Feedipedia
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Broadening Horizons
April 2020 #53

National Feed Security System: what it entails and making it operational in East Africa

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Introduction

Countries in East Africa have very high annual population growth rates – from 1.81 in Kenya to 3.92 percent in Sudan – and over the coming years, if production gaps are not addressed, these countries will become increasingly reliant on external markets for foods of animal origin (Alexandratos and Bruinsma, 2012). The reliance on external markets would be a missed development opportunity given the widespread benefits that could be generated by inclusive growth of the livestock subsector, particularly for dryland communities in East Africa (FAO, 2012a). Across the region, the increasing demand for livestock products has not yet been matched by a growth in production, implying that there are potential widespread benefits for both producers and consumers if the former can respond to this rising demand. Livestock are critical to incomes, livelihoods, nutrition, food security and resilience in much of East Africa.

In this region, livestock are largely reared in an extensive range-based system that depends on availability of pasture and water. This production system is constantly challenged by climatic variability. The seasonality of feeds and water means that people and livestock have to move to areas of greater availability of these resources, which is increasingly leading to resource-based conflicts, overgrazing and degradation of rangelands (Thornton, 2010) in East Africa. In addition, this herd mobility denies milk to women and children when herds move, exacerbating already poor nutrition among these vulnerable groups. However, poor animal nutrition due to inadequate supply of good quality feed critically limits the efficiency of livestock production and reproduction, their health and welfare, human health and the economic benefits derived from livestock-based livelihoods in the region. Livestock feed and feeding systems are constrained by a host of interconnected factors, including recurrent droughts, restrictions of livestock mobility, grassland degradation, overgrazing, land tenure and land use changes, resource use conflicts, encroachment of invasive plant species, soil infertility and inadequate inputs and planting material. Moreover, inadequate water management technologies such as non-application of climate information to guide decision making on water and fodder management, inadequate capacity building and networking of technical, academic and professional stakeholders to improve water and feed use efficiency and failure to increase water governance in watersheds in order to strengthen integrated water and fodder resources management aggravate the situation.

Seasonal feed shortages and inefficient feed use by pastoralist and agropastoralist communities are the major challenges affecting livestock productivity in

East African countries. In addition, poor feed conservation practices, lack of knowledge on appropriate feed and feeding practices, and inadequate data on estimates of the proportion/ number of animals kept within specific production systems constrain the efficient use of available feed resources. Pastoral destitution in East Africa is largely driven by feed and water scarcity, as the natural resource base in the rangelands is shrinking fast due to prolonged and more frequent climate extreme events.

This has been clearly evident in the last 10 years, with governments and partners investing heavily in livestock feeds and other inputs to protect livestock-based livelihoods in Djibouti, Ethiopia, Kenya and Somalia. The feed is the main driver of livestock production whereas animal reproduction and breeding, and animal health and welfare, play supporting albeit important roles. Feed can account for a major part of the total cost of livestock operation. In addition, poor feeding not only affects the productivity of the animal, but also its health, behaviour and welfare. Just as importantly, the safety and quality of the food chain can be affected because of the close link between feed, animal immunity and foodborne pathogens such as Escherichia coli, Salmonella and Campylobacter. The presence of mycotoxins, heavy metals and pesticides in feed can also adversely affect animal and human health and product quality and safety (Makkar, 2016).

In recent decades, increasing climate change and variability, recurrent droughts and conflicts have exacerbated the feed gap. The slow progress in the development of the subsector, particularly of alternative feed sources such as agro-industrial by-products and unconventional feed resources, has deepened the gap in the availability of and accessibility to animal feed. Given the severe impacts that poor access to livestock feed and water can have on local economies, livelihoods, and food security, actions should ideally be taken early, as soon as there are indications of future feed and water access challenges, in order to prevent, rather than respond to, food security and livelihood crises. With this in mind, early warning tools that forecast and monitor animal feed availability and livestock body conditions are needed to provide decision makers with timely data and information to predict when a crisis is coming and enable the on-time implementation of appropriate and well targeted livestock-related early actions.

Studies have shown that the early actions see high returns on investment. For example, an FAO study of an Early Warning Early Action project in northern Kenya found that the benefit-cost ratio was 3.5 (considering the value of the saved animal or its higher market value due to better body conditions, as well as the value of the additional milk available). When the costs of avoiding emergency humanitarian assistance and livestock restocking programs were also factored in, this ratio rose even further, to 9. This analysis illustrates the value that early actions can play during the beginning stages of a drought emergency (FAO, 2018). However, these early actions can only be taken with sound and timely information. A National Animal Feed Security System (NAFSS) that monitors animal feed and water availability, can play a vital role in alerting decision makers of the right time to implement early actions.

What is National Animal Feed Security System

The NAFSS is a complete set of an array of components, namely tools; and of procedures, facilities, skills, infrastructure, personnel, organizations, and institutions required to implement them. One of the major inputs for the tools is the feed related data, and rest of the components of the NAFSS play important roles in proper collection, handling and processing of the data and in dissemination of the analysed results. An equally vital role of institutions such as Ministry of Agriculture and Livestock and/or Central Statistical Bureau of countries is to integrate the NAFSS into their functions to sustain its operation so that early warning/early action data are timely available. The NAFSS is an integral part of the 'Big Data' that many countries are aspiring to establish to formulate informed policies and strategic decisions, resulting in livestock production systems that are more efficient, environment friendly and resilient to droughts and other emergencies.

Recently FAO and IGAD joined hands in establishing and strengthening the NAFSS in East African countries. This effort has emanated from the East Africa Animal Feed Action Plan (FAO and IGAD, 2019), the formulation of which was spearheaded by these two organizations, jointly with a number of national and international partners. The NAFSS was presented to Member States (MS) of IGAD (Djibouti, Ethiopia, Eritrea, Kenya, Somalia, South Sudan, Sudan, and Uganda in Nairobi in February 2020, and the major pillars of this System are the three tools: a) Feed Inventory and Feed Balance, b) Predictive Livestock Early Warning, and c) Feed Security Assessment. A snapshot of these tools and their linkages are shown on Figure 1.

Feed Inventory and Feed Balance

Efficient use of available feed resources is key to productive animal production and food security. However, it is impossible to effectively manage a resource if its availability/supply is not known (Makkar and Ankers, 2014). Additionally, increasing demand for livestock products at the global, regional, and local levels is imposing strong pressures on limited resources. With this in mind, the sufficiency of a country's feed supply can ultimately only be gauged relative to its demand. To better understand these, comparison between supply and demand, called an animal feed balance can be created and analysed. Advantages of feed inventory and feed balance for countries have been discussed in our earlier articles (FAO, 2012b; Makkar and Ankers, 2014; Makkar et al., 2019).

Piloting this methodology, animal feed balances have been developed and are now available for the regions of Ethiopia (Makkar et al., 2019). Similarly, feed balances are available for the 23 arid and semi-arid land (ASAL) counties of Kenya as of August 2018. For other countries in the Horn of Africa, however, feed inventories and balances are not yet available despite their strategic role for livestock development opportunities. Given this gap, the FAO and IGAD are embarking to improve on the current FAO animal

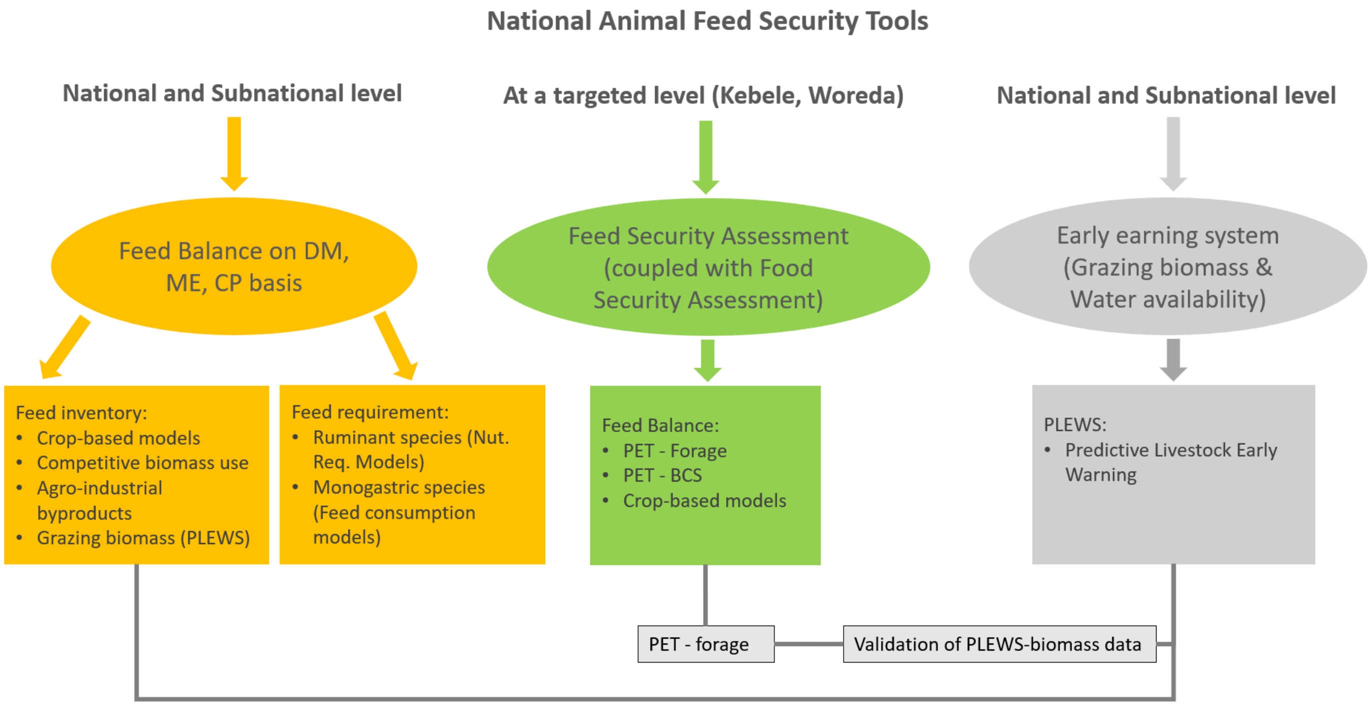

Figure 1. National Animal Feed Security Tools (DM, Dry Matter; ME, Metabolizable Energy; CP, Crude Protein; PET, Pictorial Evaluation Tool; BCS, Body Condition Score; PLEWS, Predictive livestock Early Warning System)

feed methodology and then expanding its use to other countries in the region, in addition to institutionalizing the methodology into existing early warning systems.

It should be noted that since the original FAO methodology was published in 2012, operational templates and working procedures for estimating animal feed inventories and balances are now available, which have been validated and used in Ethiopia and Kenya. Additionally, the new Predictive Livestock Early Warning System (see below) model based on remote sensing has been developed and can serve as an inexpensive and regularly updated source of information on rangeland biomass availability. Geostatistical integration of simulation model output and remote sensing data , are also being employed to interpolate forage availability across constituent zones (Angerer et al. 2014, Matere et al. 2019). As part of the NAFSS, these new innovative approaches will be incorporated into the methodology and scaled up, informing the national feed inventories and balances across the IGAD region.

Predictive Livestock Early Warning System

The mapping of zones and systems at risk of feed and water scarcity is important for providing early warning and better planning for early response to emergencies associated with droughts. This information can also assist in designing appropriate value-chain development programs.

This type of mapping can be visualized by the Predictive Livestock Early Warning System (PLEWS), a decision support tool that can provide near-real time estimates of edible vegetation and statistically project conditions for up to six months into the future. The PLEWS was initially developed by Texas A&M University, at the request of the National Drought Management Authority (NDMA) of the Government of Kenya, in order to support the development of an additional early warning indicator that would improve the evaluation of triggers for drought response on rangelands. In addition to Kenya, the system is currently being used in the United States, Mongolia, and Peru.

In Kenya, PLEWS is used in conjunction with the vegetation condition index (VCI), the standard precipitation index (SPI) and monthly socio economic data collection to trigger government-led drought response aimed at preventing livestock losses and protecting gains made in pastoral and agro-pastoral communities. The predictive component of the tool was pivotal in demonstrating to the Government of Kenya the likely severity of the 2017 drought and was used to justify the declaration of a national emergency.

An advantage of PLEWS compared to other feed assessment approaches is that its fully automated near real-time nature provides estimates of forage and water availability without the high costs associated with traditional, on-the-ground data collection. The data on rangeland biomass availability obtained by PLEWS can be integrated into the assessment of feed inventory and feed balance (Figure 1). Unlike other remote sensing tools, PLEWS is also innovative in two key ways: 1) the model enables the statistical projection of future rangeland forage conditions, rather than just reporting current conditions, which provides earlier early warning for response programming, and 2) unlike the Normalized Difference Vegetation Index (NDVI) which measures vegetative greenness, PLEWS is able to exclude inedible species and takes into consideration the specific feeding preferences of different livestock species through the use of the PHYGROW model.

The PLEWS uses remote sensing data from the GeoEye and Land-Sat 8 OLI satellites to aid in identification of rainfed livestock water ponds/pan, as well as to assist in delineation watershed contributing areas to parameterize the water balance model for monitoring livestock forage conditions. The satellite imagery is also used to identify sites for PHYGROW modelling of forage on offer for livestock. Geostatistical methods are used to integrate remote sensing and PHYGROW model outputs to produce maps of forage biomass availability. Outputs are also used to produce early warning products such as the Forage Condition Index (FCI) which compares current or forecast forage condition to the long-term high and low values for the last 20 years (Matere et al., 2019). The Forage Condition Index (FCI) has been validated in the field by FAO and has been found to have a 96% correlation with ground vegetation levels (Matere et al., 2019).

In Kenya, forage condition maps are produced monthly, at high resolution (ward level) for current pilot project areas and at low resolution (county level) for the rest of the country. Prior to dissemination of the maps for use in decision support, thorough triangulation of FCI results is undertaken through the use of key informants, IGAD drought website, Vegetation health condition (VHI) and Vegetation Condition Index (VCI) to evaluate correlation between PLEWS, ground conditions, and remote sensing products. This can aid in defining where discrepancies exist and where monitors may need to be dispatched to further evaluate conditions. The PLEWS maps can also be collated to generate a trend analysis for easy visualization, as presented below in Figure 2.

For PLEWS, the data are collected through training of country feed inventory data collectors to validate forage conditions in their respective areas using the Land Potential Knowledge system (LandPKS), an open source application. This entails collection of both plant communities and soil analysis data that are then used in simulations models to produce preliminary biomass estimates in tonnes per hectare. This set of data is subjected to further analyses using both national land use databases and local knowledge to screen out non grazable sections. The PLEWS also contributes to feed biomass, an essential component of the feed inventory (Figure 1).

Under this effort to establish the feed inventory for rangeland and pastureland in Kenya and other IGAD countries, GIS techniques will be employed to aggregate the total forage biomass estimated by PLEWS within administrative boundaries of a country. Subsequently, land areas having very steep slopes (>60%) or non-rangeland land uses (e.g., cropland, urban areas, bare soils, national parks, etc.) are screened and removed from the biomass

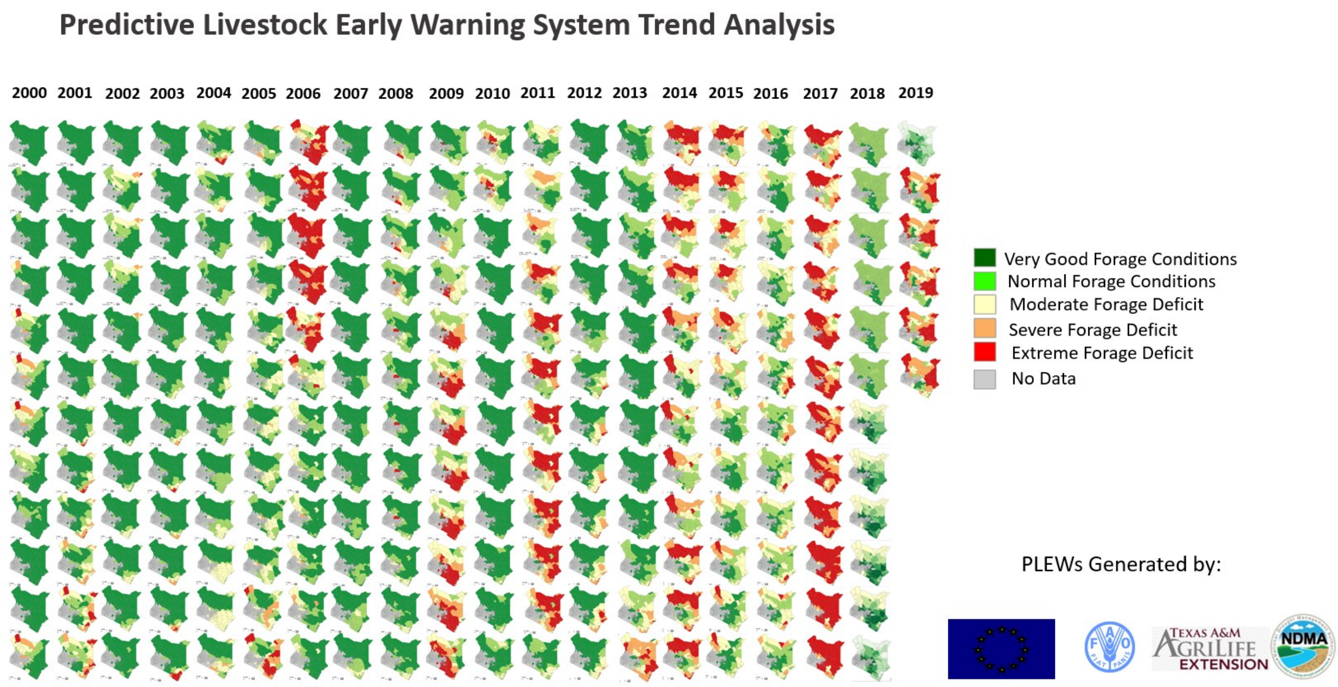

Figure 2. Trend analysis generated using PLEWS for Kenya for the last 2 decades

assessment. The aggregated forage amount for each administrative unit serves as the "supply" component for the feed balance on rangelands.

The future potential for PLEWS to be used to inform timely decisions about livestock and food security interventions is significant. For example, research has found that FCI provides exceptional insight into the relationship between available livestock feed, predominant source of household income, and child malnutrition. Additionally, food security analytical systems, such as the Integrated Food Security Phase Classification (IPC), are continuously seeking to improve the quality of their food security projections, and the predictive nature of PLEWS could enable it to play a pivotal role in these analyses.

Given the successes of PLEWS in Kenya and the current piloting of the tool in South Sudan, FAO jointly with IGAD seeks to expand and institutionalize the model throughout the IGAD region, making it a key input for Early Warning Early Action programmes, as well as other food security early warning systems.

Feed Security Assessment

The feed security assessment is a key element in the early warning system that would assist donors, international and national agencies and livestock farmers to better plan the feed requirements for the drought as well as the normal periods. Recently FAO has developed two approaches for assessing feed security situation. One is for assessment of feed security at a community level -- could be a ward, sub-county, county by livelihood zone; while the other one is for the assessment at the household (HH) level. There has been a demand from many countries for an approach for Feed Security Assessment that could be integrated with the Food Security Assessment and can be conducted by the same team that does the Food Security Assessment twice a year.

Both these approaches integrate the Pictorial Evaluation Tool (PET) for grazing biomass and animal body condition assessments. The PET can only assess feed availability in the grazing land and currently for maize and sorghum crop residues. Although crop residues are many and varied across East Africa maize and sorghum stovers are left standing in the field after harvest; therefore, allowing them to be easily inventoried via PET. Other feed inventory tools are also needed to assess the total availability of feeds, especially for the assessment in agro-pastoral and mixed systems. Furthermore, feed balance tools also needed to be integrated for calculation of the duration for which the available feed would be enough for the number of animals in the area under assessment.

The second approach of assessing feed security at the HH level (when used in conjunction with other approaches that capture information on livelihood and nutrition at the HH level) could be used to understand the relationship between livestock feed availability, animal source food production, human nutrition and livelihood. The information generated would assist planners to give due weightage to livestock production in relation to human nutrition and livelihood of livestock farmers including pastoralists. The HH level feed security assessment when conducted in representative households can also reflect the feed security situation of a village, ward or a sub-county. Such assessments conducted in several wards/sub-counties, on aggregation, reflect the feed security assessment of a livelihood zones.

The Pictorial Evaluation Tools (PET), an integral part of the feed security assessment enables quick, quantitative, objective, and evidence-based scoring of livestock body conditions and the evaluation of grazing pasture based on field observations. These tools can be used to identify negative changes in herds and pasture conditions over time and space, and can provide the needed ground truthing, through rapid assessments, to inform early warning and actions.

To assess the livestock body condition, the PET methodology presents users with photo indicators of cattle, goats, fat-tailed sheep, long tailed sheep and camels in a progressive series of body conditions, ranging from very thin to very fat for each species. The body conditions scoring follows a '1' to '5' grading system developed in Australia for domestic livestock over 40 years ago. The traditional Australian practice involves both observation and palpation of flesh in key areas of the body for all stock. However, the PET approach offers a simplified and modified version suitable for use in ranges, based on the critical observation of one highly visible target spot or feature in the body that can be accomplished by a quick look at the animal and without touching it.

Similarly, PET-Forage can be used to estimate current grazing availability by comparing areas of the pasture under observation, during a transect walk in a W-shape through a field, with photo indicators of known levels of production. These estimates are also cross-checked against the observed dry mass of a sample one square meter area that is harvested, dried, and weighed. The forage biomass data obtained using PET -Forage could also be used for validation of PLEWS data (Figure 1).

Given that poor pastoral conditions and livestock body conditions can often be key drivers of food insecurity in agropastoral or pastoral areas, the PET methodology can provide early warning of a possible food security crisis, enabling interventions before household livelihood assets are depleted or food consumption gaps and acute malnutrition are observed. Based on the PET-based forage biomass assessment and body condition score and on the feed requirement calculations based on Tropical Livestock Units, TLU (1 TLU = 250 kg body weight and feed requirement being 2.5% of the body weight), if the feed availability is for a duration of 3, 2 and <1 month of drought period, the severity of feed insecurity can be categorised as 'Minimal', 'Stressed', and 'Crisis' respectively. The body condition score approaching 1 would also designate feed insecurity as 'Crisis'. Where possible, body condition score should be assessed on a regular basis, which could be taken as a proxy for feed availability when a large set of data on body condition score has been realised. A large set of such data depicting the trends would increase reliability of such an assessment.

Operationalisation of the National Animal Feed Security System

In addition to the tools, operationalisation would require procedures, which have been laid down based on the past experiences of implementation of the tools in several countries. The templates and standard operational protocols are available with FAO and these need to be adapted in consultation with the East African countries. Capacity to use these tools and procedures, manage data and analyses, draw policy options based on the analyses would be built through conducting training workshops by FAO and IGAD. Staff that participate in these workshops would be from the Ministry responsible for the livestock development, statistical bureau, private sectors such as the feed industry, feed manufacturers associations, research organizations, academic institutions, subnational offices responsible for livestock operations, including departments such as animal production, plant breeding, remote sensing, geographic information systems, rangeland development, community representatives and forage breeders. Policy makers and science managers would also be involved in operationalisation of the NAFSS. The dissemination of the analyses and findings to stakeholders such as pastoralists, feed industries, farm equipment manufacturers, ministries and donors among others would be the next logical steps to generate impact at the grassroot level. Equally important would be to develop feed-related technological innovations keeping in view socio, cultural and economic aspects. For this, a prudent and sustainable approach would be to foster public-private partnerships, and FAO and IGAD could play an important role in realising this.

Different parts of NAFSS could be hosted, driven and coordinated by different organizations; for example, the Ministry responsible for livestock development could take responsibility for the Feed Balance; the Organization responsible for the drought management (e.g. National Disaster Risk Management Commission (NDRMC), Ethiopia; and National Drought Management Authority, Kenya) could host the PLEWS and Feed Security Assessment. The latter could also be driven and hosted by the Ministry responsible for the livestock development. The final decision on who should host the NAFSS and be responsible for its operation lies with the governments of the IGAD MS and may vary from country to country. Whatever the arrangement in a country is, the three major components of the NAFSS should function under the same umbrella in a transparent manner and with good communication among each other. Operationally also these are interlinked (Figure 1) and complement each other and are synergistic. Normally the operational domain and functionality of Feed Inventory and Feed Balance and

PLEWS are at a national, regional and/or subnational level, while those of the National Feed Security Assessment are at a local level; for example, Woreda, Kebele, village or district (Figure 1), as envisaged under the current FAO and IGAD project (although collation of the data from the smaller administrative units can also lead to higher administrative unit or national level data). When operational, frequency is highest and time response lowest of obtaining analyses for PLEWS followed by National Feed Security Assessment and then Feed Inventory and Feed Balance.

For sustainability of the NAFSS, it is vital that the three components get embedded into the functions of the host or responsible institution and must have designated task force and financial resources. The policy makers and science managers should see value in the exercise and wholeheartedly support functioning of the NAFSS.

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