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Year round feed and fodder availability in smallholder dairy farms across high and low altitude areas in Eastern Africa

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Abstract

An understanding of seasonal variation in availability of feeds and fodder resources is important in future planning and development of appropriate technologies to ensure resilience of smallholder dairy systems to seasonality driven milk fluctuations. It is against this context that this study was carried out to: 1) evaluate the current pattern of seasonal variation in feed and fodder availability in smallholder dairy farms across high and low altitude areas of Kenya and Tanzania in Eastern Africa; and 2) assess seasonal variation in year-round feeds and fodder based feeding strategies in smallholder dairy farms across the high and low altitude areas of Kenya and Tanzania in Eastern Africa. Data was collected from a purposive representative sample of 400 smallholder dairy farmers using the Feed Assessment Tool (FEAST) through cross sectional survey and observational study from 2016-2018 to capture the season's effect (wet and dry). Data was analyzed using the general linear model procedure of SPSS version 21.0 and FEAST Version 2.21. Results showed that location (country), agro-ecological zone and season were significant ($P \leq 0.05$) on rainfall variability throughout the year. Further, country, agro-ecology, seasons, production systems and their interaction were significant ($P \leq 0.05$) on year-round availability and utilization of concentrate feeds, green and dry crop residues, improved fodder, natural grass and legume forage. Rainfall variability was crucial in determining year-round variation in availability and utilization of feeds and fodder. Correlation between the feeds and fodder resources revealed highly significant ($P \leq 0.001$) positive relationships across the two countries, pointing further to the dynamics of seasonality change effects. In conclusion, different seasonality driven site/region/country specific year-round feeding/supplementation strategies could be applied depending upon the type, availability of feeds and fodder to overcome seasonal milk fluctuations in smallholder dairy farms in Eastern Africa.

Key Words: Agro-ecology: Feeds and Fodder: Seasonal Variation: Utilization: Year-round

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Introduction

Feed-year strategies involve matching the cycles of dairy production with the changing availabilities of all sources of nutrients over time [1]. Locally available feed resources have to be consistent with the diverse production objectives of farmers and with the feasibility of achieving the nutritional support required [2]. These in turn vary seasonally with farmers' bio-physical, socio-political, economic and environmental circumstances [3]. Therefore, understanding seasonal variation in feed resources [4] is important in future planning and development of appropriate technologies/strategies to ensure resilience of smallholder dairy systems to seasonality driven milk shortages [5], [6]. Based on this context, the objectives of this study were to: a) evaluate the current pattern of seasonal variation in feed and fodder availability in smallholder dairy farms across high and low altitude areas of Kenya and Tanzania in Eastern Africa; and b) assess seasonal variation in year-round feeds and fodder based feeding strategies in smallholder dairy farms across the high and low altitude areas of Kenya and Tanzania in Eastern Africa.

Material and Methods

Study location: Four distinct locations representing the highlands and lowlands agro-ecologies were selected, namely Mbulu (highlands) and Karatu (lowlands) in Manyara region of Tanzania; and Kakamega (highlands) and Siaya (lowlands) in Western region of Kenya. Karatu lies in latitudes 3.3454°S and longitudes 35.6697°E. Mbulu lies in latitudes 4.0805°S and longitudes 35.5466°E. Siaya lies in latitudes 0.0998°N and longitudes 34.2747°E, while Kakamega lies within latitudes 0.2827°N and longitudes 34.7519°E.

Data Collection: The Feed Assessment Tool (FEAST), which is a systematic method to assess local feed resource availability and use (www.ilri.org/feast) was used for data collection [7], [8]. FEAST qualitative data was collected through participatory rapid appraisal (PRA) and focus group discussions (FGD) [3]. Farmers were identified and classified into four categories (wet and dry seasons in highlands agro-ecology and wet and dry seasons in lowlands agroecology) in both Kenya and Tanzania. In each agroecology (highlands and lowlands), 18 farmers (12 men and 6 women) were selected for the survey, giving a total of 108 farmers in all the two countries. The PRA was followed by quantitative data collection carried through individual household interviews using a pre-tested structured questionnaire from a purposive multistage random [9] sample of 400 smallholder dairy farmers, 100 each for the highlands and lowlands agro-ecological zones in the two countries. Information from cross sectional survey was validated through a purposive observational study covering two seasons (wet and dry) in the study locations between July 2017 and June 2018, to monitor and capture the seasonal/year-round variations in fodder and feed sources including utilization in the study areas

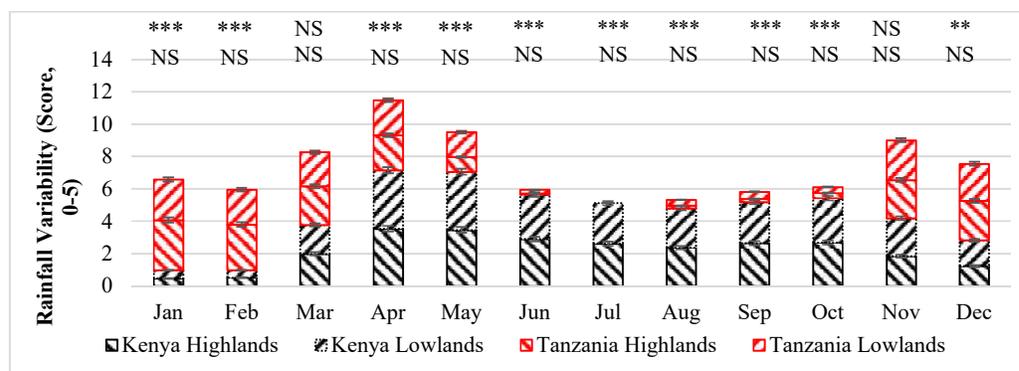
Verification of data collection method: During the cross sectional survey, the dependent variables were scored on a five point scale of 0-5 (where 0=none; 1=moderately low; 2=low; moderately high; 4=high and 5=very high) and validated during the wet and dry seasons of observational study. Verification of the method was achieved through comparison of farmer estimates of monthly rainfall, scored on a five point scale of 0-5 and actual normalized meteorological measurement of monthly rainfall. The farmer estimates and normalized rainfall data were almost similar, an indicator that the method was valid and highly applicable for this study, as it was un-biased and non-subjective [3].

Data analysis: Independent variables comprised location (country), seasons (wet and dry), agro-ecological zones (highlands and lowlands) and production systems (intensive, semi-intensive and extensive). While, dependent variables comprised five (5) point scale farmer estimates of monthly rainfall and locally available fodder and feed sources. Analysis was done using MANOVA

(Multivariate analysis of variance) at 95% Confidence Interval (Significance $P \leq 0.05$) to find out the effect of independent factors on dependent variables. Means were compared using least significant difference (LSD). Further, Pearson's correlation was carried out to find the association/relationship between the different feeds and fodder sources.

Results and Discussion

Rainfall seasonality: Country was significant ($P \leq 0.001$) on the rainfall received throughout the year (Figure 1). There was significant difference ($P \leq 0.001$) in rainfall received between Kenya and Tanzania most of the year, except during the months of March and November (Figure 1). Tanzania received more rainfall from the months of November–March compared to Kenya (Figure 1). On the other hand, Kenya received more rainfall during the months of April to October compared to Tanzania. Similar monthly rainfall was received across the highlands and lowlands agro-ecological zones of the two countries. Rainfall variability throughout the different months yearly was a confirmation of seasonality driven changes in the two countries. Overall across the two countries, wet season period peak long rains were in April, while peak short rains were in November. The dry season period with very minimal or no rains was between June–September for Tanzania and December–February for Kenya (Figure 2). Rainfall variability influences seasonal fluctuation in quantity of feeds and fodder available and utilized, as similarly reported by [10].

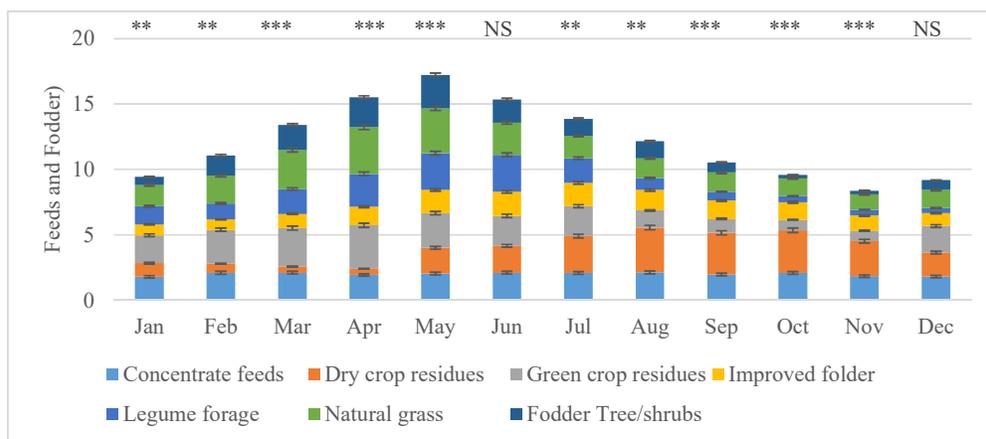


NB: NS=Not Significant; *** Significance level ($P \leq 0.001$); **Significance level ($P \leq 0.01$)

Figure 1. Rainfall variability (score, 0-5) in the highlands and lowlands areas of Kenya and Tanzania (95% CI) during 2016/17 and 2017/18

Trends and association in year-round feed and fodder availability in Eastern Africa: Effect of country, agro-ecological zone, feed and fodder type and interaction between country and feed and fodder type were significant ($P \leq 0.05$) on availability and utilization of feeds and fodder in Kenya and Tanzania (Figure 2). Overall, with exception of concentrates feeds, the other feeds and fodder resources varied greatly by country and rainfall pattern (Figure 2). The mean difference significantly ($P \leq 0.05$) showed that Tanzania had more feeds and fodder availability and utilization from January to May, while in Kenya from July to November (Figure 2). Variation in feed and fodder sources, availability and utilization during the dry and rainy season period and correlation with rainfall variability in this study, agree with many authors who have reported acute shortage of feed supply during the dry season and the available feed during this period is of very poor quality [11]. There was considerable variation in the availability and utilization of crop residues from dual-purpose food crops by type (green or dry) across highlands and lowlands of Eastern Africa. Similar findings were reported by [12], that the availability of feed on a dry matter basis from the above groups of crop residues has varied during the last two decades. Green feeds and fodder resources

(as opposed to dry ones) were positively correlated in both the highlands and lowlands of Kenya and Tanzania. There was a highly significant ($P \leq 0.001$) correlation (coefficient of determination, $R^2 \geq 0.75$) between improved (planted) fodder and natural pastures in both the highlands and lowlands of Kenya. This implied that an increase in improved fodder resulted in a tandem increase in natural pastures and vice versa. This scenario was explained by their dependence on the rainfall pattern (Figure 1). Similarly, there was highly significant ($P \leq 0.001$) positive correlation ($R^2 \geq 0.60$) between improved fodder and natural pastures with green crop residues, legume forage and fodder trees/shrubs in both the highlands and lowlands of Kenya. Results also showed highly significant ($P \leq 0.001$) positive association ($R^2 \geq 0.60$) between natural pastures, green crop residues, forage legumes and fodder trees/shrubs in both the highlands and lowlands of Tanzania in response to rainfall variability



NB: NS=Not Significant; *** Significance level ($P \leq 0.001$); ** Significance level ($P \leq 0.01$)

Fig.2. Overall trend in year-round feeds and fodder availability and utilization (95% CI) in highlands and lowlands of Kenya and Tanzania

Conclusions and Outlook

Evidenced from this study, year-round feed planning and budgeting, coupled with effective utilization of the available feeds and fodder, based on site/region specific seasonal availability trends, appear to be the necessary steps to alleviate the nutritional problems of dairy animals. The new knowledge gained with this study on variations in feeds and fodder sources, utilization and responses to environment factors can be incorporated into models of strategic optimization of dairy cow feeding strategies for overcoming seasonal milk fluctuation in Eastern Africa.

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Compliance with ethical standards: All procedures performed in study involving human and animal participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest: The authors declare that they have no competing and/or conflicting interests

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