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# Historical mobility and settlement transitions influence livestock farmers' climate risk perceptions and strategies against feed gaps in Central Côte d'Ivoire

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To meet the increasing demand for livestock and livestock products in Côte d'Ivoire, sedentary livestock farming in peri-urban areas is promoted; however, there is limited information on how these farmers manage production amid climate uncertainties. This study examined the livestock production system and evaluated farmers' perceptions of climate risks, livestock feed gaps, and management practices. A cross-sectional survey was conducted using a semi-structured questionnaire with 126 cattle farmers across two locations (Bouaké and Toumodi) in Central Côte d'Ivoire. The locations were selected as case studies representing two contrasting settlement histories of sedentary herding systems: Bouaké, with a non-pastoral tradition, and Toumodi, with a pastoral tradition. Overall, 98% of farmers reported using common grazing resources, with 70% practicing continuous year-round grazing. The most commonly perceived climate risks were decreased rainfall (94%) and increased temperatures (82%), which often led to frequent livestock feed gaps (88%) and negative impacts on livestock productivity (e.g., weight losses, mortality). Moreover, our logistic regression models revealed that perceptions of climate hazards and the occurrence of new diseases were location-specific ( $P < 0.01$ ), but the latter perception was attributed to increased herd movement to access water and forage. A high perception of climate risk was a greater concern across herders, regardless of the settlement history. However, the proportion perceiving low climate risk was generally higher among those with additional cropping activities, though this finding was inconclusive due to the small sample of mixed crop-livestock farms (25%). The primary management strategy to address feed gaps was increased mobility, which was more prevalent among herders in Toumodi (77%) with a pastoral tradition than among herders in Bouaké (~50%) ( $P < 0.05$ ). Furthermore, an exploratory latent class analysis of coping and adaptation strategies revealed that a subgroup of herders in Bouaké (42%) is not aware of significant innovative practices, making them a key target for support. We conclude that future climate adaptation efforts should prioritize underrepresented regions by

considering the specific production characteristics of settled herders and by strengthening connections among livestock keepers, breeders, and agroecological contexts.

#### KEYWORDS

adaptation, cattle, climate risk, sedentary herders, West Africa

## Introduction

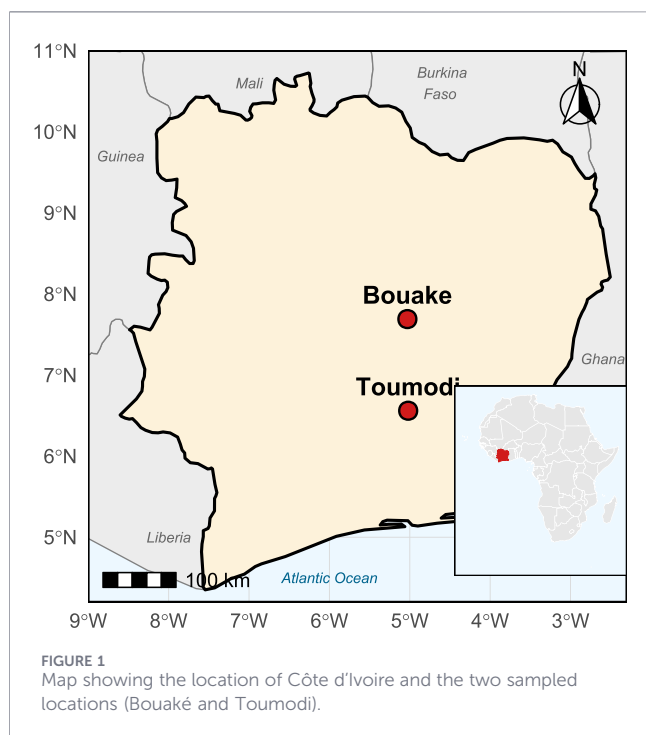
Livestock production is central to the economy in West Africa (WA) and plays a key role in the livelihoods of more than 100 million people (Molina-Flores et al., 2020; Zougmore et al., 2016). The production system in arid and semi-arid areas is traditionally managed by pastoralists who move large herds of livestock, such as cattle, seasonally into coastal areas for forage and water (Fernández-Rivera et al., 2004; Timpong-Jones et al., 2023). Therefore, the production system highly relies on rainfall patterns and vegetation dynamics for productivity (Turner and Schlecht, 2019; Zougmore et al., 2016). However, the arid and semi-arid areas of WA are among the most vulnerable regions to the changing climate (IPCC, 2022; Kongo and Arreyndip, 2025). For example, El Niño events led to extreme climatic conditions, including severe drought across many regions of WA with profound impacts on agricultural activities (Kongo and Arreyndip, 2025; Tefera et al., 2025). Given the increasing climate impacts at varying spatial scales within and between West African countries, herd mobility is necessary to exploit forage and water resources (Timpong-Jones et al., 2023; Turner and Schlecht, 2019). Although mobile livestock husbandry has been argued to be an adaptation strategy to climate uncertainties, it also faces local resource conflicts and mismanagement (Amoah et al., 2025; Timpong-Jones et al., 2023). As a result, most government livestock initiatives in WA support agro-pastoralism and sedentarization systems to reduce climate risks while enhancing livestock productivity (Gonin and Gautier, 2015; Koutchoro et al., 2025).

Nonetheless, these systems also rely on rainfall patterns, and questions remain about their suitability to manage the increased climate variability and resource competition due to shrinking grazing lands (Gonin and Gautier, 2015; Houessou et al., 2019; Zampaligré et al., 2019). Houessou et al. (2019) demonstrated that as settled pastoralists are confined to designated grazing areas, their dependence on natural vegetation is affected by ongoing climate change. In this context, feed gaps (FG) and their frequency (FG frequency) may pose serious risks for sedentary herders. Therefore, understanding perceptions of climate change and its impacts can be a valuable way to assess risks and develop more effective adaptation strategies to climate uncertainty (Douxchamps et al., 2016; Huet et al., 2020). A number of recent studies have highlighted herders' perceptions of climate change, its impacts, and how they deal with uncertainty in WA (Djakpa et al., 2024; Kima et al., 2015; Koutchoro et al., 2025; Tetteh et al., 2023; Tidjani et al., 2025; Zampaligré et al., 2014; Zampaligré et al., 2019). In general, these studies examined how herders in WA perceive climate change and its effects on the production system and provided important insights into key adaptation strategies. Moreover, they also indicate perceptions of semi-pastoralists and sedentary herders across different West African countries. For example, in semi-arid Northern Benin,

Djakpa et al. (2024) showed that pastoralists observed climate change, particularly in rainfall and temperature variability, and had adopted strategies such as introducing new breeds, sedentarizing animals, and altering mobility patterns to complement feed and water resources. In sub-humid Burkina Faso, Kima et al. (2015) demonstrated that the majority of agro-pastoralists perceived changes in temperature rather than in rainfall amounts, and adopted measures such as destocking and the use of crop residues during periods of feed scarcity. Several factors have previously been identified as determinants of both perceptions and adaptation strategies, including access to land and herd size, access to information and extension services, government support, household income, experience, and motivation, among others (Deressa et al., 2008; Huet et al., 2020; Menghistu et al., 2020). Nevertheless, there is a need to evaluate perceptions of the risks posed by climate hazards and their frequency. This approach could provide a context-specific understanding of the degree of variability in risk perceptions, thereby improving farmers' adaptive capacity (Huet et al., 2020). Furthermore, there is a need to expand research on perceptions of climate change and livestock herders' adaptation in other neglected regions of WA.

In Côte d'Ivoire (CIV), for instance, although the livestock sector accounts for only 4.5% of agricultural GDP, current efforts aim to increase self-sufficiency in livestock products (Molina-Flores et al., 2020; Ministère des Ressources Animales et Halieutiques, 2022). The primary goal of these efforts is to develop livestock policies that aim to sedentarize herds and promote peri-urban livestock production, particularly to increase meat supply amid climate uncertainties. Yet, livestock production in these systems remains largely underexploited (Bosson et al., 2022), and there is insufficient research on how those herders perceive and respond to climate-induced impacts. Additionally, Kongo and Arreyndip (2025) highlighted that CIV is vulnerable to climate hazards, such as drought, thereby raising uncertainty about the future of livestock production. There have been studies reporting on farmers' perceptions of climate change and practices for dealing with climate uncertainties in CIV (Bodji et al., 2017; Bosson et al., 2022; Comoé and Siegrist, 2015; Djezou and N'Goran, 2024). However, most studies extensively discuss farmers' perceptions of current climate variability, mainly focusing on cropping systems, while sedentary cattle farming remains underrepresented. Additionally, empirical studies on how settlement history influences husbandry and climate-risk management, towards intensification of livestock production have received little attention (Ayantunde et al., 2020). In effect, it is important to understand how the contrasting settlement histories of pastoralists and non-pastoralists influence climate change in sedentary livestock farming. Additionally, assessing the differences in climate risk perception and management will be crucial towards livestock intensification.

To address this research gap, we conducted a field survey at two locations in CIV, specifically, in Bouaké and Toumodi. Livestock



herders in Toumodi were traditionally pastoralists with large herds who had transitioned to a sedentary system, whereas herders in Bouaké have no pastoral tradition (Sokouri et al., 2014) (See section *Settlement history, origin, and location background*). Accordingly, Bouaké and Toumodi are treated throughout this study as case studies of two contrasting cattle husbandry systems, distinguished primarily by their settlement histories and grazing traditions. This allows us to characterize the current cattle husbandry practices among sedentary herders with different pastoral traditions and to analyse their perceptions of hazards and risks, primarily related to climate, feed gaps and their impacts. Feed gap is defined as a period during which the quantity and/or quality of mainly available forage is deficit for livestock nutritional and physiological requirements, typically driven by intra- and inter-seasonal shortages in pasture growth (Lamega et al., 2021; Moore et al., 2009). The study further documents differences in current management strategies across the two locations to characterize herders' adaptation profile. We hypothesize that perceptions of climate hazards, risks associated with feed gaps, and adaptation strategies differ across locations because settlement history has influenced husbandry practices. As such, this study is important for developing effective solutions to improve sedentary livestock farming in CIV, with broader implications for WA.

## Materials and methods

### Description of the study area

The study was conducted in Côte d'Ivoire, bordered by Mali and Burkina Faso to the North, Guinea and Liberia to the west, Ghana to the East, and the Atlantic Ocean to the south (Figure 1). The climate is generally characterized by four major seasons: a long dry season

(November-February), a long rainy season (March-June), a short dry season (July-August), and a short rainy season (September-October) (Sokouri et al., 2014). Two locations in the central part of CIV were selected for this study: Bouaké (7.69° N, 5.03° W), located in the Vallée Bandama district, and Toumodi (6.56° N, 5.02° W), located in the Lacs district (Figure 1). Cropping systems in the central CIV area are mostly rainfed, with cassava (*Manihot esculenta* Crantz), maize (*Zea mays* L.), yams (*Dioscorea alata* L.), and Bambara groundnuts (*Vigna subterranea* L.) being the most important crops, cultivated in mixed farming systems (Bonny et al., 2019). Both locations belong to the Sudano-Guinean agroecological zone (Sokouri et al., 2014). An estimated 17.4% of national cattle production in Côte d'Ivoire comes from the central region (Sokouri et al., 2014), significantly lower than the Northern region's estimated contribution of 78.3%. However, ongoing efforts to promote and expand domestic livestock production while reducing pressure on grazing resources have focused on developing livestock programs in the central region (Sokouri et al., 2014; Ministère des Ressources Animales et Halieutiques, 2022; Thébaud and Corniaux, 2019).

### Settlement history, origin, and location background

In this study, Bouaké-Toumodi differences are primarily linked to their settlement history and pastoral tradition, but we also recognize that the two sites differ along several other factors. First, regarding the ethnic and demographic composition, there is evidence indicating that the herder population of Toumodi predominantly descends from Fulbe (Peul) pastoralists of Sahelian origin. Their herds have gradually migrated into the sub-humid Sudano-Guinean and Guinean savannas of West Africa over the past several decades, in response to recurrent droughts in the Sahel region and changing access to rangelands (Bassett and Turner, 2007). As a consequence, they historically received comparatively favourable integration under Ivorian state policy relative to neighbouring countries (Mlan et al., 2020; Zampaligré et al., 2019). While Fulbe pastoralists were historically characterised by greater herd mobility, many Fulbe herders subsequently adopted semi-transhumant or sedentary lifestyles (Fortes-Lima et al., 2025). Bouaké's herders, by contrast, are drawn predominantly from local, historically non-pastoral agricultural populations who adopted cattle-keeping as a peri-urban commercial activity without an inherited tradition of herd mobility (Bernadet, 1988). According to Touré (2007), cattle traders have evolved into an important group of cattle owners in the peri-urban centre of Bouaké owning predominantly beef cattle (Touré, 2007). Second, the two locations differ in market access and urban scale. For example, Toumodi is a substantially smaller town compared to Bouaké, but is closer to the main cities such as Yamoussoukro and Abidjan, differences that potentially shaped access to markets and commercialization. In addition, cattle production in Toumodi was historically promoted through government policies and initiatives and the establishment of a research ranch in the 1960s to support cattle production in the region (Thébaud and Corniaux, 2019). We argue nonetheless that this comparative advantage (e.g., market-access and urban-proximity) is a product of the strategic settlement history of

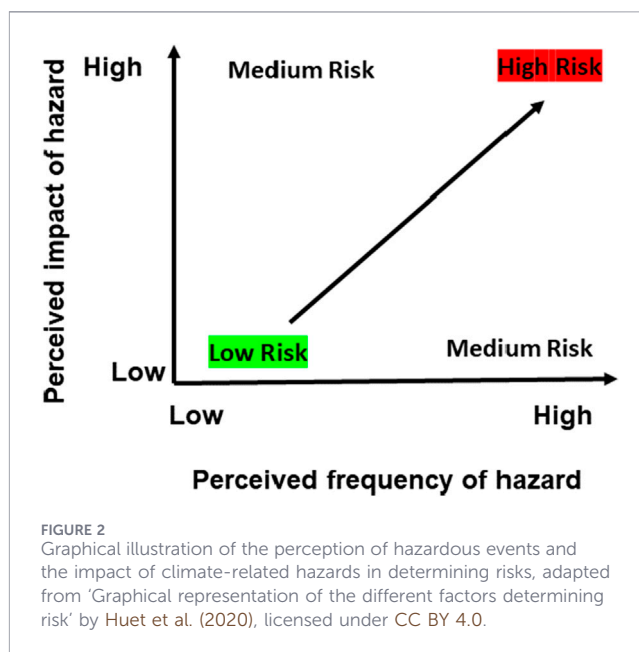
herders in Toumodi. Consequently, the two locations were deliberately chosen to contrast two husbandry systems influenced by their respective settlement histories. Livestock farmers in Toumodi have historically been pastoralists who have adopted sedentarization, whereas herders in Bouaké are characterized by peri-urban sedentarization. Throughout this document, the non-pastoral sedentary tradition in Bouaké and the settled pastoral herding tradition in Toumodi are referred to as shorthand for these systems, rather than as accurate representations of the geographic regions of Bouaké and Toumodi.

## Sampling procedure and data collection

A survey was conducted on 126 farms across the two locations (Bouaké, Toumodi) in April 2024, with assistance from extension officers from the National Ministry of Animal and Fisheries Resources. Data were collected through semi-structured interviews with either the farm owner or the herder. The selection prioritized contrast in production-system type and settlement history, and was conducted independently of the total number of cattle or the primary livelihood activity at each location. However, to ensure that the sample from each location was representative, we engaged enumerators who first met and organized cattle herders. From there, initial volunteers were selected, and additional herders were sampled based on the focus group discussion results. As such, the sampling method employed was snowball sampling, a type of convenience sampling in which the researcher selects the initial volunteers based on their relevance to the study topic or their relationship to the target demographic (Mkansi et al., 2025; Ting et al., 2025). This selection method relies on non-random criteria, where participants are linked through existing social networks (Ting et al., 2025). However, using pre-existing social networks is a practical way to identify initial cattle farmers, thereby extending the database of farmers from which the questionnaire was later administered. In effect, a list of cattle herders was provided for each location as the starting point for the sampling frame. The selected cattle herders then provided the contact details of other herders invited to participate in the survey.

The respondents from Toumodi accounted for 52.4% of farms ( $n = 66$ ), while those from Bouaké accounted for 47.6% ( $n = 60$ ). The total data of 126 herders are considered adequate for descriptive and binary logistic regression analyses, as long as the independent variables are accounted for. Data were collected on farm-specific aspects of livestock production, climate risks, perceptions of the FG, and the use of adaptation measures in both locations. The questionnaire was divided into sections (Supplementary Table S1). The table's first section focused on the socioeconomic profile of the farm head, including age and educational level. The second section covered livestock management, including livestock feeding systems, herd size, and cattle types. The third section addressed respondents' perceptions of climate change, as well as the challenges and opportunities of addressing FG.

A translator, trained in the local language (Dioula, the main language of cattle farmers in Côte d'Ivoire), conducted the questionnaire in Toumodi, and another translator did so in Bouaké. All respondents were male, with the majority aged 31–50. The exclusively male respondents reflect the socio-cultural context in which large livestock ownership and management in



central Côte d'Ivoire is predominantly male-dominated (Babo et al., 2022).

## Data analysis

### Description of livestock production Systems between locations

All descriptive and statistical analyses were performed in R (version 4.2, R Core Team, 2022). Before the analysis, the survey data were checked and cleaned of possible errors and missing values. In the first step, descriptive statistics (e.g., mean, frequency, percentage) were used to describe livestock production and household information (Supplementary Table S1, part A). In addition, specific information was subjected to bivariate analysis (Pearson's chi-squared ( $\chi^2$ ) or Fisher's Exact test) to test the significant differences between groups when appropriate.

### Perception of climate risks and perceived impacts

In a second step, we highlighted livestock herders' perceptions of climate risks based on the perceived likelihood of climate hazards and the perceived impact of climate hazards. Here, we adapted the interpretation of risks as "the probability of a particular hazardous event taking place against the probability of reaching a certain outcome" (Brooks, 2003; Huet et al., 2020) (Figure 2). In other words, the vulnerability of the livestock production system was assessed based on the perceived impact of a climate-related hazard and its related impacts. Hence, climate hazard events, such as drought (characterized by reduced precipitation), rising temperatures, and extreme rainfall, were selected as relevant to the study region in the current climate change context. According to Bodji et al. (2017), farmers in Côte d'Ivoire primarily perceive climate variability as changes in rainfall and temperature. We then assessed the impact of these hazardous events, plotting them against perceived impact (as indicated by

FG perceptions and their frequency), in line with the conceptual framework (Figure 2). In effect, when herders perceive only one hazardous event occurring occasionally, they perceive its frequency as low to medium. Meanwhile, if at least two hazards occur, the hazard frequency is considered high, and if all three hazards are perceived to have occurred recently, the frequency is considered extreme. However, for the study, the latter three-hazard combinations were not applicable; hence, the perceived frequency of the hazard was classified as low to medium (0) or high (1). On the other hand, the perception of the occurrence of FG (No/low: happening occasionally, yes/high: happening almost every year) and the FG frequency (irregular: happening occasionally, regular: happening almost every year) were defined as reported by Lamega et al. (2021). Chi-squared ( $\chi^2$ ) tests were conducted to identify the association between perceptions of hazards and perceived impact, and to evaluate the risks (low, medium, and high) associated with locations and farm activities, in line with the conceptual framework (Figure 2).

### Analysis of the influencing factors on the perception of climate risks and feed gaps

In the third step, binary logistic regression models were used to analyze factors associated with cattle herders' perceptions of climate-related events and their impacts (e.g., feed gaps). For this analysis, the dichotomous variables included perceptions of climate events and the presence or absence of impacts (scoring 1 if the herder had a positive perception and 0 otherwise), while the explanatory variables comprised socio-economic information and the production system (Supplementary Table S1). Generalized Linear Models (GLM) with a Logit Link for Binary Logistic Regression were employed to analyze these effects. The GLM logit model incorporated both production (farm activity, grazing system, production system, cattle herd size, etc.) and socio-economic (gender, education, main income, experience, foreign status, etc.) factors. However, since no women held the position of household head or farm manager, gender was excluded from the model. The model was estimated at a 5% confidence level to identify significant factors influencing cattle herders' responses to climate hazards, FG, FG frequency, and the occurrence of new diseases due to climate change. Positive signs in the variable estimates indicate that as the value increases, the probability that the herder perceives the outcome positively also increases, and the reverse is true for negative estimates. The Variance Inflation Factor (VIF) was determined for each variable in the global model to evaluate multicollinearity. Here, a VIF threshold of 10 was employed to address multicollinearity (Abebe et al., 2025). The most parsimonious model with the lowest Akaike Information Criterion was subsequently chosen through stepwise model reduction, i.e., by reducing the number of predictor variables when appropriate (Bartoń, 2020). Furthermore, if a model showed an exceptionally large coefficient estimate and standard error for a specific predictor, a bias-reduced logistic regression was employed instead, using the *brglm2* R package (Kosmidis et al., 2020). The logistic regression model can be expressed as shown in Equation 1.

$$\text{logit}(P/(1-P)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad (1)$$

where: P Probability of a herder perceiving hazardous events or climate risks,  $[P/(1-P)]$  odds or likelihoods ratio, which refers to the

odds of the perception;  $\beta_0$  intercept;  $\beta_1 X_1 \dots \beta_k X_k$  are the regression coefficients of production and socio-economic factors. A similar model was also used to examine the perception of feed gaps and their frequency.

In addition, the remaining variables (i.e., perceptions of the effects of feed gaps on livestock production; strategies to address feed gaps; and innovative strategies to improve livestock systems; see Supplementary Table S1) were analyzed using bivariate analysis. This analysis identified the most influential factors in perceptions and strategies across locations and farm activity, followed by *post hoc* pairwise tests.

### Typology of coping with feed-gap coping and innovative adaptation strategies

To assess whether herders' reported coping strategies and prospective adaptation or innovation strategies formed distinct husbandry clusters beyond geographic location, an exploratory latent class analysis (LCA) was conducted using the *poLCA* package in R (Linzer and Lewis, 2011). The analysis included twelve binary indicators, i.e., six current coping strategies (continuous grazing, crop-residue feeding, feed purchase, destocking, increased mobility, national transhumance) and six potential innovations (digital herd monitoring, breeder cooperatives, paddock rotation, government aid, adapted breeds, drought-resistant forage), across all valid responses from the herders. Models with one to four latent classes were estimated, and the number of classes was selected using the Bayesian Information Criterion (BIC).

## Results

### Household description and livestock production characteristics

The number of participants was well distributed across the two locations (Table 1). All respondents were male, attributable to the selection criteria requiring contact mainly with cattle farmers. In Bouaké, 100% of the responding herders were farm heads with an average of 20 years of farming experience. In contrast, Toumodi had a mix of farm heads (73%) and managers (27%), with an average farming experience of 25 years. More than half of the respondents (59.5%) have some level of education. As expected, there was substantially higher share of foreign-born/immigrant respondents in Toumodi (75%) relative to Bouaké (25%; Table 1) which is consistent with the strategic settlement history (see *Settlement history, origin, and location background*). The respondents indicated to have originated from countries such as Burkina Faso, Mali and Niger. The average cattle herd size was higher in Toumodi (114.1) than the average in Bouaké (56.37) (Table 1); the median herd size values were more comparable, (60 in Toumodi and 50 in Bouaké). The reported herd size refers to the total combined herd but the respondents also kept additional livestock, including goats, pigs, and sheep, which were not directly recorded in this study.

Overall, 75% of respondents identified as livestock-only farmers, while 25% were mixed crop-livestock (agro-pastoral) (Table 1). The

TABLE 1 Descriptive results of the household information and farm characteristics (Bouaké: non-pastoral tradition sedentary herders N = 60, Toumodi: pastoral tradition, settled for sedentary herding N = 66) and across all herders (N = 126).

| Characteristic                           | Locations        |                   |                        |
|------------------------------------------|------------------|-------------------|------------------------|
|                                          | Bouaké<br>N = 60 | Toumodi<br>N = 66 | All herders<br>N = 126 |
| Gender: Male (%)                         | 100              | 100               | 100                    |
| Farm head as a respondent (%)            | 100              | 72.70             | 85.7                   |
| Farming experience (years)               | 19.8             | 25.2              | 22.8 ± 10              |
| Formal education (yes) (%)               | 49.9             | 68.7              | 58.70                  |
| Origin CIV (%)                           | 75               | 25.8              | 49.20                  |
| Average herd size (cattle)               | 56.4             | 114.1             | 86.6 ± 112.9           |
| Additional livestock (%)                 | 64.9             | 54.5              | 59.52                  |
| Livestock-farm as a primary activity (%) | 48.3             | 89.2              | 69                     |
| Additional cropping activity (%)         | 18.3             | 32.8              | 25.4                   |
| Natural pasture lands utilization (%)    | 100              | 95.5              | 97.6                   |
| Year-round grazing feeding system (%)    | 44.1             | 95                | 69.7                   |
| Additional dairy cattle (%)              | 0                | 6.1               | 3                      |
| Farms owning Zébu cattle (%)             | 100              | 87.7              | 93.2                   |

percentage engaged in crop-livestock activity was higher in Toumodi (32.8%) than in Bouaké (18.3%), although this difference was not statistically significant ( $\chi^2 = 2.68$ ,  $P = 0.1$ ). This discrepancy likely results from the selection criterion, which selected farms with predominantly livestock activities. Moreover, the large majority of respondents (89.2%) in Toumodi considered livestock keeping as their primary economic activity, compared with 48.3% in Bouaké ( $\chi^2 = 22.77$ ,  $P < 0.001$ ). For the remaining Bouaké respondents, livestock keeping is a secondary activity, while their primary activities include crop farming or off-farm/peri-urban employment, reflecting the more diversified urban economy of Bouaké, Côte d'Ivoire's second-largest city.

Regarding grazing systems, most herders (69.7%) practice year-round grazing. Herd feeding management across both locations involves grazing natural pastureland. However, year-round grazing of these pastures was more prevalent in Toumodi (95%), whereas in Bouaké, only 44% of herders allowed it, despite high utilization of grazing resources (Table 1). A possible reason for this is the smaller herd size in Bouaké and the lower reliance on livestock activities, which may provide greater economic and management flexibility for stall-feeding.

All farms kept beef cattle ( $n = 126$ ), while only 3.2% of the farms ( $n = 4$ ) kept dairy cattle in addition. Zebu cattle were the most common breed, followed by mixed breeds (16%), with N'dama, Meres, Baoulé, and their crossbreds making up less than 5%. Farms are engaged in the sale of livestock and livestock products through private abattoir and butchery services (91%), but also through livestock traders (50%). The main costs for livestock production varied by location. In general, the current on-farm expenses reported by herders included medicines and veterinary consultations (99%), salaries (58%), feed (49%), land rental (30%), and water resources (7%). However, a higher proportion

of farmers in Toumodi reported expenses for veterinary costs (51%), salaries (38%), and land (27%), whereas feed costs were reported by a higher proportion of farmers in Bouake at 29%.

## Diversity in the perception of climate hazards, risk, and the influencing factors

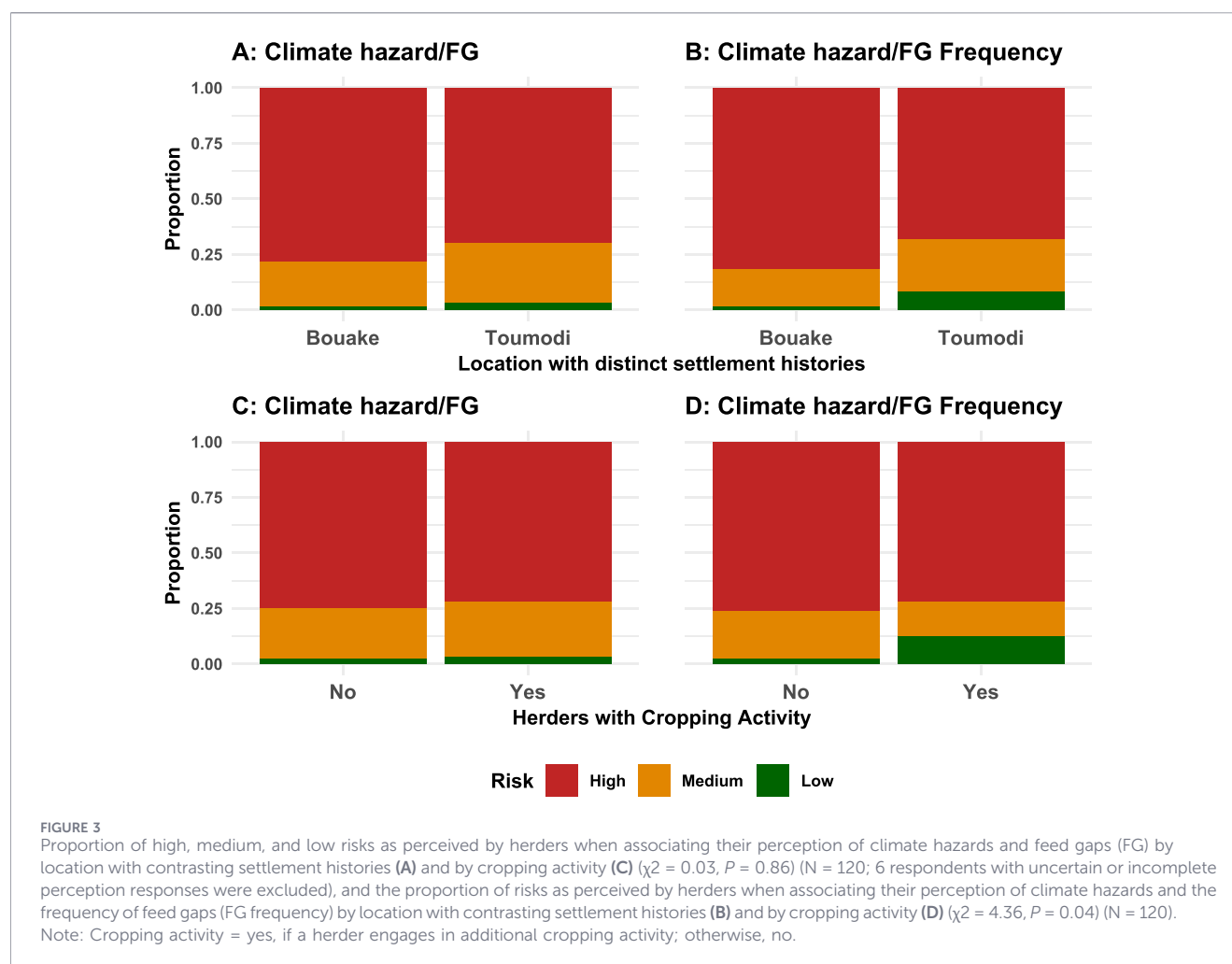
The most common climate hazards perceived by livestock farmers were increased rainfall breaks and increased temperatures. Across the two locations, approximately 94% of the herders interviewed reported changes in rainfall patterns, including unusual breaks in rainfall. In Toumodi, the within-location percentage was 97%, compared with 90% in Bouaké (overall 94%; Table 2); therefore, no statistically significant differences were observed between the two locations ( $P = 0.15$ ). Approximately 82.5% of herders overall reported an increase in mean temperature; however, this perception was significantly more prevalent in Bouaké (93.3%) than in Toumodi (72.7%) ( $P = 0.002$ ; Table 2). This result was consistent with the significant effect of location on climate-hazard perception in the regression model ( $P = 0.01$ ; Supplementary Table S2).

The majority (80%) reported both rainfall breaks and increased temperatures, while 20% reported at least one climate hazard (e.g., rainfall breaks/drought, temperature increases, increased precipitation). Interestingly, long-term weather records (1981–2010) compared with the most recent years (2018–2023) at the two locations showed particularly strong increases in temperature from May to September in Toumodi and from July to November in Bouaké (Supplementary Table S3). On the other hand, we found a significant increase in rainfall in Toumodi in recent years, whereas in Bouaké we observed a decrease between April and August. Thus, cattle herders' observations appear to align, to some extent, with

TABLE 2 Herders' perceptions of climate hazards and their impacts by location (Bouaké and Toumodi) and overall (N = 126).

| Perception of climate hazards and impacts    | Bouaké | Toumodi | Overall | P-value         |
|----------------------------------------------|--------|---------|---------|-----------------|
| Increased rainfall breaks <sup>#</sup>       | 90%    | 97%     | 93.7%   | 0.15            |
| Increased rainfall (total) <sup>*</sup>      | 10%    | 0%      | 4.8%    | <b>0.01</b>     |
| Increased mean temperature <sup>#</sup>      | 93.3%  | 72.7%   | 82.5%   | <b>0.01</b>     |
| Perception of feed gaps <sup>*</sup>         | 83.3%  | 92.3%   | 88%     | 0.21            |
| Regular occurrence of feed gaps <sup>*</sup> | 86.7%  | 88.9%   | 87.8%   | 0.92            |
| Occurrence of new diseases <sup>*</sup>      | 50%    | 81.8%   | 66.7%   | <b>&lt;0.01</b> |

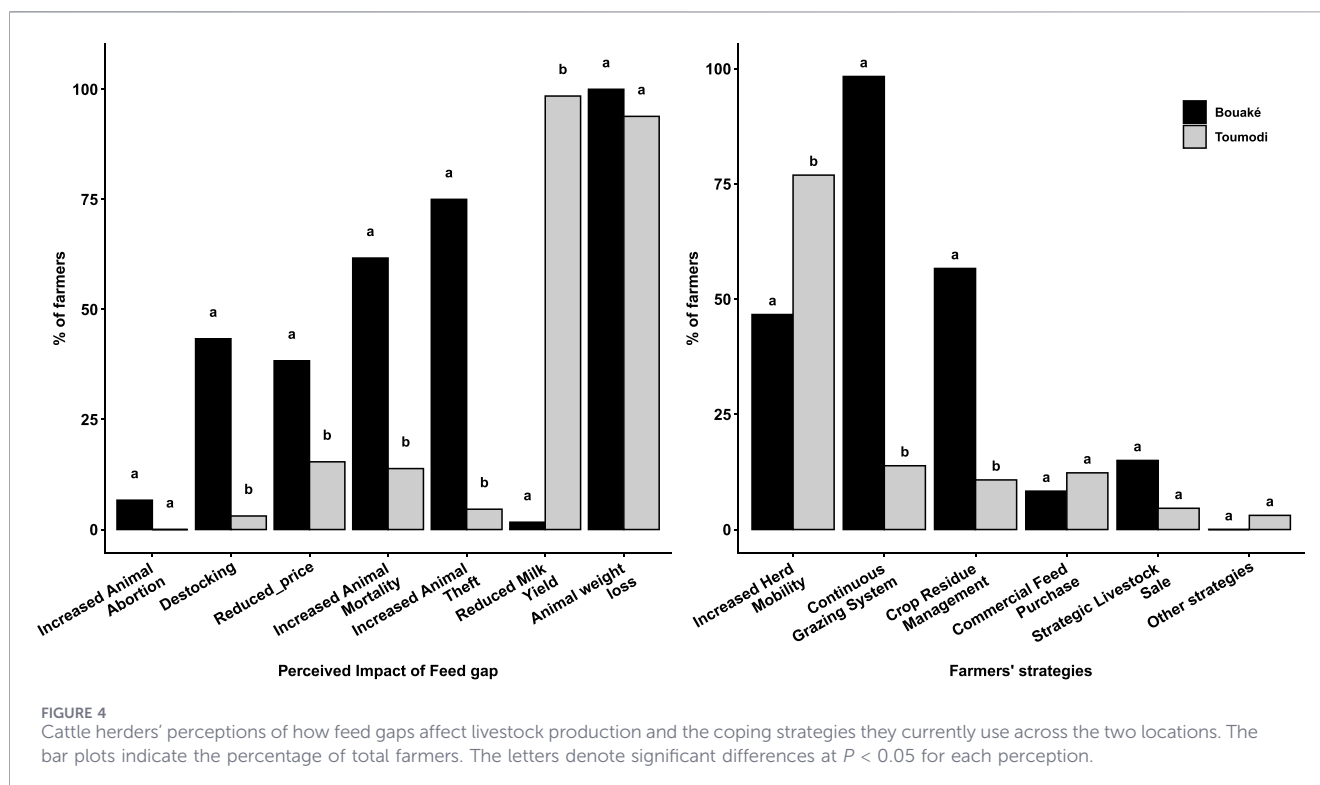
Values are the percentage (%) of respondents reporting a positive perception of each predictor. Location differences were assessed using Pearson's  $\chi^2$  (\*) or Fisher's Exact test (#). Bold values indicate statistically significant results ( $p < 0.05$ ).



changes in weather. Regarding herders' own perceptions of total rainfall, only a small minority overall (4.8%) perceived an increase, and this perception was significantly more common in Bouaké (10%) than in Toumodi (0%) ( $P = 0.010$ ; Table 2). As a result, the majority of herders perceive feed gaps (88%), and these gaps occur more frequently (88%) (Table 2); no significant location difference was found for either feed gap perception ( $P = 0.21$ ) or its frequency ( $P = 0.92$ ). Only 4% of herders were unsure whether

feed gaps existed, and 3% were unsure whether they occurred regularly. Interestingly, they also cited the emergence of new diseases as one of the impacts of climate hazards (66%). This perception was significantly higher in Toumodi (82%) than in Bouaké (50%) ( $\chi^2 = 14.32$ ,  $P < 0.01$ ; Table 2).

The association between perceptions of climate hazards and the occurrence of feed gaps was not significant ( $\chi^2 = 0.03$ ,  $P = 0.86$ ). In effect, the risk perception was similar across the two locations



(Figure 3A) and between farming activity (Figure 3C). In contrast, the association between the perception of climate hazard and the frequency of feed gaps was significant ( $\chi^2 = 4.36$ ,  $P = 0.04$ ). This was explained by a higher proportion of low-risk perceptions in Toumodi than in Bouaké (Figure 3B). Additionally, herders who engaged in additional cropping activities had a higher perception of low risk (Figure 3D). However, the differences are small and may also reflect the fact that a higher percentage of mixed crop-livestock (agro-pastoralists) were located in Toumodi (Table 1). Overall, the results indicate that high-risk perception was a stronger concern across farms, regardless of the settlement history or farming activity. Perceptions of feed gaps and their frequent occurrence are common among farms with large herds (Toumodi) as well as among farms with smaller herds (Bouaké). Interestingly, the results suggest that, particularly regarding the frequency of feed gaps, agro-pastoralists tend to perceive low risk more often (Figure 3D), despite having a similar perception of high risk associated with feed gaps (Figure 3C). This is partly because mixed crop-livestock farmers can mitigate feed gaps during less severe periods by using crop residues, thereby reducing the perceived frequency of these gaps.

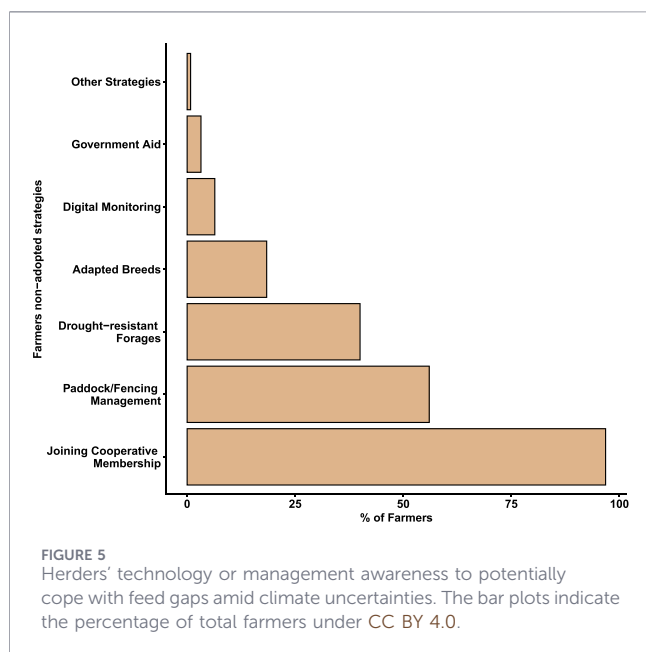
## Factors influencing perceptions of climate hazards and feed gaps

According to the logistic regression model outputs (Supplementary Table S2), many factors (household information, production system) did not have a significant impact on the probability of the perceptions; however, factors such as location and grazing system significantly or marginally influenced the perception (Supplementary Table S2). Accordingly, residing in Toumodi was associated with a significantly lower perceived risk

of climate hazards ( $P = 0.01$ ), and the practice of seasonal grazing marginally decreased the probability of perceiving climate hazards ( $P = 0.08$ ) (Supplementary Table S2). Interestingly, having household help was associated with a decreased likelihood of perceiving a feed gap, although this was not significant ( $P = 0.08$ ; Supplementary Table S2). Being in Toumodi significantly influenced farmers' perceptions of the occurrence of new diseases affecting livestock production ( $P < 0.01$ , Supplementary Table S2). For the given data set, however, McFadden's *Pseudo-R*<sup>2</sup> indicated that the models for the perception of climate hazards, feed gaps, and the occurrence of new diseases had a moderate fit (0.15–0.16), while the model for the frequency of feed gaps had no strong predictive value (Supplementary Table S2).

## Feed gaps, challenges, and strategies

The perceived effects of feed gaps and current coping strategies were plotted to assess differences between locations (Figure 4), which could clearly be linked to the settlement history. The perceived effects of feed gaps ranged from animal physiology (e.g., body weight loss, which may occur frequently) to management and farm economics (e.g., premature sales of animals at reduced prices) (Figure 4). The perception of animal body weight loss did not differ by location ( $P > 0.05$ ). Nearly 100% of farmers in both locations reported this effect, indicating a longer-term impact on overall farm productivity. Among non-pastoral Bouaké herders, for example, the effects of feed gaps may be harsh, occasionally increasing animal theft due to increased mobility (75%) or leading to animal mortality (>50% of farmers). In Toumodi, the impacts are often negligible or moderate, except for milk reduction, which was considered a significant effect reported by all herders



(Figure 4,  $P < 0.01$ ). In general, financial losses were also perceived as significant in Bouaké, as herders are quick to destock and sell livestock at reduced prices during periods of severe feed gaps to avoid mortality ( $P < 0.01$ , Figure 4).

Our results further indicate that cattle herders employed a range of coping strategies to address feed gaps. The most common strategies included increasing livestock mobility to seek pasture, such as through national transhumance (i.e., different forms of transhumance taking place within the country of origin), and using crop residues as feed. These strategies vary between the two locations ( $P < 0.05$ ). In Toumodi, where herders have a history of pastoralism, mobility increased significantly (76.9%). Meanwhile, the use of crop residues as additional feed is significantly higher in Bouaké (56.7%) than in Toumodi (10.8%), despite the presence of agro-pastoralists in Toumodi. This discrepancy largely reflects a management strategy in which collecting crop residues, forages, or tree leaves as feed was more common as a preventive measure than growing fodder crops specifically for this purpose. In Bouaké, 44% of herders practiced year-round continuous grazing (Table 1), and most supplemented their animals with crop residues (57%) to mitigate feed gaps. Therefore, the combination of year-round grazing and residue supplementation was the dominant strategy in Bouaké. Meanwhile, in Toumodi, increasing mobility to better manage animals was the most common strategy. Nevertheless, other less common coping strategies among farmers included purchasing feed, selling livestock (destocking), and feeding specific tree leaves.

Additionally, herders described potential innovative strategies and specific management techniques that could be improved to reduce climate risk. Herders reported strengthening the association of cattle breeders (98%) to promote and coordinate programs for livestock breed improvement, thereby increasing profitability and system performance. The use of paddocks for pasture rotation (57%)

and the utilization of forages adapted to drought (38%) were relatively common among herders (Figure 5). In this respect, cattle herders aim to manage pastures effectively to prevent uncontrolled grazing and, by using drought-resistant forage, potentially extend the grazing season.

Moreover, an exploratory latent class analysis of coping and innovative adaptation strategies identified three classes of herders (BIC = 1280.9; Figure 6). Class 1 ( $N = 62$ , of which 61 are from Toumodi) relies heavily on mobility (78%) but has limited crop residue management (11%), with relatively high intent for the utilization of paddocks (75%) and drought-resistant forage (76%). Meanwhile, Class 2 ( $N = 28$ , of which 25 are from Bouaké) is characterized by reliance on continuous grazing (100%) and relatively higher destocking (20%), but also engages in mobility (90%) and reports high use of national transhumance (47%). However, awareness of drought-resistant forages (6%) and adapted livestock breeds (12%) as management strategies to address feed gaps was low, although nearly 25% of herders were interested in using paddocks for rotational grazing. Class 3 ( $N = 34$ , all herders from Bouaké), by contrast, is characterized by continuous grazing (99%) and feeding on crop residues (97%), with low mobility (11%). In class 3, the standout innovative management strategy for the herders is implementing paddocks for rotational grazing (Figure 6).

## Discussion

The present study evaluated cattle herders' risk perceptions and management strategies in response to climate variability in central Côte d'Ivoire. The findings for the locations, i.e., Bouaké and Toumodi, reflect the two sedentary production systems with contrasting settlement histories (non-pastoral and pastoral, respectively). Three main results support settlement history and pastoral tradition as the most parsimonious explanation for the specific contrasts: (i) the consistent divergence in respondent geographic origin (Table 1); (ii) the location-specific herd mobility, transhumance use, and disease-risk perception; and (iii) the similarities between our findings and independent studies of pastoral mobility and sedentarization elsewhere in West Africa's Sudano-Guinean zone (Koutchoro et al., 2025; Tidjani et al., 2025). In effect, our results suggest that herders commonly perceived rising temperature and variable rainfall patterns. Most herders reported more frequent feed gaps and new diseases (Supplementary Table S2). Herders' observed impacts of feed gaps ranged from negative effects on animal physiology to impacts on farm management and economics. Risk assessments, based on the interaction between perceptions of climate hazards and feed gap frequency, showed that herders in Toumodi tended to have a relatively higher proportion of low-risk perceptions. Meanwhile, there were no significant differences between locations in the proportion of high-risk perception, indicating that herders are generally vulnerable regardless of their location, production, or management systems (Figure 3). Moreover, this location effect on low-risk perception reflects the specific interaction between climate-hazard perception and feed-gap frequency, whereas a comparison of feed-gap frequency did not differ significantly between locations (86.7% vs. 88.9%,  $P = 0.920$ ; Table 2).

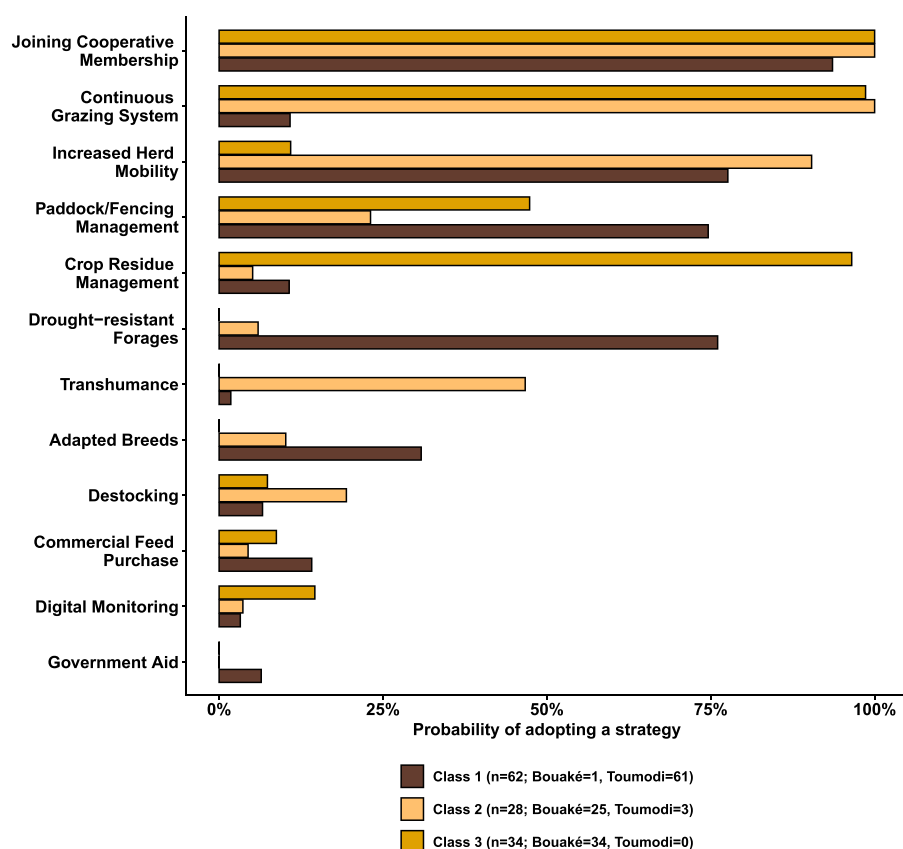


FIGURE 6

Latent classes combining herders' strategies and new management intentions. The bar plots indicate the probability of adopting each strategy within each latent class. Ranked from top to bottom: herders and breeders association/cooperative, Continuous grazing, increased herd mobility, use of paddocks, utilization of crop residues, planted drought-resistant forages, transhumance, livestock breeds adapted to drought, destocking, feed purchase, digital tools for monitoring vegetation and animal health, and government aid under CC BY 4.0.

## A livestock production system at high risk

Generally, farmers in West Africa are aware of climate change, which is often perceived as weather variability (Amadou et al., 2022; Comoé and Siegrist, 2015; Djakpa et al., 2024; Kima et al., 2015). With respect to the Sudano-Guinean zone Thompson and Amos (2017) found a higher perception of increasing temperatures as well as seasons of increased rainfall breaks (Thompson and Amos, 2017). Therefore, herders' perception of changes in rainfall patterns and increased temperatures as the main climate-related hazards (Table 2) is consistent with the literature. However, regarding perceptions of rainfall changes, herders at both locations reported a strong perception of increased rainfall breaks. Our rainfall trend results (Supplementary Table S3) did not support this finding; instead, they showed an overall increase in rainfall, except in Bouaké, where we observed a slight decrease between April and July. This discrepancy between perception and observation is justified because the rainfall data (Supplementary Table S3) capture changes in total monthly and seasonal rainfall amounts, whereas herders' perceptions mostly reflect changes in the intra-seasonal distribution. This means that any temporal irregularity of rainfall, specifically the occurrence of dry spells (e.g., late rainy season), would be perceived as "increased rainfall

breaks". This distinction, whereby farmers in Sub-saharan Africa (SSA) assess rainfall variability as within-season dry spells, is well-documented in the climate perception literature in SSA (Amadou et al., 2022; Bodji et al., 2017; Comoé and Siegrist, 2015; Huet et al., 2020), and in Côte d'Ivoire, it has been associated with the recognition of unpredictable rainfall patterns, rather than rainfall amounts (Comoé and Siegrist, 2015). Consequently, even a year with above-average total rainfall may include prolonged intra-seasonal dry spells that reduce soil water availability and pasture growth, all of which may directly trigger livestock feed gaps. On the other hand, we noted an increase in mean temperatures that aligns with herders' observations. Recent climate studies on rainfall and temperature trends in West Africa also reported extreme weather variability (Efon et al., 2023; Kima et al., 2015; Tefera et al., 2025). Tefera et al. (2025) showed that in Ghana and Burkina Faso, temperature and rainfall increased between 1881 and 2021, confirming broader global climate change patterns (Tabari, 2020). Furthermore, higher temperatures directly affect surface water availability through evaporation, which can influence farmers' risk perceptions. Some effects of increased temperature on livestock have been thoroughly discussed in the literature. These include decreased quantity and quality of feed resources, reduced milk yield, body weight loss, reduced reproductive performance, and disease

(Godde et al., 2021; Moore et al., 2009; Rojas-Downing et al., 2017; Thornton et al., 2009). Notably, perceptions of increased mean temperature were significantly more common in Bouaké than in Toumodi (93.3% vs. 72.7%,  $P = 0.002$ ; Table 2), consistent with the effect of location on the climate-hazard-perception outcome in the regression model ( $P = 0.01$ ; Supplementary Table S2). In contrast, perceived increases in rainfall breaks did not differ significantly between the two locations (90.0% vs. 97.0%,  $P = 0.150$ ; Table 2), suggesting a shared concern over intra-seasonal rainfall distribution regardless of settlement history. In effect, our results showed that risk perceptions associated with feed gaps were similar across the two locations, with negative implications for sedentary herding (Figures 3A,C).

In contrast, the perceived frequency of feed gaps and their impacts on cattle differed between Bouaké and Toumodi (Figure 4), suggesting a strong effect of the local environment and farm type/management. Our logistic regression outputs reinforce this, showing that location and management rank above socioeconomic factors (Supplementary Table S2). First, the results suggest that residing in Toumodi significantly decreased the probability of perceiving climate hazards ( $P = 0.01$ ); simultaneously, herders in Toumodi recorded the highest perception of new livestock diseases (81.8% vs. 50.0% in Bouaké,  $\chi^2 = 14.32$ ,  $P < 0.01$ ; Supplementary Table S2). This finding appears paradoxical, but the two locations differ in management and adaptive capacity. Herders in Toumodi possess larger herds (~114 vs. 56 TLU), greater herding experience embedded in mobility strategies, and are considerably more reliant on livestock as their primary economic activity (89.2% vs. 48.3% in Bouaké, Table 1). In effect, their lower climate risk perception may be linked to their greater control over feed resources, likely achieved through seasonal mobility. Greater herd mobility can also provide herders more opportunistic access to spatially and temporally variable natural resources, thereby buffering the impacts of seasonal food shortages (Ayantunde et al., 2014). In Bouaké, increasing urbanization has led to a gradual decrease of peri-urban grazing areas and might therefore limit farmers' opportunities to access grazing resources within the area (Bamba et al., 2025). The availability of feed resources, and therefore also the occurrence of feed gaps, partly depends on the season but also on the types of crops grown in the area (Umutoni et al., 2015). As in this study no feed samples were analyzed, it is not possible to test whether the type of crops growing in the study area and thus the feed values are significantly different between the sites. In addition, although this finding was not statistically significant, a greater proportion of livestock herders from Toumodi are also practicing crop production. According to Lamega et al. (2021), additional crop production has shown to decrease the effect of feed gaps. However, moving herds across landscapes in search of pasture exposes animals to new disease environments, thereby increasing the likelihood of new disease emergence. However, Djakpa et al. (2024) reported that transhumant herders did not perceive a significant increase in the incidence of new diseases due to climate change in northern Benin. In a similar context, Comoé and Siegrist (2015), in Korhogo (Nord Côte d'Ivoire) and Toumodi (central Côte d'Ivoire), found that farmers attributed pest and disease outbreaks to climate change, consistent with our results.

Second, the marginal effects of seasonal grazing and having household help (farm help) also support the distinct adaptive

capacity of farming households. Therefore, herders who practice seasonal rather than year-round grazing could actively manage pasture access, thereby buffering against feed shortages that drive perceptions of climate change. Meanwhile, having household help enables cut-and-carry feeding practices that potentially decouple animals from direct feed stress during dry periods. The results further indicate that in the central CIV context, structural production systems, e.g., location, settlement history, grazing system, and access to labour, rather than socioeconomic factors, shape the perceptions of climate risks, although socioeconomic factors may also play a role (Dang et al., 2019; Menghistu et al., 2020; Tetteh et al., 2023).

## Managing feed gaps and implications of this study

Despite differences in the perceived climate hazards and impacts on cattle, our results showed no clear difference in high-risk perception across locations (Figure 3). In reality, our results suggest that high-risk perception means herders face significant climatic threats to livestock production in central Côte d'Ivoire.

Nevertheless, farmers' perceptions of climate threats can differ across locations, as shown by Comoé and Siegrist (2015), due to local environmental and socioeconomic conditions.

In the present study, we focus on cattle herders and perceived climate risks related to forage availability, which may limit consideration of perceived impacts on other aspects of the farming systems. A critical challenge that herders face in SSA is the feed gap, projected to worsen due to climate uncertainties (Duguma and Janssens, 2021; Karimi et al., 2018; Kima et al., 2015; Lamega et al., 2024; Zougmore et al., 2016). Interestingly, the potential for a low-risk perception increased in Toumodi, possibly because nearly a third of herders (32.8%; Table 1) are agro-pastoralists who cultivate crops primarily as an alternative livelihood. This suggests that engaging in cropping may also help buffer the impact of the feed gap, or rather, periods of low rangeland productivity, consistent with other studies in SSA (Amadou et al., 2022; Deressa et al., 2011; Lamega et al., 2021; Menghistu et al., 2020; Zampaligré et al., 2019).

In this regard, two main approaches were identified as strategies against feed gaps. These strategies were: herd mobility or flexibility, which was common among herders in Toumodi, and feeding crop residues, which was notably prevalent among herders in Bouaké (Figure 4). However, the results also showed that herders in Toumodi predominantly practice year-round (continuous) grazing of natural pasture (95% vs. 44% in Bouaké; Table 1); given their comparatively larger herds, this pattern may place additional pressure on rangeland productivity despite their reliance on mobility. The herd sizes recorded here in Toumodi exceed those typically reported for smallholder mixed crop-livestock herds in the West African Sahel, which are usually well under 30 TLU, but are broadly consistent with the larger scale of specialized, market-oriented peri-urban and pastoral cattle-keeping documented elsewhere in the sub-region (Amadou et al., 2022; Kaimba et al., 2011). It is well understood that herders across WA primarily rely on natural pasture for livestock feed. Consistent with our study, Sokouri et al. (2014) found that herders in Côte d'Ivoire preferred locally adapted breeds, such as Zebu cattle, as

an appropriate response to rangeland and environmental degradation because they can withstand high temperatures and suit long walks. Using such breeds supports continuous local grazing or transhumance, i.e., moving animals in search of new pastures and water, even during severe feed gaps. Generally, herders in Toumodi have long developed mobility strategies to maximize access to pasture, as noted by Comoé and Siegrist (2015). This strategy is widespread among pastoralists and semi-pastoralists (Kaimba et al., 2011), and compared with large herds, small-herd farms are usually less mobile (Houessou et al., 2019; Kaimba et al., 2011). Interestingly, although only 6% of Toumodi herders formally keep additional dairy cattle (Table 1), even predominantly beef-oriented Zebu herds of pastoral origin are routinely milked for household consumption and local sale in West African pastoral systems (Babo et al., 2022; Molina-Flores et al., 2020). As a result, a reduction in forage availability translates directly into perceived milk loss for most herders (Babo et al., 2022; Molina-Flores et al., 2020). By contrast, Bouaké's herders manage smaller, non-mobile, purely beef-oriented herds without this milking tradition, so the same feed gaps instead manifest as acute physical and financial impacts, e.g., animal theft, mortality, and distress sales, rather than milk loss. This adds to the reasons why herders in Toumodi, who have significantly larger herds, adopt increased mobility as an adaptive strategy. Such an approach offers an opportunity to access alternative grazing lands for feed, whereas Bouaké's herds plausibly buffer feed gaps directly, at the cost of body condition, survival, and forced destocking (Figure 4). However, increased mobility as an adaptation strategy has only limited potential for expansion, as land-use conflicts remain a major challenge for livestock production in WA (Timpone-Jones et al., 2023; Turner and Schlecht, 2019). In contrast, livestock farmers in the Sudano-Guinean zone and the Sudanian zone in Benin, where land-use conflicts also constrain pastoral mobility, predominantly perceived sedentarization as a strategy that could increase animal weight and health as well as improve access to feed and water (Tidjani et al., 2025).

Thus, complementing herd mobility with feeding crop residues was considered an important strategy to address feed gaps, consistent with other studies across similar livestock production systems in Iran (Karimi et al., 2018), Ethiopia (Bryan et al., 2009), South Africa (Lamega et al., 2024), Benin (Koutchoro et al., 2025), or Senegal (Eeswaran et al., 2022). Yet, the lower utilization in Toumodi, despite a higher proportion of agro-pastoralists, suggests that the potential of crop-livestock systems remains underexploited. It should be noted that not all crop residues are nutritionally equivalent as supplementary feed. In this paper, crop residues were treated as a general category, without distinguishing between different types of crops. In Benin, for example, Houessou et al. (2019) argued that the failure of crop-livestock integration, in which forage is grown and provided to animals during dry spells, stems from agro-pastoralists viewing crop cultivation as an alternative source of income rather than as a means of managing livestock risk. Furthermore, in Ethiopia, Abazinab et al. (2022) showed that, despite mixed crop-livestock systems being ranked as the most important adaptation strategy to climate change by livestock farmers, forage production ranked lowest, mainly due to a lack of knowledge about forage production, a shortage of seeds, and a shortage of land. This is also true for herders in central Côte

d'Ivoire, and as suggested by Sokouri et al. (2014), they do not want to grow forage for their animals because they believe that owning local breeds is enough to withstand harsh environmental conditions. As such, destocking to ensure sufficient feed was available was mainly seen as a consequence of climate impacts rather than as a strategy during periods of feed shortages. Interestingly, the latent class analysis (Figure 6) indicates that herders in Bouaké are not homogeneous in their coping and adaptation. A subgroup of herders (42%) also relies heavily on mobility and transhumance, strategies more typical of Toumodi. This suggests that some herders may be transitioning away from strictly sedentary systems and calls for targeted management policies.

Currently, some West African countries have climate act plans aimed at improving farmers' adaptation strategies in animal husbandry. These investments should help alleviate the pressure on rangelands and decrease dependence on seasonal mobility. In this study, we observed that herders recognize the need to improve pasture management, including the use of drought-resistant forage crops and paddock rotation (Figure 5). Additionally, belonging to a cooperative that supports breeding initiatives and veterinary support may be crucial for sedentarization. Pastoralists and semi-pastoralists prioritize traits that tolerate drought and heat stress (Eeswaran et al., 2022), a priority that can be supported through cooperative efforts. Climate adaptation plans for herders also recognize the specific agroecological context in which they live, as it influences their adaptation measures (Snaibi et al., 2021; Zampaligré et al., 2014). Therefore, promoting the development of institutions, facilitating and empowering participatory approaches could be a first entry point for managing grazing resources for herders in central Côte d'Ivoire.

## Limitations of the study and future perspectives

Although the sample size ( $N = 126$ ) and the cross-sectional design were appropriate for this study, they may have limited statistical power to detect socio-economic effects and may have prevented causal inference regarding the relationships among perception, coping strategies, and risk outcomes. Furthermore, we collected the sample through snowball sampling, prioritizing contrasting settlement histories; therefore, our findings should be considered indicative of the sampled communities rather than fully representative of all sedentary cattle-farming households in central Côte d'Ivoire. Future research involving a survey across diverse locations along the Sahel-Sudanian gradient, covering the full range of agro-ecological conditions, location dynamics, and settlement histories, could enhance understanding of perceived risk patterns and lead to more robust conclusions. In addition, the questionnaire did not record herd sex or age structure, so we cannot verify the proportion of breeding females, young stock, and males within the reported herd sizes at each location. West African cattle herds, including those of pastoral origin, are typically managed as breeding (cow-calf) herds in which female animals dominate and underpin milk production, herd growth, and long-term wealth accumulation, rather than as feedlot-style herds of marketed males (Amadou et al.,

2022; Babo et al., 2022). Consequently, include this composition distinction in future surveys could prove interesting to capture the specific role of female animals but also of the women who are often responsible for their management and milk processing, and small ruminants even in male-headed pastoral households (Babo et al., 2022).

Moreover, future research exploring the types of crop residues prevalent in the area and cattle management practices could provide deeper insights into cattle production systems in central Côte d'Ivoire.

## Conclusion

This study offers an initial assessment of cattle herders' perceptions of climate hazards and their perceived impacts, comparing two locations with different settlement histories to evaluate risks. We demonstrated that the settlement and husbandry history, and the grazing system, were the main drivers of risk perception, supporting our hypothesis that the local agroecological context and settlement history shape how herders experience and respond to climate uncertainty. However, climate-hazard perception only marginally supported the hypothesis, as perceived rainfall breaks did not differ across locations. This is because the frequency of feed gaps is primarily driven by stochastic weather fluctuations, underscoring the unpredictability of climate-related risks to livestock feed among sedentary herders in central CIV. Therefore, while promoting sedentarization, livestock development policies must be reconciled with the reality that seasonal herd mobility remains essential as a coping mechanism, particularly in Toumodi, where herders have a pastoral history. Moreover, improving small-scale communal water points and infrastructure would likely reduce herd mobility and the associated disease risk. Given that agro-pastoralists tend to perceive lower climate-related risk, policies should actively support crop-livestock integration in central CIV, including subsidizing fodder crop production and crop residue management infrastructure for non-pastoral herders in Bouaké. Integrating bioclimate indicators or satellite-derived vegetation indices (NDVI) alongside farmer perceptions would help disentangle actual climate exposure from perceived climate risk and further strengthen the evidence base for climate-resilient policy targeting. In effect, this study lays the foundation for future research in comparable settings and recommends multi-site designs that explicitly distinguish settlement history from factors like market access and urban proximity; additionally, it gathers data on herd sex and age structure, as well as quantitative feed-balance information, alongside perception surveys. Overall, our findings suggest that climate policies must acknowledge the ongoing, functional importance of herd mobility even among those who are settled.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical approval was not required for the studies involving humans because the research involved a questionnaire-based survey of livestock farmers and did not involve the collection or analysis of human biological samples or any medical or physical interventions. The study was conducted in accordance with applicable local legislation and institutional requirements. Participation was voluntary, and written informed consent was obtained from all participants prior to data collection. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

TE, SL, A-JN'G, and JI conceptualized and designed the study. TE, A-JN'G, AA, and FK conducted field data collection. TE analyzed and drafted the manuscript. SL, A-JN'G, AA, FK, and JI edited and reviewed the manuscript. SL provided supervision. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontierspartnerships.org/articles/10.3389/past.2026.17299/full#supplementary-material>

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