

Livestock feed markets across seasons in periurban areas of Niger: seller and buyer profiles, feed price and quality

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Keywords

Peri-urban agriculture, feeding systems, feed resources, prices, nutritive value, Sahel, Niger

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Summary

Livestock productivity in West African Sahel is constrained by seasonal scarcity of feed and by its low quality in the dry season. Feed resources scarcity in the region has also been aggravated by the increase in livestock population, which has heightened the demand for feed, particularly in periurban areas. Livestock feed markets have thus sprung up in many cities and towns. To understand the dynamics of these markets, surveys were conducted in five of them in Maradi and five others in Niamey, Niger, in the early dry season (October-November 2019), late dry season (March-June 2020), and wet season (August-September 2020) with a semi-structured questionnaire. Results showed that diverse feed types were sold or bought, and mainly by adult male vendors or buyers, in both markets across seasons. The buyers gave as major reasons for purchasing livestock feed the insufficient household feed biomass, the poor-quality household feed, and the need for supplementary feeds to maintain and improve animal performance. Prices of livestock feeds at both markets varied significantly with season, market location and feed type. In both sites, prices of legume residues (cowpea hay, cowpea husk, groundnut haulm) were higher than the other feed types. Results further showed that there was no clear relationship between price and nutritional quality across seasons.

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■ INTRODUCTION

Livestock productivity in West African Sahel is constrained by seasonal scarcity of feed resources and, often, by their low quality in the dry season (Amole et al., 2022a). The marked variation in the availability and quality of feed resources largely explains the perennial cycles in ruminants of weight gain in the wet season and weight loss in the dry season by (Ayantunde et al., 2001). Addressing the challenge of feed scarcity will improve livestock productivity and thus enhance livelihoods of crop and livestock smallholders in the region.

The feed gap in the region has also been aggravated by the increase in livestock population (Ayantunde et al., 2014) which has in turn increased the feed demand, particularly in periurban areas. Therefore, there has been a rising trend in feed purchase, particularly by livestock keepers in periurban areas; prices may vary with season, market location and feed type (Graef et al., 2008). Many feed markets have thus emerged across West African Sahel. “[They] are usually located near livestock markets and they mainly sell crop residues, agricultural by-products such as cotton-seed cake and cereal bran, and concentrate feed from the small-scale feed mill” (Ayantunde et al., 2014; Doamba, 2020).

This study adds to the body of knowledge on livestock feed marketing in West African Sahel (Amole et al., 2022a; Ayantunde et al., 2014; Doamba, 2020; Jarial et al., 2016; Wane et al., 2010; 2014). In that region, livestock feed marketing can be at livestock markets, along roads, in agrodealer shops particularly agro-industrial by-products, at small-scale feed factories for concentrate feeds or at farm gate where crop residues are sold directly to nearby farmers (Amole et al., 2022a). This study also provides additional information on the

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feed value chain in the region which is rapidly developing though still weak according to Traore (2016); this author reports in a study conducted in Yatenga Province of Burkina Faso that the feed value chain consists mainly of actors such as collectors, transporters, wholesalers, retailers, and buyers. Strengthening the feed value chain in the region can provide livelihood opportunities for both rural and urban-poor populations.

The objectives of this study were to characterize the livestock feed markets and collect information on the price of livestock feeds at different markets across seasons in periurban areas of Niger to inform and guide the development of cost-effective strategies to improve animal nutrition and livestock productivity based on locally available feed resources. The conceptual model underpinning this study is presented in a simplified form in Figure 1 based on previous works on livestock feed price in West African Sahel (Ayantunde et al., 2014; Doamba, 2020; Wane et al., 2014). Some other factors that could affect livestock feed prices, e.g. government policies such as subsidy, infrastructure for feed storage before sale, origin and volume of feed supply in markets, are not considered in this study. In line with the conceptual model, our hypothesis was that the price of livestock feed varies with season, feed type and quality.

■ MATERIALS AND METHODS

Surveys were conducted in five feed markets each of Maradi and Niamey in the early dry season (October-November 2019), late dry season (March-June 2020), and wet season (August-September 2020) using a semi-structured questionnaire. The feed markets surveyed in Maradi area were Kassoua Mata, Karazome, Tarna, Kara, and Tacha Dakoro, whereas in Niamey area they were Koira Tegui, Wankama, Harobanda, Tourakou, and Guessel. About ten feed vendors were randomly selected in each market and interviewed on the price of the feeds sold in each season. In addition to the inventory of the feeds and their prices, feed samples were collected for laboratory analysis to determine their nutritional quality. About ten feed buyers were also randomly selected in each market and interviewed on the reasons for feed purchase and on purchase frequency. Using the dominant language in each area, interviews were conducted in Hausa in Maradi, and in Djerma in Niamey, by two enumerators on each site.

The feed samples collected from the markets were analyzed by near-infrared reflectance spectroscopy (NIRS) after grinding (2 mm sieve) for dry matter (DM), ash, total crude protein (CP), fiber

components (neutral detergent fiber [NDF], acid detergent fiber [ADF] and acid detergent lignin [ADL]), metabolizable energy (ME) and in vitro organic matter digestibility (IVOMD). CP was estimated from nitrogen content (N × 6.25). Data analysis was performed with SAS (1987) using means and frequency procedures for descriptive statistics. General linear model (GLM) procedures for variance and regression analyses were used to assess the relationships between market location, season, and price. GLM was also used to determine whether there was a relationship between feed price and nutritional quality. For analysis of the variance model, response (dependent) variables were price and nutritional quality (DM, ash, CP, fiber components, ME and IVOMD), whereas market location, season and feed type were the independent variables. Unless specified otherwise, the level of significance was set at p < 0.05.

■ RESULTS

Feed sellers and buyers' profiles

In all the markets in both areas, the vendors and buyers were mostly adult males (Table I), aged between 39.13 ± 2.45 and 49.29 ± 2.79 years, and between 39.40 ± 1.89 and 43.39 ± 1.41 years, respectively, regardless of the season. In Maradi and Niamey, the vendors' minimum age was 16 and 14 years, and maximum age 81 and 78 years, respectively. The involvement of young feed sellers (≤ 25 years old) varied with the season: in Maradi and Niamey, they were about 20% and 30% in the late dry season, 10% and 9% in the wet season, and 13% and 14% in the early dry season, respectively. The lowest proportion of young feed sellers in the wet season in both markets was due to their involvement in cropping activities. The vendors in Maradi and Niamey had a similar number of years of experience, which varied on average from 8.92 ± 1.48 to 10.39 ± 1.21 years across seasons. The experience in selling feed ranged from about 1 to 20 years in both locations.

Table II shows the educational level of feed sellers in Maradi and Niamey across seasons. At least 50% of the feed sellers in Maradi had Koranic education, and between 13% and 20% did not have any education. In Niamey, the proportion of vendors who had Koranic education was lower and of those who had no schooling was higher than in Maradi. The number of feed buyers in Maradi and Niamey who had formal education (primary, secondary and post-secondary school) was higher than that of feed sellers. This was expected because feed buyers included salaried workers who generally had formal education, whereas feed sellers were mostly unschooled farmers. The feed buyers had diverse occupations with similar trends in both Maradi and Niamey (Figure 2).

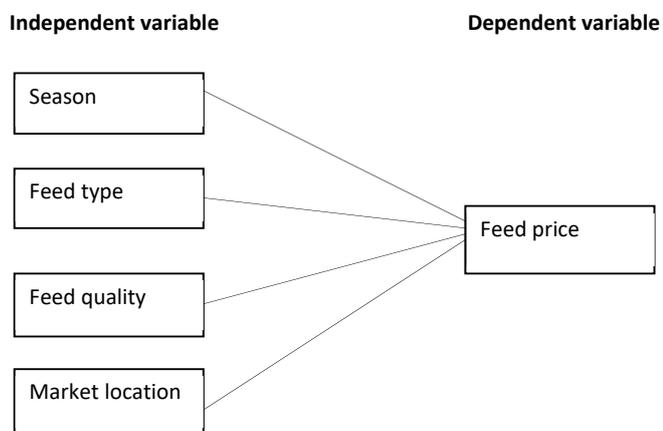


Figure 1: Conceptual model of determinants for livestock feed price in Maradi and Niamey markets, Niger // *Modèle conceptuel des déterminants du prix de l'alimentation du bétail sur les marchés de Maradi et Niamey, Niger*

Table I: Feed sellers and buyers across seasons at markets in Maradi and Niamey, Niger // *Vendeurs et acheteurs d'aliments pour bétail au fil des saisons sur les marchés de Maradi et de Niamey, au Niger*

| | Wet season | | Early dry season | | Late dry season | |
|------------------|------------|---|------------------|---|-----------------|----|
| | M | F | M | F | M | F |
| Feed sellers (n) | | | | | | |
| Maradi | 33 | 6 | 32 | 6 | 33 | 7 |
| Niamey | 50 | 3 | 39 | 3 | 34 | 18 |
| Feed buyers (n) | | | | | | |
| Maradi | 42 | 8 | 41 | 9 | 32 | 18 |
| Niamey | 52 | 8 | 47 | 3 | 58 | 8 |

M: male; F: female // *M: homme ; F: femme*

Table II: Educational level of feed sellers and buyers across seasons at markets in Maradi and Niamey, Niger /// Niveau de scolarité des vendeurs et acheteurs d'aliments pour bétail au fil des saisons sur les marchés de Maradi et Niamey, Niger

| Schooling | Maradi | | | Niamey | | |
|------------------|------------|------------------|-----------------|------------|------------------|-----------------|
| | Wet season | Early dry season | Late dry season | Wet season | Early dry season | Late dry season |
| Feed sellers (n) | | | | | | |
| None | 5 | 6 | 8 | 31 | 23 | 19 |
| Koranic | 23 | 26 | 20 | 18 | 15 | 19 |
| Primary | 10 | 4 | 11 | 3 | 3 | 10 |
| Secondary | 1 | 2 | 1 | 1 | 1 | 4 |
| Post-secondary | 0 | 0 | 0 | 0 | 0 | 0 |
| Feed buyers (n) | | | | | | |
| None | 10 | 12 | 9 | 18 | 11 | 18 |
| Koranic | 21 | 20 | 23 | 20 | 11 | 22 |
| Primary | 14 | 13 | 12 | 19 | 23 | 18 |
| Secondary | 4 | 4 | 5 | 2 | 3 | 7 |
| Post-secondary | 1 | 1 | 1 | 1 | 2 | 1 |

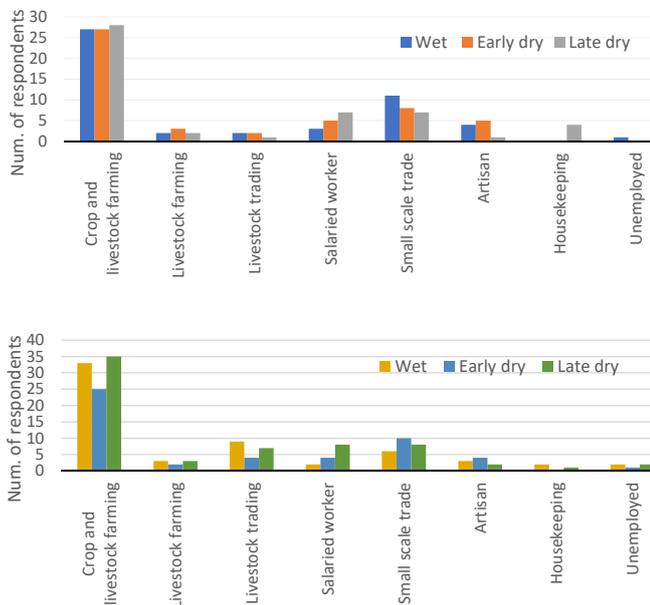


Figure 2: Primary activity of feed buyers according to the season in (top) Maradi, (bottom) Niamey markets, Niger /// *Activité principale des acheteurs d'aliments pour bétail selon la saison sur les marchés de Maradi (en haut) et de Niamey (en bas), Niger*

Inventory of feed sold and bought across seasons

Table III shows diverse feed types sold in both Maradi and Niamey markets in the wet, early dry and late dry seasons. The most commonly sold feeds in both sites were cereal bran, legume residues, particularly cowpea hay and husk and groundnut haulm, and cereal straw, which were sold in all seasons. More browse, bush hay and soybean hay were sold in Niamey than in Maradi, whereas it was the opposite for cereal grains (Table III). More vendors mentioned crop residues (cereal straw and legume residues) as being sold in the early dry season, which corresponded with the crop harvest, than in the other seasons. Irrigated fodder was only mentioned by two vendors in Niamey and in the early dry season. None of the feed sellers mentioned the sale of concentrate feed in either Maradi or Niamey. The responses of feed buyers were similar to those of feed sellers (Table III). The commonly bought feeds across seasons in both Maradi and Niamey were cereal bran, legume residue, browse and bush hay.

Reasons to purchase feed, purchase frequency

Figure 3 shows the major reasons given by buyers to purchase feed in both Maradi and Niamey markets. The highest number of respondents mentioned insufficient household feed biomass and poor feed quality as reasons for feed purchase in the late dry season compared to other seasons, in particular as grazing resources were available in the wet season.

The frequency of feed purchase was highest (every week) in the late dry season in both Maradi and Niamey (Table IV). A significant number of the buyers also bought feed every week in both the dry and wet seasons in both locations although some of the buyers purchased feed only a few times in the dry and wet seasons. In livestock keeping in periurban areas of West African Sahel, feed is routinely purchased across seasons.

Price of livestock feeds across seasons

The price of livestock feeds sold at markets in Maradi and Niamey varied significantly with the season, market location and feed type (Table V). In both sites, the prices of legume residues (particularly cowpea hay and husk) and soybean hay were the highest in the wet and late dry seasons compared to other feed types. The price of nearly all feed types was higher in Niamey than in Maradi. The price of crop residues (cereal straw and legume residues) was lowest in the early dry season, i.e. at harvest when crop residues are most available. Almost all prices were highest in the late dry season when feed deficit was highest. The prices of cereal bran (millet, maize, sorghum and wheat brans) were generally stable across seasons and ranged on average from 157 ± 7 CFA francs in the early dry season in Maradi to 252 ± 12 CFAF in the late dry season in Niamey (Table V). The analysis of variance showed that feed prices were determined by the season, market location and feed type (p < 0.05). The age and years of experience of the vendor did not significantly (p < 0.05) affect feed prices. However, their number of years of experience was significant (p < 0.10).

Livestock feed quality across seasons

Legume residues, cereal bran, and cottonseed cake had higher CP than other feed types across seasons (Table VI). In all seasons and in both sites, cereal straw had the lowest CP content (less than 10%). Cereal bran had the highest IVOMD in both sites across seasons, whereas cereal straw had the lowest. Cereal grain had the highest

Table III: Feeds sold and bought across seasons at markets in Maradi and Niamey, Niger /// *Aliments pour bétail vendus et achetés au fil des saisons sur les marchés de Maradi et de Niamey, Niger*

| | Maradi | | | Niamey | | |
|------------------------------------|------------|------------------|-----------------|------------|------------------|-----------------|
| | Wet season | Early dry season | Late dry season | Wet season | Early dry season | Late dry season |
| Feed* sellers (numb. of responses) | | | | | | |
| Browse | 7 | 1 | 1 | 13 | 12 | 2 |
| Bush hay | 3 | 4 | 7 | 5 | 27 | 14 |
| Cereal bran | 61 | 58 | 52 | 53 | 45 | 50 |
| Cottonseed cake | 1 | 4 | 2 | 0 | 1 | 0 |
| Cereal grain | 14 | 7 | 12 | 0 | 0 | 12 |
| Cereal straw | 2 | 11 | 4 | 4 | 12 | 7 |
| Green pasture | 8 | 4 | 8 | 10 | 0 | 20 |
| Irrigated fodder | 0 | 0 | 0 | 0 | 2 | 0 |
| Cowpea hay | 2 | 14 | 11 | 14 | 34 | 24 |
| Cowpea husk | 18 | 34 | 27 | 8 | 11 | 9 |
| Groundnut haulm | 16 | 32 | 24 | 2 | 11 | 8 |
| Soybean hay | 0 | 1 | 0 | 2 | 4 | 4 |
| Feed* buyers (numb. of responses) | | | | | | |
| Browse | 2 | 1 | 2 | 1 | 3 | 5 |
| Bush hay | 2 | 4 | 4 | 4 | 33 | 24 |
| Cereal bran | 48 | 61 | 55 | 53 | 58 | 58 |
| Cottonseed cake | 1 | 0 | 0 | 0 | 1 | 0 |
| Cereal grain | 4 | 3 | 5 | 0 | 0 | 10 |
| Cereal straw | 2 | 6 | 4 | 4 | 10 | 6 |
| Green pasture | 6 | 2 | 4 | 6 | 0 | 14 |
| Cowpea hay | 1 | 13 | 5 | 4 | 38 | 32 |
| Cowpea husk | 11 | 25 | 21 | 2 | 6 | 3 |
| Groundnut haulm | 8 | 30 | 16 | 6 | 8 | 6 |
| Soybean hay | 0 | 1 | 0 | 1 | 3 | 2 |

* Browse: *Faidherbia albida*, *Acacia raddiana*; bush hay: dry herbaceous species e.g. *Alysicarpus ovalifolius*, *Cenchrus biflorus*, *Zornia glochidiata*; cereal bran from wheat, sorghum, millet, maize and rice; cereal grain: mainly spoiled sorghum grain; cereal straw from sorghum, millet and rice; green pasture: freshly harvested herbaceous species e.g. *Al. ovalifolius*, *Andropogon gayanus*, *Z. glochidiata*, *Echinochloa stagnina* /// * *Ligneux* : *Faidherbia albida*, *Acacia raddiana* ; *foin de brousse* : espèces herbacées sèches par ex. *Alysicarpus ovalifolius*, *Cenchrus biflorus*, *Zornia glochidiata* ; *son de céréales de blé, sorgho, millet, maïs et riz* ; *grain de céréales* : principalement de sorgho détérioré ; *paille de céréales de sorgho, millet et riz* ; *pâturage vert* : espèces herbacées fraîchement récoltées par ex. *Al. ovalifolius*, *Andropogon gayanus*, *Z. glochidiata*, *Echinochloa stagnina*

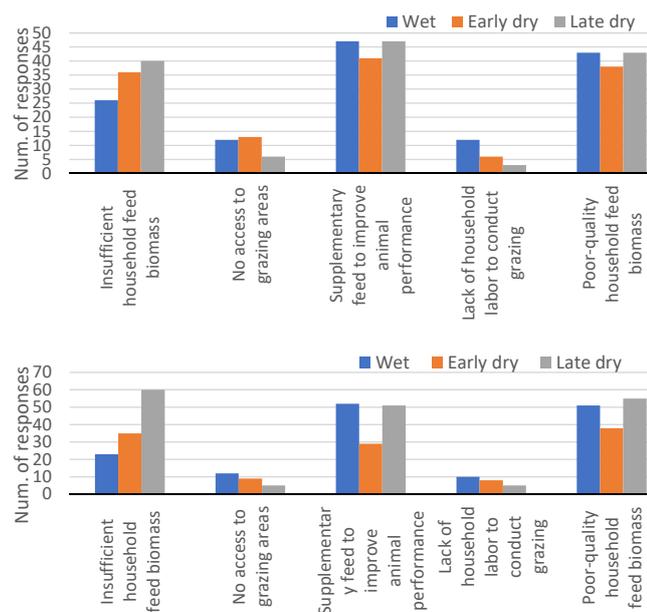


Figure 3: Reasons for feed purchase according to the season in (top) Maradi, (bottom) Niamey markets, Niger (a respondent can give more than one reason) /// *Raisons de l'achat d'aliments pour bétail selon la saison sur les marchés de Maradi (en haut) et de Niamey (en bas), Niger (une personne peut donner plus d'une raison)*

metabolizable energy in all seasons in Maradi, whereas cereal bran had the highest ME in Niamey. Cereal straw and bush hay tended to have the lowest ME. ADL was highest in the late dry season with both bush hay and cereal straw having a significantly ($p < 0.05$) higher ADL than other feed types. The analysis of variance showed that the nutritional quality varied significantly ($p < 0.05$) according to the feed type in all seasons in both sites. The price had a significant effect in the late dry season on CP, NDF, ADF, ME and IVOMD contents in Niamey, and on fiber components in Maradi. The price had no significant effect on the nutritional quality of the feeds sold in both sites in the wet and early dry seasons.

■ DISCUSSION

The results showing the predominance of adult males among feed sellers in both sites were consistent with those from Jarial et al. (2016) in livestock feed markets in Niger. The average age of 39 to 49 years of the majority of feed sellers in Maradi and Niamey in our study was similar to that of 24 to 52 years reported by Doamba (2020) in feed markets in periurban Burkina Faso. However, the difference in the lower bound of age suggests that sale of livestock feeds is more attractive to young people in periurban Burkina Faso than in Niger. Part of the reason could be the larger scale of livestock production in periurban Burkina Faso, particularly smallholder dairy production

Table IV: Frequency of buying feed across seasons at markets in Maradi and Niamey, Niger /// *Fréquence d'achat d'aliments pour bétail au fil des saisons sur les marchés de Maradi et Niamey, Niger*

| Frequency | Maradi (num. of respondents) | | | Niamey (num. of respondents) | | |
|---|------------------------------|------------------|-----------------|------------------------------|------------------|-----------------|
| | Wet season | Early dry season | Late dry season | Wet season | Early dry season | Late dry season |
| Every week in the dry season | 1 | 13 | 21 | 1 | 18 | 43 |
| A few times in the dry season | 1 | 2 | 14 | 1 | 2 | 11 |
| Every week in both dry and wet seasons | 28 | 25 | 8 | 28 | 21 | 10 |
| A few times in both dry and wet seasons | 20 | 10 | 7 | 30 | 9 | 2 |

Table V: Price (FCA francs / kg of dry matter) of common feeds across seasons at markets in Maradi and Niamey, Niger /// *Prix (franc CFA/kg matière sèche) des aliments courants pour bétail au fil des saisons sur les marchés de Maradi et Niamey, Niger*

| | Maradi (mean ± standard error) | | | Niamey (mean ± standard error) | | |
|-----------------|--------------------------------|-----------------------|-----------------------|--------------------------------|-----------------------|-----------------------|
| | Wet season | Early dry season | Late dry season | Wet season | Early dry season | Late dry season |
| Browse | 49 ± 4 ^d | – | 118 ± 34 ^e | 174 ± 15 ^c | 166 ± 18 ^c | 179 ± 4 ^c |
| Bush hay | – | 86 ± 15 ^c | – | 110 ± 9 ^d | 91 ± 7 ^d | 106 ± 31 ^d |
| Cereal bran | 205 ± 7 ^c | 157 ± 7 ^b | 231 ± 10 ^d | 219 ± 11 ^c | 224 ± 13 ^b | 252 ± 12 ^b |
| Cottonseed cake | – | 200 ± 40 ^a | 160 ± 5 ^e | – | 300 ± 8 ^a | – |
| Cereal grain | 182 ± 5 ^c | 232 ± 22 ^a | 277 ± 9 ^c | – | – | 209 ± 8 ^c |
| Cereal straw | 81 ± 14 ^d | 27 ± 12 ^d | 101 ± 18 ^e | 104 ± 12 ^d | 51 ± 8 ^d | 87 ± 15 ^d |
| Cowpea hay | 239 ± 25 ^b | 197 ± 31 ^a | 377 ± 11 ^a | 349 ± 21 ^a | 303 ± 22 ^a | 424 ± 35 ^a |
| Cowpea husks | 301 ± 10 ^a | 132 ± 4 ^b | 319 ± 22 ^b | 297 ± 28 ^b | 216 ± 23 ^b | 385 ± 24 ^a |
| Groundnut haulm | 185 ± 14 ^c | 122 ± 8 ^b | 207 ± 13 ^d | 253 ± 40 ^b | 183 ± 16 ^c | 292 ± 15 ^b |
| Green pasture | – | 64 ± 6 ^c | 76 ± 28 ^f | – | – | 98 ± 5 ^d |
| Soybean hay | 250 ± 11 ^b | – | – | 287 ± 65 ^b | 247 ± 26 ^b | 315 ± 27 ^b |

^{a,b,c,d,e,f} Values followed by different superscripts in the same column are significantly different ($p < 0.05$) /// ^{a,b,c,d,e,f} Les valeurs suivies de lettres différentes en exposant dans une même colonne sont significativement différentes ($p < 0,05$)

(Doamba, 2020), and the associated high demand for livestock feeds which tends to make sale of livestock feed more attractive to young people in Burkina Faso than in Niger. Besides, it provides means of livelihood for some young people in periurban Burkina Faso (Doamba, 2020). The average nine years' experience of feed sellers in both Maradi and Niamey was significant ($p < 0.10$), suggesting that selling livestock feed required solid experience, particularly with preserving and packaging different feed types, and negotiating prices with buyers. As it is preferable to have experience when selling livestock feeds, this may explain why crop farmers often sell their crop residues to feed vendors instead of directly to buyers (Ayantunde et al., 2014; Jarial et al., 2016). The significant proportion (9% to 30% of total respondents) of young people (≤ 25 years old) selling livestock feeds in both sites suggests that this activity could contribute to employment opportunities for youths in periurban areas of Niger. According to Fox et al. (2016), "Given the large number of unemployed youths in West Africa and the inability of the formal sector to provide jobs for them, the informal sector, particularly agriculture sector, will remain a major employer of the less educated youths."

Feed buyers generally had a higher educational level than vendors in both sites, in agreement with findings by Doamba (2020) in Ouagadougou, Burkina Faso, where about 40% of feed buyers had at least the primary school level, whereas about 19% of feed sellers had the primary school level. Besides, our results confirmed that some feed buyers' primary activity was not farming, but salaried work, small-scale business or craftsmanship, a general trend observed in periurban areas of West African Sahel (Ayantunde et al., 2014); these feed buyers, however, drive the demand for livestock feeds, particularly in periurban areas of the region.

The feed types sold and bought at markets in Maradi and Niamey were consistent with results by Jarial et al. (2016) and Doamba (2020) in feed market in Niger and Burkina Faso, respectively. The dominance of crop residues in the feed markets supports the growing importance of crop residues as a source of livestock feed in the Sahel (Ayantunde et al., 2018). According to these authors, crop residues can account for up to 45% of ruminant livestock diet in arid and semi-arid zones of West Africa due to significant decline in grazing areas in the region as a result of expansion of crop fields. The challenge with the increasing importance of crop residues as a source of livestock feed is how to preserve quality which often declines rapidly. The absence of irrigated fodder at the feed markets except in the early dry season in Niamey indicates a low adoption of forage species in West African Sahel (Amole et al., 2022b). Unlike in periurban livestock feed markets in Burkina Faso and Mali (Ayantunde et al., 2014; Doamba, 2020), cottonseed cake is not commonly sold in periurban livestock feed markets in Niger. This is expected as cotton is not widely grown in Niger compared to Burkina Faso and Mali. The absence of concentrate feed in Maradi and Niamey indicates a slow growth of the feed industry particularly for ruminants in Niger (Balehegn et al., 2020; Jarial et al., 2016). The development of the feed industry is important to meet the growing feed demand for periurban livestock production and to ensure stability in feed supply as the availability of crop residues can be unstable.

The major reasons given for the purchase of feed in both Maradi and Niamey are consistent with observations by Graef et al. (2008) and Roessler et al. (2016), i.e. it bridges the deficit in household produced biomass, particularly in the dry season in periurban livestock production in West African Sahel. The increasing livestock population in periurban Sahel in the past three decades has intensified the

Table VI: Nutritional quality (mean ± standard error) of feeds sold across seasons at Maradi and Niamey markets, Niger /// *Qualité nutritionnelle (moyenne ± écart-type) des aliments pour bétail vendus au fil des saisons sur les marchés de Maradi et de Niamey, Niger*

| | | Ash (%) | CP (%) | NDF (%) | ADF (%) | ADL (MJ/kg DM) | ME (%) | IVOMD (%) |
|-------------------------|-----------------|---------------------------|----------------------------|----------------------------|----------------------------|---------------------------|---------------------------|----------------------------|
| Wet season | | | | | | | | |
| M | Browse | 5.08 ± 0.62 ^e | 12.91 ± 0.16 ^c | 49.62 ± 0.41 ^b | 28.04 ± 0.54 ^d | 7.18 ± 0.01 ^b | 9.28 ± 0.17 ^b | 63.66 ± 0.27 ^a |
| M | Cowpea hay | 10.81 ± 0.97 ^b | 14.97 ± 1.18 ^b | 47.26 ± 2.96 ^{bc} | 35.92 ± 0.20 ^c | 6.70 ± 0.45 ^b | 8.38 ± 0.26 ^c | 58.78 ± 1.10 ^b |
| M | Cowpea husk | 9.55 ± 0.63 ^c | 9.17 ± 0.70 ^d | 56.88 ± 1.01 ^b | 47.45 ± 0.90 ^a | 8.98 ± 0.27 ^a | 8.60 ± 0.11 ^c | 57.06 ± 0.72 ^b |
| M | Groundnut haulm | 10.75 ± 1.57 ^b | 10.97 ± 0.17 ^d | 50.41 ± 0.85 ^b | 43.06 ± 2.41 ^b | 8.81 ± 0.31 ^a | 8.00 ± 0.15 ^c | 54.33 ± 0.91 ^b |
| M | Cereal bran | 7.27 ± 0.43 ^d | 15.52 ± 0.43 ^b | 41.72 ± 1.09 ^c | 14.08 ± 1.14 ^e | 2.91 ± 0.11 ^d | 9.79 ± 0.13 ^a | 67.78 ± 0.61 ^a |
| M | Cereal grain | 1.59 ± 0.34 ^f | 10.49 ± 0.51 ^d | 37.60 ± 0.68 ^d | 9.73 ± 0.44 ^f | 3.90 ± 0.12 ^d | 10.22 ± 0.11 ^a | 66.73 ± 0.40 ^a |
| N | Bush hay | 12.09 ± 0.17 ^a | 8.38 ± 0.85 ^e | 47.30 ± 2.56 ^{bc} | 40.24 ± 1.33 ^b | 5.84 ± 0.54 ^{bc} | 7.53 ± 0.13 ^d | 55.67 ± 0.75 ^b |
| N | Cowpea hay | 10.91 ± 1.34 ^b | 15.37 ± 0.47 ^b | 42.14 ± 4.01 ^c | 31.53 ± 2.44 ^c | 5.13 ± 0.74 ^c | 9.34 ± 0.38 ^b | 64.17 ± 2.23 ^a |
| N | Cowpea husk | 9.23 ± 3.25 ^c | 7.73 ± 0.17 ^e | 55.04 ± 3.37 ^b | 49.98 ± 0.50 ^a | 8.12 ± 0.75 ^a | 8.53 ± 0.43 ^c | 59.32 ± 1.63 ^b |
| N | Groundnut haulm | 10.76 ± 2.33 ^b | 14.06 ± 0.84 ^b | 45.43 ± 1.87 ^c | 38.96 ± 0.76 ^c | 9.29 ± 0.31 ^a | 8.11 ± 0.16 ^c | 54.81 ± 0.39 ^b |
| N | Soybean hay | 9.04 ± 0.16 ^c | 18.32 ± 0.32 ^a | 40.75 ± 0.87 ^c | 26.09 ± 0.43 ^d | 5.92 ± 0.18 ^{bc} | 8.79 ± 0.02 ^c | 61.24 ± 0.25 ^{ab} |
| N | Cereal bran | 6.70 ± 0.42 ^d | 15.65 ± 0.70 ^b | 40.46 ± 0.77 ^c | 13.35 ± 0.87 ^e | 2.79 ± 0.16 ^d | 10.04 ± 0.18 ^a | 65.03 ± 0.91 ^a |
| N | Cereal straw | 12.92 ± 0.39 ^a | 7.07 ± 0.22 ^e | 61.77 ± 0.81 ^a | 52.65 ± 0.68 ^a | 2.92 ± 0.12 ^d | 6.93 ± 0.13 ^e | 50.11 ± 0.53 ^c |
| Early dry season | | | | | | | | |
| M | Bush hay | 6.76 ± 1.16 ^d | 9.95 ± 2.19 ^e | 40.16 ± 2.50 ^c | 19.38 ± 6.59 ^e | 6.37 ± 0.37 ^b | 8.34 ± 0.25 ^b | 58.81 ± 1.06 ^b |
| M | Cowpea hay | 10.58 ± 4.33 ^a | 14.23 ± 1.01 ^c | 39.91 ± 2.43 ^{cd} | 30.20 ± 1.72 ^c | 5.31 ± 0.61 ^c | 9.13 ± 0.18 ^a | 64.36 ± 0.77 ^a |
| M | Cowpea husk | 4.87 ± 0.29 ^e | 8.03 ± 0.67 ^e | 61.36 ± 1.26 ^b | 47.36 ± 1.09 ^a | 10.35 ± 0.21 ^a | 7.91 ± 0.06 ^b | 55.00 ± 0.53 ^b |
| M | Groundnut haulm | 9.05 ± 1.26 ^{ab} | 11.54 ± 0.75 ^d | 52.24 ± 0.98 ^b | 39.65 ± 0.97 ^{bc} | 9.04 ± 0.45 ^a | 8.07 ± 0.18 ^b | 54.86 ± 1.07 ^b |
| M | Cottonseed cake | 2.61 ± 0.28 ^f | 24.98 ± 1.31 ^a | 56.16 ± 0.86 ^b | 35.18 ± 1.24 ^c | 9.53 ± 0.29 ^a | 8.71 ± 0.14 ^b | 62.40 ± 1.25 ^a |
| M | Cereal bran | 4.75 ± 0.33 ^e | 15.03 ± 0.63 ^c | 41.54 ± 1.09 ^c | 9.58 ± 0.85 ^f | 3.52 ± 0.12 ^d | 9.45 ± 0.10 ^a | 66.32 ± 0.69 ^a |
| M | Cereal grain | 1.52 ± 0.77 ^f | 13.39 ± 0.73 ^c | 34.54 ± 1.45 ^d | 8.42 ± 1.04 ^f | 4.62 ± 0.08 ^c | 9.88 ± 0.15 ^a | 66.09 ± 1.05 ^a |
| M | Cereal straw | 6.48 ± 0.45 ^d | 6.01 ± 0.49 ^f | 70.13 ± 2.14 ^a | 40.34 ± 2.89 ^b | 4.97 ± 0.61 ^c | 7.22 ± 0.34 ^c | 48.36 ± 3.00 ^c |
| N | Browse | 4.77 ± 0.53 ^e | 14.54 ± 0.79 ^c | 43.90 ± 2.42 ^c | 25.38 ± 1.79 ^d | 9.28 ± 0.32 ^a | 7.81 ± 0.10 ^b | 56.93 ± 0.64 ^b |
| N | Bush hay | 4.38 ± 0.17 ^e | 6.07 ± 0.27 ^f | 77.30 ± 1.59 ^a | 50.34 ± 1.71 ^a | 7.22 ± 0.29 ^b | 6.60 ± 0.26 ^d | 48.74 ± 1.92 ^c |
| N | Cowpea hay | 7.72 ± 0.41 ^c | 16.17 ± 1.02 ^b | 38.68 ± 1.91 ^{cd} | 27.74 ± 1.78 ^d | 4.72 ± 0.30 ^c | 9.38 ± 0.21 ^a | 65.08 ± 1.46 ^a |
| N | Cowpea husk | 8.66 ± 0.89 ^b | 8.24 ± 1.04 ^e | 57.34 ± 0.73 ^b | 46.93 ± 1.44 ^a | 9.48 ± 0.14 ^a | 7.74 ± 0.17 ^b | 54.88 ± 1.12 ^b |
| N | Groundnut haulm | 9.86 ± 1.26 ^a | 11.44 ± 0.59 ^d | 46.55 ± 0.31 ^c | 34.41 ± 1.33 ^c | 7.27 ± 0.07 ^b | 8.10 ± 0.18 ^b | 56.20 ± 0.53 ^b |
| N | Soybean hay | 8.73 ± 0.32 ^b | 17.37 ± 0.85 ^b | 41.97 ± 2.26 ^c | 27.72 ± 1.71 ^d | 6.68 ± 0.27 ^b | 8.18 ± 0.11 ^b | 56.91 ± 0.90 ^b |
| N | Cereal bran | 4.80 ± 0.15 ^e | 16.70 ± 0.85 ^b | 41.73 ± 0.85 ^c | 9.76 ± 0.53 ^f | 3.18 ± 0.14 ^d | 9.79 ± 0.16 ^a | 68.89 ± 1.04 ^a |
| N | Cereal straw | 6.58 ± 1.73 ^d | 8.00 ± 1.65 ^e | 76.11 ± 1.12 ^a | 43.29 ± 1.35 ^b | 4.95 ± 0.63 ^c | 7.98 ± 0.27 ^b | 50.81 ± 3.02 ^c |
| Late dry season | | | | | | | | |
| M | Browse | 9.56 ± 0.56 ^b | 11.62 ± 0.47 ^c | 51.92 ± 0.76 ^c | 29.28 ± 0.85 ^{bc} | 7.22 ± 0.11 ^d | 8.84 ± 0.10 ^b | 54.71 ± 0.48 ^b |
| M | Cowpea hay | 9.70 ± 0.77 ^b | 15.62 ± 1.01 ^b | 44.84 ± 0.86 ^b | 34.10 ± 0.06 ^b | 7.61 ± 0.02 ^d | 8.86 ± 0.17 ^b | 56.92 ± 0.78 ^b |
| M | Cowpea husk | 7.04 ± 0.40 ^c | 7.31 ± 0.40 ^d | 60.16 ± 0.97 ^b | 47.49 ± 1.13 ^a | 9.74 ± 0.27 ^c | 8.12 ± 0.08 ^b | 56.42 ± 0.53 ^b |
| M | Groundnut haulm | 10.44 ± 0.95 ^b | 13.42 ± 0.64 ^b | 43.19 ± 1.32 ^c | 35.75 ± 1.38 ^b | 7.95 ± 0.23 ^d | 8.19 ± 0.13 ^b | 56.91 ± 1.04 ^b |
| M | Soybean hay | 7.32 ± 0.50 ^c | 17.16 ± 0.94 ^a | 36.88 ± 0.47 ^d | 25.81 ± 0.36 ^c | 6.25 ± 0.28 ^d | 8.61 ± 0.48 ^b | 60.12 ± 0.16 ^a |
| M | Cereal bran | 5.96 ± 0.39 ^d | 14.66 ± 0.64 ^b | 42.45 ± 0.74 ^c | 12.24 ± 0.75 ^d | 3.18 ± 0.14 ^e | 9.55 ± 0.13 ^a | 66.89 ± 0.81 ^a |
| M | Cereal grain | 1.31 ± 0.53 ^f | 8.65 ± 1.09 ^d | 35.08 ± 1.75 ^d | 8.10 ± 0.45 ^e | 4.37 ± 0.14 ^e | 9.85 ± 0.15 ^a | 65.94 ± 0.84 ^a |
| M | Cereal straw | 14.29 ± 5.57 ^a | 5.19 ± 0.44 ^e | 65.57 ± 5.43 ^a | 49.93 ± 8.62 ^a | 13.32 ± 1.06 ^b | 6.52 ± 0.61 ^c | 48.38 ± 1.57 ^c |
| N | Bush hay | 8.62 ± 1.13 ^b | 6.72 ± 0.56 ^{de} | 61.34 ± 3.00 ^b | 46.29 ± 1.91 ^a | 17.78 ± 0.92 ^a | 6.89 ± 0.16 ^c | 48.91 ± 1.32 ^c |
| N | Cowpea hay | 9.55 ± 0.79 ^b | 13.00 ± 1.38 ^b | 48.08 ± 2.51 ^c | 35.83 ± 3.29 ^b | 6.61 ± 0.66 ^d | 8.52 ± 0.24 ^b | 59.59 ± 1.79 ^{ab} |
| N | Cowpea husk | 8.01 ± 1.31 ^b | 8.12 ± 0.29 ^d | 59.60 ± 1.51 ^b | 48.09 ± 0.58 ^a | 9.50 ± 0.47 ^c | 8.15 ± 0.07 ^b | 57.38 ± 0.77 ^b |
| N | Groundnut haulm | 8.45 ± 3.18 ^b | 12.25 ± 1.30 ^{bc} | 43.63 ± 1.39 ^c | 35.57 ± 2.60 ^b | 6.65 ± 0.46 ^d | 8.11 ± 0.19 ^b | 57.64 ± 0.68 ^b |
| N | Soybean hay | 10.02 ± 2.54 ^b | 17.50 ± 0.87 ^a | 39.44 ± 3.54 ^{cd} | 28.42 ± 1.23 ^{bc} | 6.39 ± 0.44 ^d | 8.31 ± 0.11 ^b | 58.26 ± 0.08 ^b |
| N | Cereal bran | 5.43 ± 0.28 ^d | 15.51 ± 0.54 ^a | 42.21 ± 0.59 ^c | 11.21 ± 0.35 ^d | 2.86 ± 0.12 ^e | 9.96 ± 0.12 ^a | 67.73 ± 0.76 ^a |
| N | Cereal grain | 3.31 ± 0.55 ^e | 7.43 ± 0.54 ^d | 31.01 ± 1.51 ^d | 21.67 ± 0.56 ^c | 3.89 ± 0.07 ^e | 8.61 ± 0.28 ^b | 56.16 ± 1.34 ^b |
| N | Cereal straw | 12.84 ± 2.56 ^a | 5.86 ± 0.62 ^e | 70.34 ± 1.86 ^a | 50.02 ± 1.46 ^a | 14.73 ± 0.49 ^b | 6.73 ± 0.21 ^c | 47.51 ± 1.01 ^c |

CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin; ME: metabolizable energy; IVOMD: in vitro organic matter digestibility; DM: dry matter; M: Maradi; N: Niamey; ^{a,b,c,d,e,f} Values followed by different superscripts in the same column are significantly different (p < 0.05) /// CP : protéine brute ; NDF : fibre au détergent neutre ; ADF : fibre au détergent acide ; ADL : lignine au détergent acide ; ME : énergie métabolisable ; IVOMD : digestibilité in vitro de la matière organique ; DM : matière sèche ; M : Maradi ; N : Niamey ; ^{a,b,c,d,e,f} Les valeurs suivies de lettres différentes en exposant dans une même colonne sont significativement différentes (p < 0,05)

feed demand (Ayantunde et al., 2014). The need for supplementary feeds mentioned as one major reason for feed purchase is particularly important in periurban areas of Maradi and Niamey as smallholder dairy production and sheep fattening are common in view of the increasing commercial orientation of periurban livestock production. Given that dairy production and animal fattening require energy and protein-rich supplementary feeds for good performance (Ayantunde et al., 2007), it is understandable that periurban livestock keepers invest in supplementary feeds for their animals. The dependence on feed purchase by many periurban livestock keepers in West African Sahel raises the issue of profitability of periurban livestock production in the region (Debrah et al., 1995; Roessler et al., 2016).

The results on the price variation of livestock feeds sold at markets in our study sites were similar to findings by Ayantunde et al. (2014) and Doamba (2020) in periurban areas of Bamako, Mali, and Ouagadougou, Burkina Faso, respectively. As the availability of crop residues, which dominate feed markets in the Sahel, varies with season, prices tend to follow seasonal availability. This explains why the feed price, particularly of crop residues, was lowest in the early dry season, period of harvest when crop residues were the most available, whereas the crop residues price was highest in the late dry season, when availability was generally low, as reported by Amole et al. (2022a). The high price of legume residues in our study was similar to findings by Ayantunde et al. (2014) in periurban Bamako. The price range of legume residues in our study was within the range of 200 and 400 CFAF per kilogram of dry matter reported for periurban areas of Burkina Faso. The high prices of legume residues in our study reflected more their high demand than their quality. For example, the prices of cowpea hay and groundnut haulm were consistently higher than those of cereal bran despite the fact that their nutritional quality in terms of CP, ME and IVOMD was comparable all year round. Without feed standards and labeling, particularly for crop residues, in West Africa, the price will keep depending on seasonal availability, market location, market knowledge, feed type, buying habits, loyalty to a product and negotiation between vendors and buyers. Buyers' perception of feed quality also influences the price as observed by Ayantunde et al. (2014) in feed markets in Bamako. These authors report that there is a general perception among livestock keepers in suburban areas of West African Sahel that cowpea hay and groundnut haulm are the best feeds for animal fattening and for dairy cows based on a long tradition of feeding animals with these legume residues.

The feed type positive effect on nutritional quality is expected as the chemical composition varies with feed materials (Amole et al., 2022a). The lack of a clear trend in terms of relationship between price and nutritional quality across seasons from our results confirms the absence of quality standardization for feeds on sale at the markets in our study. Similar observation has been reported for feeds sold in periurban Bamako (Ayantunde et al., 2014). Jarial et al. (2017) also reported that in Niger feed pricing was less explained by laboratory fodder quality traits than by factors such as the perceptions of farmers, traders and livestock keepers. Policy-makers need to address quality standardization and labeling that will enable pricing based on the feed nutritive value, ensuring buyers pay for quality products in markets in West African Sahel. This is also essential as an efficient use of feed resources will keep improving livestock productivity in the region. Our results can guide livestock feed policies in Niger and in the region in terms of development of least-cost feed rations for ruminant livestock to enhance productivity.

■ CONCLUSION

With increasing livestock population in periurban areas of West African Sahel and the associated growth in the demand for feeds,

feed markets have sprung up in many cities and towns in the region. Results showed that male adults predominated in the sale and purchase of feeds in the surveyed livestock feed markets in Maradi and Niamey, Niger. However, a significant proportion of youths sold feed in both sites, suggesting that sale of livestock feed in periurban areas of Niger could contribute to employment opportunities for youths. The major reasons given for feed purchase in both sites, e.g. insufficient or poor-quality household-feed biomass, need for supplementary feeds to improve animal performance, and non-access to grazing areas, confirmed the dependency trend of feed purchase by many periurban livestock keepers in West African Sahel. The lack of clear relationship between feed price and quality suggested that feed pricing could not be satisfactorily explained by laboratory fodder quality traits, whereas other factors such as perception of farmers, traders and livestock keepers seemed to play a major role. To improve feed quality in markets in the region, policy-makers need to address the issue of quality standardization and labeling which will enable pricing based on the feed nutritive value and thus ensure that buyers pay for quality products.

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Conflicts of interest

The authors declare there is no conflict of interest.

Author contributions statement

AAA participated in the design and planning of the study, wrote the first draft and reviewed the manuscript; KA coordinated data collection; GS and OM collected data; all authors authorized the submission of the final version for publication.

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Résumé

Ayantunde A.A., Adamou K., Seybou G., Moumouni O. Marchés d'aliments pour bétail dans les zones périurbaines du Niger au fil des saisons : profil des vendeurs et des acheteurs, prix et qualité des aliments

La productivité du bétail dans le Sahel ouest-africain est limitée par la rareté saisonnière des aliments pour animaux et par leur mauvaise qualité pendant la saison sèche. La rareté des ressources alimentaires dans la région a également été aggravée par l'augmentation du nombre de têtes de bétail, ce qui a accru la demande d'aliments pour animaux, en particulier dans les zones périurbaines. Des marchés d'aliments pour bétail ont ainsi émergé dans de nombreuses villes et agglomérations. Pour comprendre la dynamique de ces marchés, des enquêtes ont été menées dans cinq d'entre eux à Maradi et dans cinq aussi à Niamey, au Niger, au début de la saison sèche (octobre-novembre 2019), à la fin de la saison sèche (mars-juin 2020) et à la saison humide (août-septembre 2020), à l'aide d'un questionnaire semi-structuré. Les résultats ont montré que divers types d'aliments pour animaux étaient vendus ou achetés, principalement par des vendeurs ou des acheteurs adultes de sexe masculin, sur les deux sites et à toutes les saisons. Les acheteurs ont donné comme principales raisons d'achat des aliments pour bétail l'insuffisance de la biomasse alimentaire disponible dans leurs exploitations, la mauvaise qualité de ces aliments, et le besoin d'aliments complémentaires pour maintenir et améliorer les performances des animaux. Les prix des aliments pour bétail sur les deux marchés variaient significativement selon la saison, la localisation du marché et le type d'aliment. Dans les deux agglomérations, les prix des résidus de légumineuses (foin de niébé, gousse de niébé, fanes d'arachide) étaient plus élevés que ceux des autres types d'aliments. Les résultats ont également montré qu'il n'y avait pas de relation claire entre le prix et la qualité nutritionnelle en fonction des saisons.

Mots-clés : agriculture périurbaine, technique d'alimentation, ressources alimentaires, prix, valeur nutritive, Sahel, Niger

Resumen

Ayantunde A.A., Adamou K., Seybou G., Moumouni O. Los mercados de forraje en la zona periurbana de Níger a lo largo de las estaciones: perfiles de los vendedores y compradores, precios y calidad del forraje

La productividad del ganado en el Sahel del oeste africano está limitada por la escasez estacional de alimento y su mala calidad durante la estación seca. La escasez de recursos alimenticios en la región también se ha visto agravada por el aumento del número de cabezas de ganado, que ha incrementado la demanda de forraje, especialmente en las zonas periurbanas. Por ello, han surgido mercados de forraje en muchos pueblos y ciudades. Para comprender la dinámica de estos mercados, se realizaron encuestas en cinco mercados de Maradi y en otros cinco de Niamey, en Níger, al principio de la estación seca (octubre-noviembre de 2019), al final de la estación seca (marzo-junio de 2020) y en la estación húmeda (agosto-septiembre de 2020), utilizando un cuestionario semiestructurado. Los resultados muestran que se vendieron o compraron diversos tipos de forraje, principalmente por vendedores y compradores adultos de sexo masculino, en ambos lugares y en todas las estaciones. Los compradores señalaron como principales razones para la compra de forrajes la falta de biomasa alimenticia disponible en sus explotaciones, la mala calidad de estos alimentos y la necesidad de alimentos complementarios para mantener y mejorar el rendimiento de los animales. Los precios de los forrajes en ambos mercados variaban significativamente según la estación, la ubicación del mercado y el tipo de forraje. En ambas aglomeraciones urbanas, los precios de los desechos de leguminosas (heno de caupí, cáscaras de caupí, hojas y tallo de cacahuete) eran más elevados que los de otros tipos de forraje. Los resultados también mostraron que no había una relación clara entre el precio y la calidad nutricional en función de las estaciones.

Palabras clave: agricultura peri urbana, sistemas de alimentación, recursos de piensos, precios, valor nutritivo, Níger