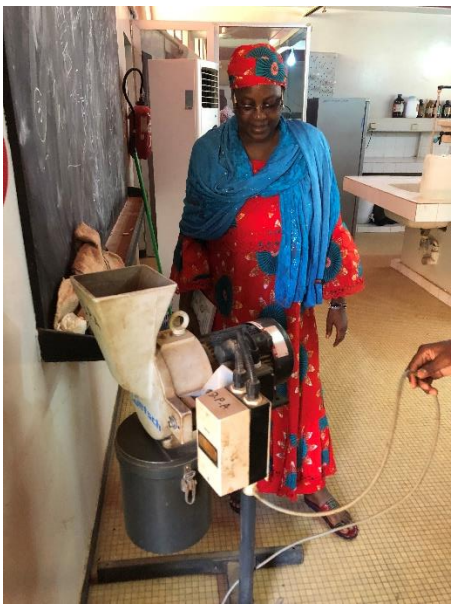


Figure 11. Samples cut to prepare silage on site.

The laboratory facilities at UAM were found to be generally well equipped. These labs have lab personnel and students who can conduct in research. However, the problem in these labs and other labs most of the time, seemed to fall into a need for more training in the basics of management, as there is an absence of trained lab managers in running efficient day to day lab operations. At AMU, for example, after the team inquired and inspected the state of some lab equipment, it was found malfunctioning. No one had consulted the operations manuals to try to troubleshoot the problems. The manuals existed in the lab director's office who pulled them from their folder, but they were never consulted. The fume hood existed but was not in use as it seemed no one really asked how they were supposed to operate or the current lab personnel was not yet in charge when the fume hood was originally installed. The group confessed that they were not aware that the fume hood had a blower and motor on the roof of the building that powered the unit. Further investigation of the fume hood determined that the motor did not turn on when was switched on. However, the lab director took immediate action to confirm that there was a motor actually on the roof and promised to have an electrician verify that it is plugged into the power grid and that the belt that turns the fan has the right tension and was not damaged, which would require replacement.



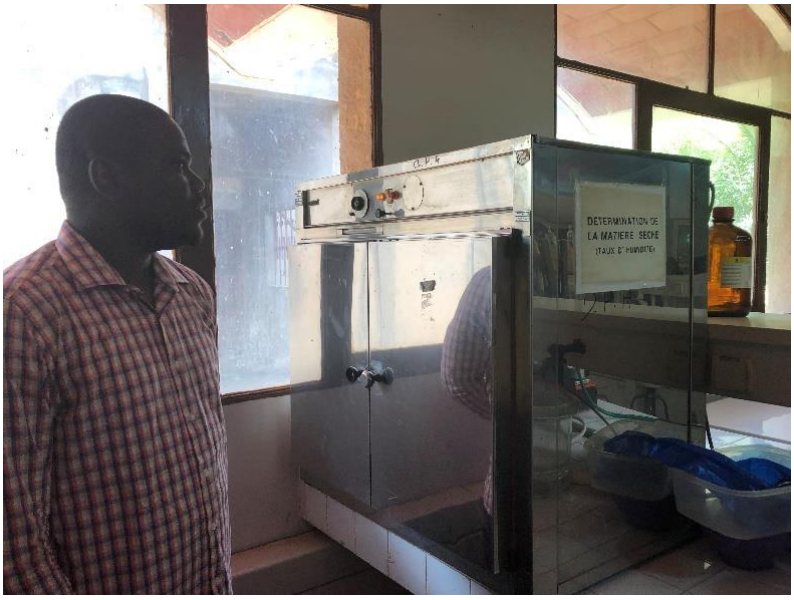
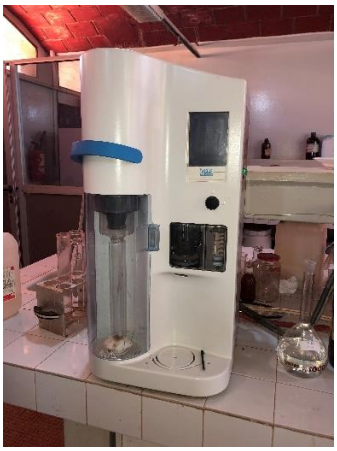


Figure 12 (a & b). Lab equipment at CRESA located in Niamey, Niger.



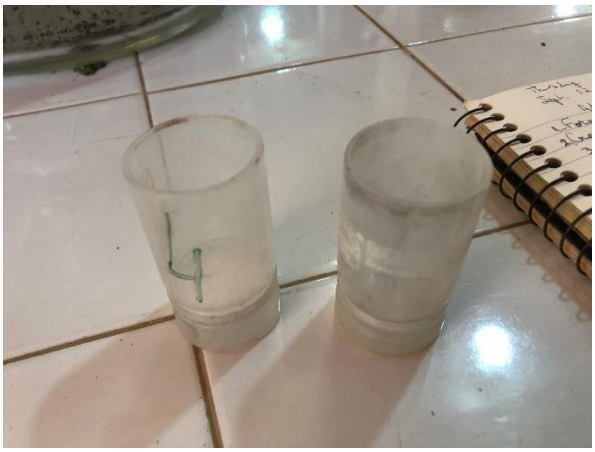


Figure 13 (a & b). Examples of weighing instruments in labs

Other training needs

Interviews with forage lab technicians illustrated that they were involved in preparing nutritional and proximate analysis tests in the laboratory setting. In addition to good lab management training, there is a need for reviewing procedures for weighing samples in the laboratory environment. Visits to different labs showed that technicians lack this skill, which could ultimately affect the results of the analysis. There is also a need for reviewing procedures for fiber analyses using the Ankom digester or using the traditional Van Soest procedure. Many Velp titration systems for Kjeldahl determination were malfunctioning. The lab technicians would need to consult the operations manuals to address the deficiencies in order to have them again in working order. Training focused on dry matter and organic matter determinations also appeared important for the proper operation of the lab from the analysis and testing aspects.

Lab-related courses in academia: Existing courses and potential new courses

In general, universities require the completion of math and science courses before enrolling in the lab courses, that are included in a certificate or an undergraduate degree program. However, some concepts that are important for lab courses, such as data analysis and lab techniques, sample collection, and handling and storage, are needed as pre-requisites to facilitate better learning and technical skills development. Course instructors should provide an introduction to the use and maintenance of laboratory equipment and safety procedures before users can access lab facilities to conduct any lab work. Measurement and calculation concepts should be reviewed along with scientific terminology related to laboratory procedures. Some basic concepts of chemistry should be also included with safety in mind in the course as students become familiar with toxicology and reaction hazards. To successfully conduct IVOMD analysis, basic microbiology concepts would be advisable to be incorporated in the course curricula. A new or revised lab course or a certificate program should be considered by UAM or another university in Niger guided by the main purpose of preparing the lab technicians to be comfortable in the lab environment and pass-on their knowledge and skills to users.

Recommendations

The recommendations presented below are focused on strengthening the human capacity of lab personnel and users, which is critical to re-start some labs or introduce better lab management procedures to improve the functionality of the lab environment, including the safety of lab procedures. Other issues described above (related to the state of lab equipment) are also important but to a lesser extent until lab personnel are trained to properly maintain and care for the lab infrastructure.

- Professional lab training focused on best lab management practices is needed for all lab personnel and users, including researchers, academics, and students. This training should be offered on an annual basis by labs. It is advisable to make this training mandatory for all new users of the lab.
- Professional training is also needed to reinforce the importance of managing the lab, especially as this relates to sample intake, processing, supply purchases and storage, equipment maintenance, manuals, procedures, inventory, safety, and disposal of hazardous waste.
- A specialized protocol training is needed in the area of analyzing N, DM, OM, NDF, ADF, ADL, energy, fat, IVOMD digestibility and NIRS. These topics could be integrated into the training curricula and offered for forage lab personnel. Combining training with a hands-on practice in a local lab will help learners to master the content of the training.
- All laboratory personnel should be required to take a refresher lab course. This should include upper management, lab directors, lab managers, and technicians. It is required for the following reason: problems can and usually start the minute some scientific equipment is purchased and an installation contract is signed with a distributor. When a distributor wins the bid, usually due to their offering the lowest price, one must ensure that training is included in the purchase contract and offered to the eventual operators and that a few first runs of the apparatus are included in that contract so the piece of equipment does not become an instant surplus. It does not reflect well on the institution receiving the equipment nor on the donor institution when valued equipment remains idle. All parties benefit from having a functional laboratory and well-trained personnel.

Conclusions

Over the course of the assessment, several forage and non-forage labs in Niger were visited. Most labs, especially the forage labs, have adequate facilities and are set up fairly well with equipment, reagents, and other

lab supplies to support forage research. The researchers (from universities and research entities) along with lab technicians and students have received the necessary academic training to conduct forage essays and trials in the field and bring samples into the laboratories. However, there is a need to implement major improvements in the day-to-day laboratory management and operations. Refresher trainings should be provided on a continuous basis that over time will equip lab personnel with the necessary professional approaches to sustain functional labs and maintain lab equipment and instruments.

In Niger, there is a dire need to increase the number of trained lab personnel as current labs are faced with steep competition from the private sector that offers higher salaries to lure the best talents toward the petroleum industry, the solar energy industry and others. As a result, the UAM administrators are now seriously considering adding a major or specialized training on laboratory management to prepare qualified lab managers, administrators and technicians.

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

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