Land Use Policy 48 (2015) 401–411

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Intra-urban and peri-urban differences in cattle farming systems of Burkina Faso

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ARTICLE INFO

Article history:
Received 22 January 2015
Received in revised form 31 May 2015
Accepted 27 June 2015

Keywords:
Animal fattening
Beef production
Dairy
Systems typology
Urbanization
West Africa

ABSTRACT

Little is known about the classification of urban and peri-urban cattle farming systems in West Africa. To contribute to filling this knowledge gap, we conducted a questionnaire-based survey in 137 and 133 cattle enterprises located, respectively, within and beyond the municipal boundaries of the city of Bobo Dioulasso in Burkina Faso. Categorical principal component and two-step cluster analysis techniques were used to group the different farms. The farmer's engagement in crop production, the area of cultivated land, his experience in cattle farming, the orientation of the cattle enterprises towards fattening or milk production and the feeding mode (zero-grazing, grazing only or grazing plus supplementation), among others, were relevant differentiating factors. Overall nine distinct clusters reflecting different farming systems in the intra-urban and peri-urban areas were identified. Farm types in the intra-urban area were mainly oriented towards meat production and included intensive landless cattle fattening (n = 30; 21.9%), semi-intensive grassland-based cattle farming (n = 40; 29.2%), extensive cattle farming (n = 20, 14.6%), semi-intensive maize-cattle farming (n = 37, 27.0%) and intensive maize-cattle farming (n = 10, 7.3%). In contrast, farms in the peri-urban area were mostly oriented towards milk production and classified as semi-intensive pastoral (n = 11; 8.3%), semi-sedentary pastoral (n = 38; 28.6%), medium-scale agro-pastoral maize-dairy farming (n = 40, 30.1%), and small-scale agro-pastoral dairy-maize farming (n = 44; 33.1%). The intensive landless fattening enterprises seem to be most promising for the future exploitation of the growing demand of urban customers for beef, whereas small dairy herds integrated or not with crop production appear to be the most adapted to the continuously changing peri-urban environment.

1. Introduction

During the past two decades, numerous papers were published on urban and peri-urban agriculture (UPA). A variety of definitions for UPA have been suggested. The most widely cited ones (Mougeot, 2000; Jacobi et al., 2000; Smit et al., 2001) refer to any form of farming or livestock keeping that takes place within and around cities, whereby a subdivision into “intra-urban” (or urban) and “peri-urban” agriculture has been controversial, given unclear boundary definitions (Willis, 2007; Simon, 2008; Stewart et al., 2013). Binns and Lynch (1998) argued that it is unnecessary to differentiate between urban and peri-urban agriculture because producers, regardless of their location, have largely the same motivations, usually share a common market and face similar production and marketing challenges. While the intra-urban area is defined as the heart of the built-up or the fully urbanized area of a city, most scholars define the peri-urban area as the zone around cities and urban agglomerations that stretches into the rural hinterlands (McGranahan et al., 2004), the peri-urban being, in contrast to the urban, characterized by fast changes of land use and social, economic and environmental settings (Belevi and Baumgartner, 2001; Douglas, 2006; Galli et al., 2010; Piorr et al., 2011).

The presence of such invisible boundaries strongly affects the local farming systems (Galli et al., 2010), and a recent study revealed that farming systems significantly differ and perform dif-

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http://dx.doi.org/10.1016/j.landusepol.2015.06.031

ferently depending on their intra-urban or peri-urban location (Aubry et al., 2011). It has also been argued that within a single urban area, a high diversity of farm types and farm strategies exist (Douglas, 2006). This may also hold true for peri-urban areas, which, even though they contain both rural and urban elements, may have their own distinctive characteristics (Birley and Lock, 1998; Drechsel et al., 1999; Adams et al., 2000).

With respect to livestock keeping within and around cities, a functional understanding of the prevailing production systems in both areas is needed to analyse how the degree of urbanization influences animal enterprises across the interface (Brook and Dávila, 2000; Mougeot, 2000). Compared to gardening and crop farming, keeping various types of livestock in and around the major and secondary cities has in many sub-Saharan African countries received little systematic attention by scientists and policy makers. Despite official by-laws limiting its practice in many countries (Assemblée Nationale du Burkina Faso, 2005; Geyer, 2011; Simiyu and Foeken, 2011; Schmidt, 2012), this activity is flourishing (Masters et al., 2013). In the West African Sudano-Sahelian region, more than 70% of UA practitioners are livestock keepers (Dossa et al., 2011a), of which 82% raise cattle (Amadou et al., 2012).

Yet, all previous studies in Burkina Faso (Hamadou et al., 2003, 2008; Marichatou et al., 2003; Hamadou and Kiendrebeogo, 2004; Sidibe et al., 2004), Niger (Vias et al., 2003; Boukary et al., 2007; Chaibou et al., 2011), and Mali (Bonfoh et al., 2003) diverged when defining the limits of intra- and peri-urban areas, which hampers their comparison. Furthermore, they mainly focused on dairy cattle and did not comprehensively consider the diversity of existing urban, peri-urban and rural cattle farming systems (Zorom et al., 2013). Also, despite its numerous benefits, city authorities are concerned about pollution and public health issues associated with keeping large farm animals in close proximity to human populations. Yet, the development and establishment of proper policy interventions to minimize public health risks that might ensue from urban livestock enterprises (Amadou et al., 2014) require a clear distinction between urban, peri-urban and rural locations as well as a better understanding of the diversity of production systems and their resources use efficiencies.

This study, therefore, aimed to identify and characterize the different cattle farming systems in the fully urbanized and the peri-urban areas of a typical secondary city in the West African Sudano-Sahelian region (Dossa et al., 2011b; Abdulkadir et al., 2012; Amadou et al., 2012).

2. Materials and methods

2.1. Study area

The study was conducted in the city of Bobo Dioulasso (11°11′N and 4°17′W), the second largest city of Burkina Faso with about 490,000 inhabitants in 2006 (INSD, 2010) who grew to 800,000 by 2012 (UN-Habitat, 2014). Located at an altitude of 430 m above sea level, Bobo Dioulasso lies in the Southern Sudanian Savannah zone characterized by a sub-humid climate with three seasons: a rainy season (May–October), a cool dry season (November–February) and a hot dry season (March–May). The unimodally distributed average annual rainfall varies between 900 and 1200 mm. The official administrative boundaries of the city have been expanded in 2004 to include 25 administrative subunits in the contiguous built-up area, and 35 independent villages that are in the immediate periphery of the city but remain unconnected to the main contiguous built-up area (Werthmann and Sanogo, 2013). In this study, the contiguous built-up area is referred to as intra-urban area and its surroundings, including the 35 villages, as peri-urban area, with the physical boundary of the built-up area being the limit between the two (Fig. 1).

2.2. Data collection

Because lists of households keeping livestock were not available in both intra-urban and peri-urban areas, a fully randomized sampling was not feasible. We therefore conducted a preliminary exploratory survey in February and March 2013 with farmers from all 25 administrative units representing the intra-urban area and from the 35 villages representing the peri-urban area. Using a snowball sampling procedure, 400 livestock keeping households were approached in each area as primary sampling units and interviewed mainly on the livestock species owned.

As secondary sampling units, 150 cattle farming households were randomly selected in each area (six per administrative unit in the intra-urban area and five per village in 30 out of the 35 villages in the peri-urban area) and interviewed from May to September 2013 using a structured questionnaire. It included questions on general household characteristics, cattle herd size and structure, production objectives and management practices, and practices of other agricultural activities. The questionnaire was pretested in April 2013 on a sample of 15 farmers who are not included in the final sample.

2.3. Data analysis

Before processing, collected data was screened for consistency and completeness. This resulted in the removal of 13 intra-urban and 17 peri-urban cattle farm households (HH) from the sample. Subsequently, the data from the remaining 137 intra-urban and 133 peri-urban farms were analysed. After a general description of the sample, a farm typology was undertaken for each area separately. Categorical Principal Components Analysis (CATPCA) was used to eliminate redundancy caused by correlation between variables and to identify the main cluster-determining variables (Meulman and Heiser, 2004; Linting et al., 2007). HHSIZE, GRAZ and TLU were significantly ($p \leq 0.001$) correlated with AGE ($r = 0.472$), FEEDMOD (Pearson Chi-Square = 270 and Cramer's $V = 1$) and BCATSIZ ($r = 0.942$), respectively, and were therefore removed from the analysis (Table 1).

Since all farmers in the peri-urban area used crop residues to feed their animals, the variable "feeding crop residues" (CROP_RES) was removed for the CATPCA performed on the peri-urban farms. In the final CATPCA, we set the number of dimensions at a default value of two and retained those variables with a loading score ≥ 0.6 on one of the two components (Stevens, 1992) as the most discriminating ones. These variables were subsequently used as input variables in a two-step cluster analysis (Mooi and Sarstedt, 2011) to identify the most powerful discriminating variables for separate classification of the 137 intra-urban and the 133 peri-urban farms into homogeneous types of cattle farming systems. Although the two-step clustering approach determines an optimal cluster solution, several cluster solutions were explored and those with an overall silhouette measure of cohesion and separation >0.5 were accepted. They were then compared by their overall goodness-of-fit (Linting et al., 2007) to select the most appropriate one.

A dummy variable "cluster membership" was created that identified which farm belonged to which cluster. The final clusters were profiled by cross tabulating the variable "cluster membership" with both qualitative and quantitative explanatory variables used in the clustering algorithm; based on the outcome, a cluster name was assigned. Subsequently, we assessed the cluster solutions' validity and stability through discriminant and multinomial logistic regressions analyses performed on a set of variables that were not used in the cluster analysis. In the multinomial regression analysis, the chi-square (χ^2) statistic was used to assess the differences in likelihood of cluster membership between the final model and reduced model (the intercept-only model) and to ascertain the significance of pre-