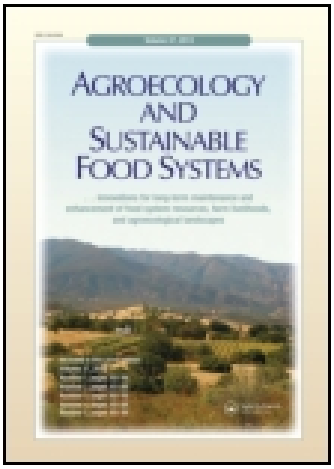


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# Adaptation of Periurban Cattle Production Systems to Environmental Changes: Feeding Strategies of Herdsmen in Southern Benin

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# Adaptation of Periurban Cattle Production Systems to Environmental Changes: Feeding Strategies of Herdsmen in Southern Benin

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*We undertook a survey of 112 cattle farms in the periphery of Cotonou in Benin, with the aim to characterize the diversity of the production systems and to better understand herders' feeding strategies and perspectives. We used the categorical component analysis and two-step clustering techniques to classify the farms into homogeneous groups. The adaptive strategy of a given farm was predicted through logistic regression analysis technique. Four distinct farm types were identified as follows: large integrated agro-silvopastoral (17%), small agro-silvopastoral (28%), pastoral (30%), and silvopastoral (25%). Irrespective of farm type, low availability, and difficult access to pasture due to increased crop/vegetable farming, climate variability and urbanization were commonly reported by all herders. Current coping strategies included the use of lowlands pastoral resources and exploring new grazing routes. Future strategies included moving animals towards rural locations and significantly ($p < 0.001$) depended on farm type and its proximity to urban centers.*

*KEYWORDS cattle farming, farm typology, urban fringes, resilience, adaptive strategies*

I. B. Koura and L. H. Dossa contributed equally to the contents of this article.

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## 1. INTRODUCTION

Livestock occupies a prominent place in the economy of West African countries and contributes up to 30% to the total gross domestic product (GDP) (Renard et al. 2004) and 44% to agricultural GDP with about 60,000,000 heads of cattle (CSAO-OCDE/CEDEAO 2008). In Benin, it contributes about 6.2% to the total GDP (Food and Agriculture Organization of the United Nations [FAO] 2006). The large and increasing urban demand for milk, milk products, and meat has facilitated the development of cattle farming activities around most sub-Saharan African cities (Alary and Faye 2007; FAO 2009). According to Ly et al. (2010) it is the low capacity of rural pastoral systems in West Africa to satisfy the urban demand that favors the development of the periurban production systems. But, paradoxically, livestock farms and animal numbers in the periurban areas of the region have been rising rapidly along with the urbanization of these areas, causing a shrinkage of grazing areas and a depletion of feed resources (Coulibaly et al. 2007; Ly et al. 2010). Feed scarcity has become the major constraint in the periurban ruminant production systems (Coulibaly 2008; Hamadou et al. 2008; Duku et al. 2010) and as a response, herders have developed various coping strategies (Hamadou et al. 2008; Duku et al. 2010; Amadou et al. 2012). Despite its importance, cattle production in and around the major and secondary cities in southern Benin has received very little attention from research, development and policy. Consequently, little is known about the different prevailing production systems and adaptive feeding strategies of the cattle herders. The objective of this study was, therefore, to characterize these production systems in terms of their diversity and feeding coping strategies in order to face the rapidly changing environmental conditions in the area.

## 2. MATERIALS AND METHODS

### 2.1. Study Area

The study area covered a radius of 35 km around the city of Cotonou. This area is geographically situated between 6.15° and 6.42° North latitude and between 2° and 2.15° East latitude and included mainly the municipalities of Abomey-Calavi and Ouidah (Figure 1). The climate is the subequatorial type, characterized by two rainy seasons alternating with two dry seasons. The soils are sandy, hydromorphic, lateritic, and ferruginous types (Volkoff 1976–1978). The vegetation consists of shrubs, grassland swamps, swamp forest, and mangrove forest on the coastal belt and of semi-deciduous dense forests on soil tray bar (Akoègninou et al. 2006).

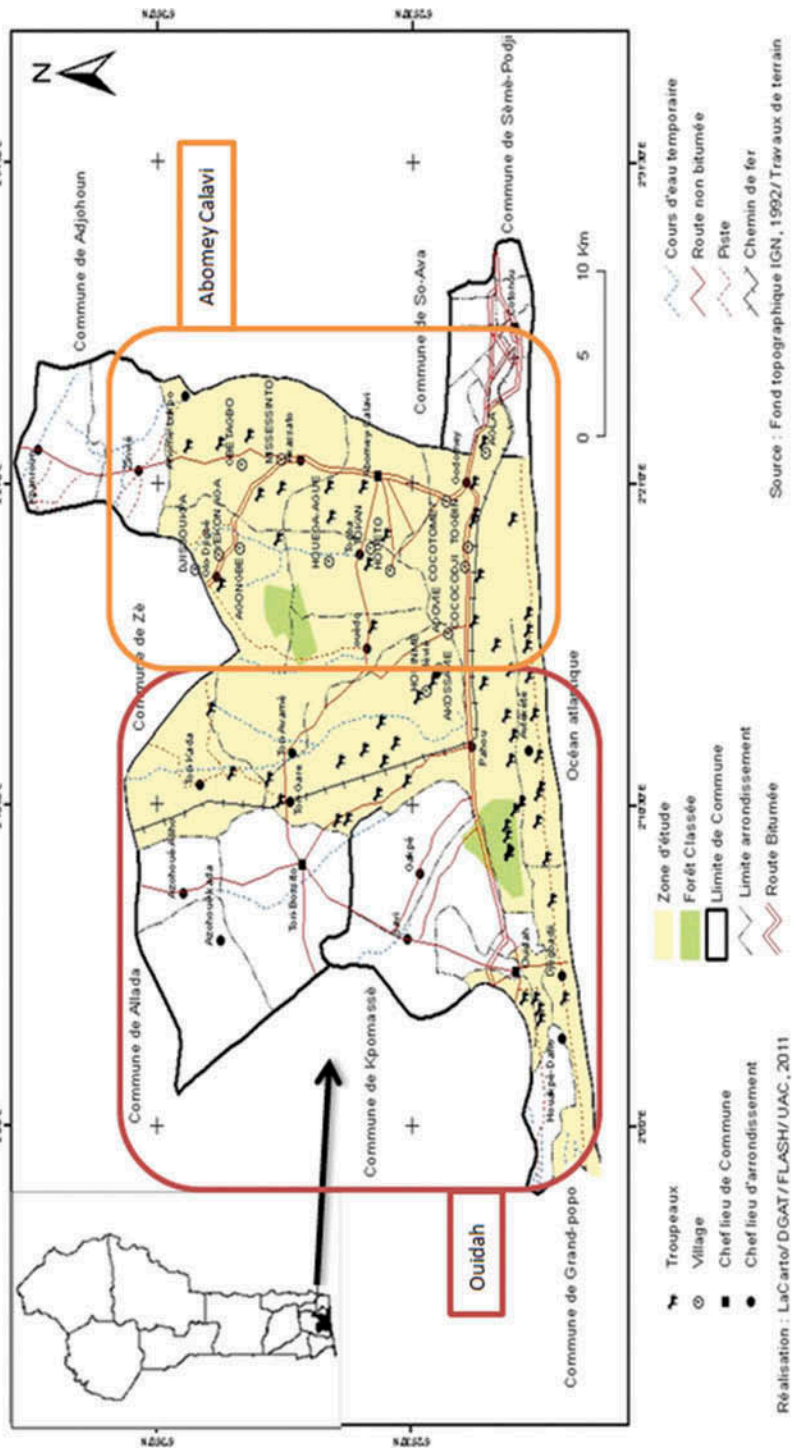


**FIGURE 1** Study area in southern Benin.

## 2.2. Data Collection

A total of 112 farms were surveyed between October and November 2012 using a semi-structured questionnaire including questions on the farm socioeconomic characteristics, the cattle management practices, the production threats particularly those related to feed and the herders' current and future coping strategies. Table 1 presents the list of variables included in the questionnaire. Sixty percent of the farms surveyed were located in the town of Abomey-Calavi and the 40% remaining in Ouidah.

## 2.3. Data Analysis

### 2.3.1. Farm typology

As both nominal and metric variables were used to describe the characteristics of the farms, categorical principal components analysis (CATPCA), implemented in the module categories SPSS/PASW 17 (SPSS Inc. 2010), was performed to explore the relationship between the original variables and to reduce the set of 12 variables into a smaller number of components. Only variables that loaded greater than 0.5 (Dominguez-Rodrigo et al. 2009; Costantini et al. 2010; Dossa et al. 2011) on one of the components were selected for further analysis. The variables retained were then used in the two-step cluster analysis procedure to identify homogeneous clusters of farms. We used the log-likelihood distance measure to establish different clusters (up to 15 clusters) and the Schwarz-Bayesian information criterion (BIC) to decide which cluster-solution showed the best fit (Mooi and Sarstedt 2011). The obtained groups were characterized and named. Cross-tabulations, with calculation of chi-square statistics were used to compare the farm types for their qualitative characteristics whereas means and standard deviation values of the continuous variables were calculated and compared across farm types using the non-parametric Kruskal-Wallis W test. The Mann-Whitney test was used for post hoc analyses.

### 2.3.2. Herders' perceptions of reasons for feed scarcity

Recorded herders' perceptions were analyzed according to the characteristics of farms. Cross-tabulations and chi-square statistics were used to relate the perceptions to qualitative characteristics of the farm types. The Mann-Whitney U test was used for comparing the quantitative variables between groups.

### 2.3.3. Herders' coping strategies

Cross-tabulations and chi-square statistics were used to analyze the relationship between the characteristics of farms and future adaptation strategies

**TABLE 1** Main variables included in the questionnaire administered to 112 cattle herders in southern Benin

| Variables | Farm characteristics | Perceptions of reasons for feed scarcity | Coping strategies |
|---|---|---|---|
| Categorical | | | Current |
| | Administrative unit (Calavi, Ouidah) | Loss in forage species diversity (yes, no) | Herd division (yes, no) |
| | Farm land ownership (yes, no) | Low availability of pasture (yes, no) | Moving herd to other area close to Cotonou (yes, no) |
| | Source of labour (family, hired, both) | Lack of access to pasture (yes, no) | Exploring new grazing routes (yes, no) |
| | Practice of crop cultivation (yes, no) | Low water availability (yes, no) | Exploiting low lands (yes, no) |
| | Possession of land title (yes, no) | Lack of access to water (yes, no) | Herd definitive displacement far from Cotonou (yes, no) |
| | Feeding mode (grazing only, grazing + supplementation) | Herder's effort (more, less) | Future (Moving, other) |
| | Use of tree fodder (yes, no) | | |
| | Involvement in conflicts (yes, no) | | |
| | Tree plantation (yes, no) | Main factor influencing feed availability (agriculture, urbanization, climate variability, high concentration of livestock, extension of sand quarries) | |
| Continuous | | | |
| | Tree plantation area (ha) | Walking distance (km) | |
| | Total farm size (ha) | Walking duration (h) | |
| | Total cropped area (ha) | | |
| | Workforce (n) | | |
| | Cattle herd size (heads) | | |
| | Distance to the nearest urban center (km) | | |
| | Number of herd's owners (n) | | |

of the herdsmen. Then a stepwise logistic regression analysis using the backward procedure was performed to identify the socioeconomic factors that affect herder's choice of a given future strategy (1: moving or 2 others) and adoption of dietary restrictions.

## 3. RESULTS

### 3.1. Cattle Farm Typology

Source of labor, practice of crop cultivation, possession of land title, feeding mode, tree plantation, size of plantation, total farm size, total workforce, and herd size were retained for the farm classification based upon the results of the CATPCA analysis (Table 2). The two-step cluster analysis suggested four distinct farm types named as follows; large agro-silvopastoral farms (LAS, 17%), small-scale agro-silvopastoral farms (SAP, 28%), pastoral farms (PAS, 30%), and silvopastoral farms (SIP, 25%). Tables 3 and 4 show the main characteristics of the four farm types.

*Farm type 1 (LAS,* n = *19 farms)*: this was the smallest group but comprised the largest farms in terms of cattle herd size (64 heads), total farm

**TABLE 2** Results of CATPCA analysis performed on 112 periurban cattle farms in southern Benin

| | | |
|---|---|---|
| Total Cronbach's alpha[a] | 0.898 | |
| Total eigenvalue | 5.668 | |
| Total % variance | 47.235 | |
| | Dimension | |
| | 1 | 2 |
| Cronbach's alpha | 0.793 | 0.547 |
| Total eigenvalues | 3.664 | 2.004 |
| % total variance | 30.532 | 16.703 |
| Label | Component loadings | |
| Farm land ownership | 0.101 | 0.487 |
| Source of labour | −0.035 | **0.847** |
| Crop cultivation | **–0.857** | −0.121 |
| Possession of land title | **0.691** | −0.108 |
| Feeding mode | **0.641** | −0.059 |
| Tree plantation | **–0.692** | −0.133 |
| Tree plantation area | **–0.742** | −0.336 |
| Total farm size | **0.625** | −0.262 |
| Workforce | −0.260 | **0.719** |
| Cattle herd size | **–0.505** | −0.014 |
| Distance to nearest urban center | −0.387 | −0.371 |
| Number of herd's owners | −0.371 | 0.408 |

*Note*. Bold data represent loads greater than 0.5 supporting the retention of the corresponding variables for the farm classification analysis.

[a]Total Cronbach's alpha is based on the total eigenvalue.

**TABLE 3** Quantitative characteristics of the four periurban cattle farm types identified in southern Benin

| Quantitative variables | Farm type | | | |
|---|---|---|---|---|
| | LAS ($n = 19$) | SAP ($n = 31$) | PAS ($n = 34$) | SIP ($n = 28$) |
| Workforce ($n$) | $1.7^{a} \pm 0.8$ | $1.9^{a} \pm 0.9$ | $1.3^{bc} \pm 0.5$ | $1.3^{c} \pm 0.5$ |
| Total farm size (ha) | $8.6^{a} \pm 6.9$ | $3.8^{bd} \pm 3.9$ | $1.8^{c} \pm 1.1$ | $4.1^{cd} \pm 4.5$ |
| Tree plantation area (ha) | $8.2^{a} \pm 6.8$ | $1.9^{bd} \pm 2.8$ | $0.0^{c} \pm 0.2$ | $2.8^{d} \pm 3.5$ |
| Cattle herd size (heads) | $64.4^{a} \pm 31.6$ | $50.4^{abc} \pm 25.8$ | $38.8^{b} \pm 20.3$ | $43.5^{bd} \pm 22.4$ |
| Walking duration in wet seasons (h) | $8.4^{a} \pm 1.0$ | $7.0^{bd} \pm 1.0$ | $6.3^{c} \pm 0.8$ | $6.8^{d} \pm 1.3$ |
| Walking duration in dry seasons (h) | $9.3^{a} \pm 1.0$ | $7.6^{b} \pm 1.0$ | $7.3^{c} \pm 1.0$ | $8.0^{d} \pm 1.3$ |

$^{a,b,c,d}$Significant differences between means on the same line; Kruskal–Wallis test.

LAS = Large agro-silvopastoral; SAP= Small agro-silvopastoral; PAS= Pastoral; SIP= Silvopastoral.

**TABLE 4** Qualitative characteristics of the four periurban cattle farm types identified in southern Benin

| Variables | LAS ($n = 19$) | SAP ($n = 31$) | PAS ($n = 34$) | SIP ($n = 28$) | $\chi^2$ | $P$ ($\leq$) |
|---|---|---|---|---|---|---|
| Source of labor | | | | | 60.4 | 0.001 |
| Family | 95 | 36 | 100 | 100 | | |
| Hired | 0 | 13 | 0 | 0 | | |
| Both | 5 | 52 | 0 | 0 | | |
| Crop cultivation | | | | | | |
| Yes | 73.7 | 64.5 | 0 | 0 | 61.0 | 0.001 |
| No | 26.3 | 35.5 | 100 | 100 | | |
| Tree plantation | | | | | | |
| Yes | 100 | 61.3 | 0 | 100 | 81.6 | 0.001 |
| No | 0 | 38.7 | 100 | 0 | | |
| Possession land title | | | | | | |
| Yes | 100 | 65 | 24 | 82 | 38.1 | 0.001 |
| No | 0 | 35 | 76 | 18 | | |
| Feeding mode | | | | | | |
| Grazing (G) only | 0 | 100 | 100 | 100 | 112.0 | 0.001 |
| G + supplementation | 100 | 0 | 0 | 0 | | |
| Perceived forage species disappearance | | | | | | |
| Yes | 79.0 | 32.2 | 6.0 | 57.1 | 32.7 | 0.001 |
| No | 21.0 | 67.8 | 94.0 | 42.9 | | |
| Perceived changes in walking distances | | | | | | |
| Longer | 79.0 | 71.0 | 100 | 75.0 | 11.04 | 0.05 |
| Shorter | 21.0 | 29.0 | 0.0 | 20.0 | | |

LAS = large agro-silvopastoral; SAP = small agro-silvopastoral; PAS = pastoral; SIP = silvopastoral.

size (8.6 ha), and area under tree plantation (8.2 ha). which represented 95% of the total farm size. The area under crop cultivation was about 1.2 ± 1.0 ha. These farms were mainly located in Ouidah (84%) and were

the farthest (≈13.0 km) from the urban center compared to farms in other groups. Furthermore, in sharp contrast with the other 3 farm types, they possessed a land title, offered feed supplements (mainly crop residues) to their animals, and did not use tree fodder. The majority (90%) of herders in this farm group experienced conflicts with crop farmers and walked significantly ($p < 0.001$) longer distances in search of forage and water during both wet (8.4 hours) and dry (9.3 hours) seasons than herders from other farm types. Herdsmen average age was 35.9 ± 8.8 years.

*Farm type 2 (SAP,* n = *31 farms)*: This group shared many similarities with the previous, but had significantly ($p < 0.001$) lower total farm size (3.8 ha) and area under plantation (1.9 ha). The area under tree plantation represented one half of the total farm size. The second half was used for crop cultivation. Farms in this group used significantly ($p < 0.001$) higher hired labor than in other three farm groups. Considerable proportions of them were located in Ouidah (68%) and had land title (65%).

*Farm type 3 (PAS,* n = *34 farms)*: this was the largest farm group in our sample. Compared to other groups, farms in this group were significantly predominant (75%) in Abomey-Calavi and significantly ($p < 0.001$) fewer proportions of them had a land title (24%) and experienced conflicts with crop farmers (6%). They had significantly ($p < 0.001$) the lowest total farm size (1.8 ha) and cattle herd size (38 heads). They were neither involved in crop cultivation, nor in tree plantation. The herders were significantly ($p < 0.001$) younger and walked significantly ($p < 0.001$) shorter distances in search of forage and water (6.3 and 7.3 hours in wet and dry seasons respectively) compared to their counterparts from the other three groups.

*Farm type 4 (SIP,* n=*28)*: Farms in this group shared similarities with farms in LAS and SAP groups, especially in terms of location, proportions of farms owning land title, involvement in conflict with crop farmers, and practice of tree plantation. But in sharp contrast to farms in the two other groups, they did not grow crops. This group was also characterized by the higher proportion of farms (39%) using tree fodder to feed their animals compared to farms in LAS (0%), SAP (13%), and PAS (18%). Average farm size was 4.1 ha with more than half (2.8 ha) under tree plantation. Its herd size (43 head) was comparable to those in SAP and PAS farm groups but significantly lower than in the LAS farm group.

## 3.2. Herdsmen Perceptions of Reasons for Feed Scarcity

All interviewed herders reported difficulties to access pasture lands. They mentioned that the walking duration in search of pasture has become longer than in the past, and they have consequently invested more efforts to avoid crop fields and human dwellings when herding their animals. But the magnitude of some of the perceptions varied significantly ($p < 0.001$) from one farm type to another. All herders from the PAS farm type (100%) stated that

they had to walk longer distances ($p < 0.05$) in search of forage and water compared to those of the three other farm types (79%, 71%, and 75% from the LAS, SAP, and SIP farm types, respectively). Similarly, the proportion of respondents reporting the disappearance of forage species such as *Panicum maximum* and *Pennicetum spp.*, was significantly higher ($p < 0.001$) in the LAS (79%) and SIP (57%) farm groups. Irrespective of farm type, 77% of the respondents mentioned the expansion of croplands as the main factor affecting feed availability, whereas urbanization referring to increased infrastructures and houses was reported by 17% of the respondents who were mainly from the PAS farm type (41% of respondents against 6%, 6%, and 7% in LAS, SAP, and SIP farm type, respectively). Climate variability (40%) was cited as the second most important factor affecting feed availability and mainly by respondents from LAS (50%), SAP (39%), and SIP (54%) farm types. Water scarcity (37.5%) was mainly reported by herders from the PAS farms type (85%) whereas difficulties to access water were rarely mentioned (21%) and mostly by herders in farms close to Cotonou.



## 3.3. Herdsmen Feeding Strategies

### 3.3.1. Current strategies

Several strategies (Figure 2) were used by herders to overcome feed scarcity. The strategies most reported were the exploitation of lowlands (78%) and the exploration of new grazing routes (60%). Herd division (14%) or moving into another area in the vicinity of Cotonou (21%), either periurban (36%) or rural area (64%), was less commonly practiced. Five percent of the herders have been already moving definitively to rural areas.

### 3.3.2. Future strategies

Almost half of the cattlemen surveyed (48 of the 112) were considering moving animals to another place in the periurban area. Inertia (50%), herd division (11%), destocking (23%), division and displacement of the herd (5%), abandonment of cattle farming (6%), or definitive displacement (5%) are plausible future strategies mentioned by the 64 remaining herders. The decision to move the animals or not varied significantly according to the type of farm ($p < 0.01$), the possession of land title or not ($p < 0.05$) and the distance of the farm to the nearest urban center ($p < 0.01$). But the possession of land title was significantly ($p < 0.01$) related to the type of farm and to the farm distance from urban centers and was, therefore, not used in the logistic regression analysis of the choice of herder's future strategy as a predictor variable. The results of the logistic regression analysis are displayed in Tables 5 and 6. A test of the full model against a constant only model was statistically significant, indicating that the predictors (distance

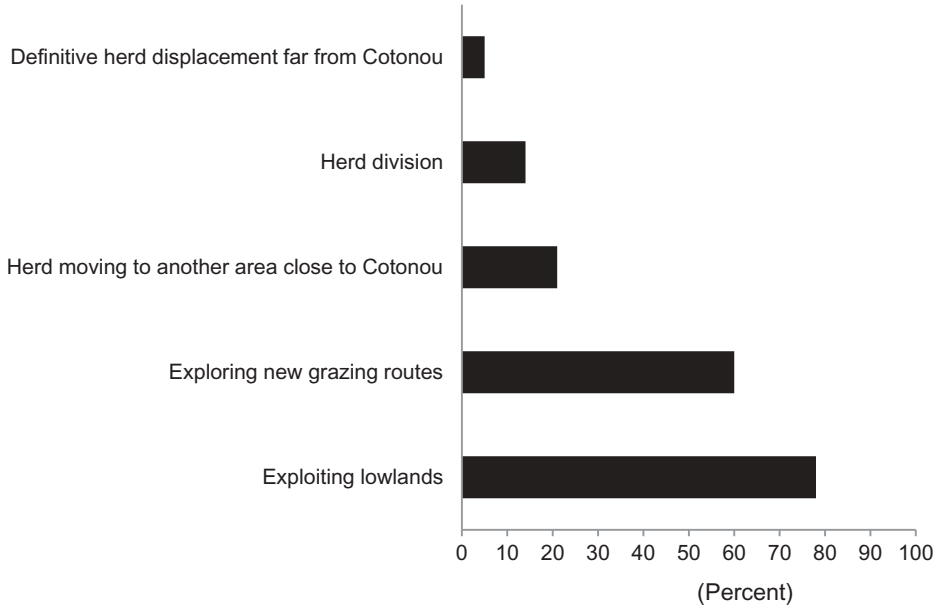


**FIGURE 2** Frequencies of periurban cattle herders' current strategies to overcome feed constraints in southern Benin ($n = 112$).



of the farm to the nearest urban center and farm type) as a set, reliably distinguished between adopters and non-adopters of herd displacement as future strategy ($\chi^2 = 20.546$, $p < 0.001$, $df = 4$). The Nagelkerke $R^2$ value of 0.225 indicated a moderately strong relationship between prediction and grouping. The nonsignificance of the Hosmer and Lemeshow test confirmed the validity of the regression model. Prediction success overall was 65.2% (66.7% for the group of herders who reported displacement as option and 64.1% for those who opted for another strategy). The $e^{\beta}$ values indicated that when the distance of the farm from the urban center decreases by 1 km, the odds ratio is 0.905 times as large and, therefore, farms are 0.905 more times likely to adopt displacement as a future adaptive strategy. This odds ratio is 0.148 times lesser when the farm is of the LAS type. These results imply that the probability that a farm moves from its current location increases with its proximity to the nearest urban center and its non-integration with agriculture or tree plantation.

## 4. DISCUSSION

### 4.1. Methodological Approach

The decision to apply multivariate statistical methods or simply to stratify using a single criterion is determined by the quality of all available data

**TABLE 5** Prediction of the future adaptive strategies (moving or not) of periurban cattle farms in southern Benin by logistic regression analysis ($n = 112$)

| Predictor | $\beta$ | SE of $\beta$ | Wald's $\chi^2$ | *df* | *p* | $e^{\beta}$ (odds ratio) |
|---|---|---|---|---|---|---|
| Constant | 0.859 | 0.487 | 3.111 | 1 | 0.078 | NA* |
| Distance to nearest urban center | −0.099 | 0.041 | 5.866 | 1 | 0.015 | 0.905 |
| Farm type | | | 7.083 | 3 | 0.069 | |
| LAS | −1.909 | 0.862 | 4.900 | 1 | 0.027 | 0.148 |
| SAP | −0.462 | 0.547 | 0.712 | 1 | 0.399 | 0.630 |
| PAS | 0.220 | 0.527 | 0.174 | 1 | 0.676 | 1.246 |
| Test | | | | | | |
| Overall model evaluation (Model $\chi^2$) | | | 20.546 | 4 | 0.000 | |
| Goodness of fit test (Hosmer and Lemeshow) | | | 4.439 | 8 | 0.816 | |
| −2 log likelihood = 132.425 | | | | | | |
| Cox and Snell $R^2 = 0.168$ | | | | | | |
| Nagelkerke $R^2 = 0.225$ | | | | | | |

*NA = not applicable; LAS = large agro-silvopastoral; SAP = small agro-silvopastoral; PAS = pastoral; SIP = silvopastoral.

**TABLE 6** Observed and predicted frequencies for future adaptive strategies (moving or not) of periurban cattle farms in southern Benin by logistic regression analysis ($n = 112$)

| | Predicted | | |
|---|---|---|---|
| Observed | Moving | Not moving | Percentage correct |
| Moving | 32 | 16 | 66.7 |
| Not moving | 23 | 41 | 64.1 |
| Overall | | | 65.2 |

*Note.* Sensitivity = 32/(32 + 16) = 66.66%; specificity = 41/(41 + 23) = 65.08%; false positive = 23/(32 + 23) = 41.08% and false negative = 16/(16 + 41) = 28.07%.

(Selter et al. 2009). Similarly, the quality of a classification depends on the choice of the appropriate method of classification and data quality (Emtage et al. 2006; Gelbard et al. 2007). In this study, the use of CATPCA as a data reduction approach permits the inclusion of variables of different levels in the classification analysis. In addition to the simultaneous use of both qualitative and quantitative variables in the group classification, the two-step procedure automatically detects the optimal number of groups.

## 4.2. Farm Typology

The four types of cattle farming systems obtained were markedly distinct and this typology reflects the different levels of integration of livestock with

agriculture and/or tree plantation in the study area. The main discriminating variables were the source of labor, the practice of crop cultivation, the possession of land title, the feeding mode, and size of plantation and crop fields. In southern Benin, farm size is variable and most integrated farms had land title. This confirms their settlement in the periurban area. However, it is worth mentioning that in the agro-silvo-pastoral farms identified, the croppers were different from the herdsmen but both worked for the same landowner. Crop residues were used to feed the animals while manure was returned to the crop fields. The observed integration of tree, livestock, or crop in LAS, SAP, and SIP farm types is probably driven by the need to diversify incomes and to better manage environmental resources and manure in a context of limited space. However, it is worth noting that the SAP farm type was the most heterogeneous group in terms of practice of crop cultivation and tree plantation and could be further subdivided in three groups reflecting 3 different stages of the evolution of an agro-silvopastoral system. The first group comprised 11 farms (35.5%) with a negligible crop component on a land area that was currently under fallow. The second group was made of 12 agropastoral farms (38.5%) which were at the startup phase of tree integration, mainly fruit trees. The third group, which integrated 8 farms (26%), could be interpreted as a fully integrated agro-silvopastoral system.

In contrast to findings by Djènontin (2009) in northern Benin and by Coulibaly (2008) in Sikasso (Mali) our typology did not reveal any agropastoral farm type where the herdsmen are at the same time croppers. This could mainly be explained by the fact that in the periurban area of Cotonou, while the hired herdsmen were only responsible for the herding of entrusted animals, the owners of the farms hired additional persons for the cropping activities.

#### 4.2.1. Feeding strategies and adaptation

The increased feed scarcity coupled with its drivers as perceived by the respondents in our study is in line with findings from previous studies (Coulibaly 2008; FAO 2009; Chaibou et al. 2011). The effect of these factors, for instance increased urbanization, agricultural pressure and climate variability, on the accessibility of grazing areas is significant (Ly et al. 2010). In this context, the large agro-silvopastoral (LAS) farm type seems to be the most adapted periurban farm type. Farms of this type devoted a small share of their total land area to cropping activities and, therefore, have enough space to feed the animals through a better integration of the different farm activities. In contrast, in some SAP farms, the practice of crop cultivation could represent a handicap to forage availability unless production of fodder trees and shrubs are adopted. Pastoral farms is the most vulnerable because they depend on communal pastures. SIP farm type could have been the most appropriate periurban farm type if they have had larger spaces.

Cattle farming around the city of Cotonou could be improved and sustained through management options such as reduction of average herd size, a better integration of livestock and crop production and increase of the total available grazing areas. However, if the first two management options are easily achievable, the latter seems difficult given the rapid urbanization (an average annual urban population growth rate of 4% according FAO 2012) context. In contrast, reducing the herd size, thus the stocking rate, would help decreasing overgrazing and improving rangeland management (Coulibaly 2008; FAO 2009).

### 4.3. Herdsmen Perspectives

The closer a farm is to the nearest urban center, the greater is its probability to move away towards a rural area. Similarly, this probability is much greater when the system is not integrated. Integrated farms are more sedentarized and integration allows them to reduce their vulnerability. The farms in the LAS type have enough space and could opt for fodder production and intensify agricultural production with the objective of producing more crop residues for livestock feeding (Somda et al. 2004; Coulibaly 2008). SAP farms could not increase their land size but may opt for herd size reduction. Nevertheless, even with the reduction of their herd sizes, their production of crop residues may be too insufficient to cover their needs. Therefore, we argue that in the periurban area of Cotonou, there is a large market potential for fodder produced in rural areas. In the silvo-pastoral farm type, animals benefit from the vegetation maintained under plantation, and this grazing area does not suffer from competition with cropland resources and has the potential to be improved. Finally, given the difficulty to increase farm areas and to grow forage crops in the periurban area and the shrinkage of grazing areas owing to increased crop production, we argue that SIP farms are and will remain the most promising periurban cattle farming system in southern Benin.

## 5. CONCLUSION

Our study revealed the existence of four distinct cattle farming systems in the vicinity of Cotonou. These systems differed significantly according to the source of labor used, feeding practices, the space available for livestock and feed constraints. Herdsmen faced difficulties for feeding their animals because of shrinkage of and lack of access to grazing areas. They were consequently exploring new grazing lands and exploiting lowlands as coping strategies. Their main perspective was either to move the animals to other areas, including periurban and rural or to adopt other strategies which may involve either division of herd, destocking, division and displacement of

the herd, abandonment of breeding or definitive displacement of the herds from the periurban area of Cotonou. While all the four identified periurban systems are threatened by rapid environmental changes, the silvopastoral system is likely to have more adaptive capacities.

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