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Research Paper

The role of backyard farms in two West African urban landscapes

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ABSTRACT

Urban and peri-urban agriculture (UPA) is a well-researched landscape component, but there is a need to extend the quantitative database on West Africa as well as to explain how UPA contributes to food systems differently across locations. We therefore performed a quantitative survey of Tamale, Ghana, and Ouagadougou, Burkina Faso, using a spatially randomised sampling frame to identify farms in peri-urban villages, open-space farming zones and isolated spaces. This was complemented with focus group discussion data. After preliminary analysis, further interviews were performed to explain trends observed. Rainy season production dominated in both cities. In Ouagadougou, commercial production was concentrated in open-space farming sites, whereas in Tamale it was more dispersed, with isolated space farms playing an unexpectedly important market role. This was attributed to Tamale's recent rapid expansion, combined with more relaxed planning implementation and a permissive legislative context. In both cities, leafy vegetables were important commercial crops. Irrigation and soil fertility management were areas where resource use efficiency could be improved. Untreated well water was a major irrigation source in Ouagadougou, as was potable water in Tamale, raising queries over sustainability. Inorganic fertiliser use was more common in Tamale than Ouagadougou, and the opposite was the case for compost and manure, ascribed to the existence of manure markets in Ouagadougou. Urban agriculture's contribution to urban food systems is thus shaped by its historical and geographical context. Attention to planning trajectories, irrigation and soil fertility management issues could help it contribute further.

1. Introduction

Urban and peri-urban agriculture (UPA) plays a unique and important role in urban food systems. Farmers use spaces in urban and peri-urban landscapes to provide themselves and others with food, whilst gaining income from sales (Dubbeling, Canton Campbell, Hoekstra, & van Veenhuizen, 2009). The opportunities and risks presented by UPA provide important considerations for planners and policy makers. It enjoys good access to inputs, including agrochemicals, organic wastes (Lee-Smith, 2013) and municipal and wastewater supplies (Tixier & Bon, 2006). Relatively affluent output markets demand a wide range of goods (Mawoisa, Aubry, & Le Bail, 2011). Yet it also competes with other urban land uses and industries for resources such as land, water and crop residues (Naab, Dinye, & Kasanga, 2013) and consumers and city authorities express health concerns over waste reuse (Mougeot, 2000). Some settings have legislative barriers (Cissé, Gueye Ndèye, & Sy, 2005) and resource use efficiencies are often low.

There is an abundance of academic and 'grey' literature on UPA as a general phenomenon. Yet the factors above interact to shape UPA in diverse ways across landscapes. Backyard gardening may exist alongside opportunistic cropping on interstitial spaces. Meanwhile, several farmers may cultivate simultaneously on contiguous fields within larger, open-space, tracts of land (Drechsel et al. 2006). Peri-urban settlements can resemble rural villages, but have access to urban markets, meeting Mougeot's (2000) definition of UPA. This paper focuses on food crop farming, a common form in the study area (an exploration of livestock production in the study cities appears in Roessler et al. (2016)), but UPA can also include livestock raising, agroforestry, ornamental horticulture and mixed production systems. These forms manifest to varying extents between locations, and their functions within urban livelihoods vary.

Papers on African UPA have hitherto mainly focused on open-space farming sites, characterising them as the locus of commercial production (Drechsel, Graefe, Sonou, & Cofie, 2006; Memon and Lee-Smith, 1993). This emphasis reflects the current policy and advocacy drive towards African agricultural commercialisation (Wiggins, Argwings-

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Kodhek, & Leavy, 2011), and the inability of remote-sensing approaches to collect data on smaller plots (Thebo, Drechsel, & Lambin, 2014). Brinkmann et al. (2012) therefore advocate work examining urban farms of all sizes more closely. East African studies have achieved this (Kutiwa, Boon, & Devuyst, 2010; Mwangi, 1995; Schlesinger, 2013) but the need remains for detailed ground-level quantitative data on West Africa.

Our study therefore augments the West African urban agriculture database by conducting a mixed-methods investigation of crop farming in Ouagadougou, Burkina Faso and Tamale, Ghana. To capture details on as many farm types as possible, we performed a quantitative survey, collecting data within three broadly defined zones. We sampled farms within contiguous open spaces, as well as identifying residential areas where we sampled what we called 'isolated space and backyard farmers'. Moustier and Danso (2006) define the latter as 'urban residents who farm around their homes'. We also included peri-urban villages.

Section 1.1 details relevant environmental and historical elements of our study site. Following the methods, we use these details in Sections 3.1–3.5 to explain broad trends of agricultural practice. Section 3.6 explains differences in prevalence, function and form of isolated and backyard farms between cities, especially in terms of commercialisation. This paper's original contribution is this use of qualitative information to contextualise randomised survey data within historical trajectories of urban landscape planning and development, less common in contemporary analysis of UPA. Our conclusion elicits implications for future research and planning agendas.

1.1. Regional agricultural context

Located in central Burkina Faso, Ouagadougou, founded in the 15th century, is the national capital and the seat of the Mossi kingdom (Balima, 1995). Tamale, the capital of Ghana's Northern region, is the largest city in the Dagomba kingdom, although not the traditional seat. These cities are in the Sudan and Guinea savanna agroecological zones respectively, both having monomodal rainfall (Fig. 1).

West African agriculture traditionally comprises rainfed household cultivation of staples, such as maize, sorghum and yam (Al-Hassan & Poulton, 2009), accompanied by marketable legumes, such as groundnut, and small quantities of vegetables. Historically, women largely provided condiments and prepared food, while men cultivated staples (Nchanji & Bellwood-Howard, 2016).

Such traditional, seasonal farming is predominantly rural. However, farmers also establish perennial cultivation in backyards and open spaces within urban landscapes. Simultaneously, accelerating urbanisation decreases land availability in the study cities (Addo, 2010). An analysis of farm size is therefore relevant, alongside evaluation of how far farmers maintain traditional rainfed farming patterns and crop mixes. A focus on irrigation is also warranted. Both study cities prioritise household as opposed to agricultural use of potable water. Yet these uses compete, as neither city has a major river. Ouagadougou's higher water table facilitates widespread well-digging, whereas in Tamale dugouts are used alongside municipal piped water. Floodplains exist alongside reservoirs, such as the three barrages spanning central Ouagadougou and the patchwork of smaller dugouts scattered around Tamale.

Farmers may produce rainy season staples in such spaces, alongside irrigated market vegetables in both rainy and dry seasons. In these cities with catering industries, markets have developed for exotic species such as cabbage and carrot, alongside traditional leaves such as amaranth, and vegetables such as onions used in both traditional and modern dishes. These markets involve gender-defined roles, with male farmers trading to female marketers (Clark, 2010), and proximity to them shapes the commercial nature of UPA (Kutiwa et al., 2010).

This marketing theme resonates in an era when commercialisation tops agricultural policy agendas, for example in the Comprehensive African Agricultural Development Plan (CAADP) of the African Union's New Partnership for Africa's Development. Although UPA is less explicitly mentioned in contemporary Ghanaian and Burkinabé agricultural policy, the 'value chain' concept valorised by CAADP permeates current approaches, linking commercial cropping to market input provision. Although subsidies are contentious, Burkina and Ghana's subsidy programmes have been in place since 2007 and 2008 respectively. Seed remains similarly controversial (Bornstein, 2014).

Land is probably the most contentious urban agricultural resource. The Ghanaian and Burkinabé governments encourage formal titling,

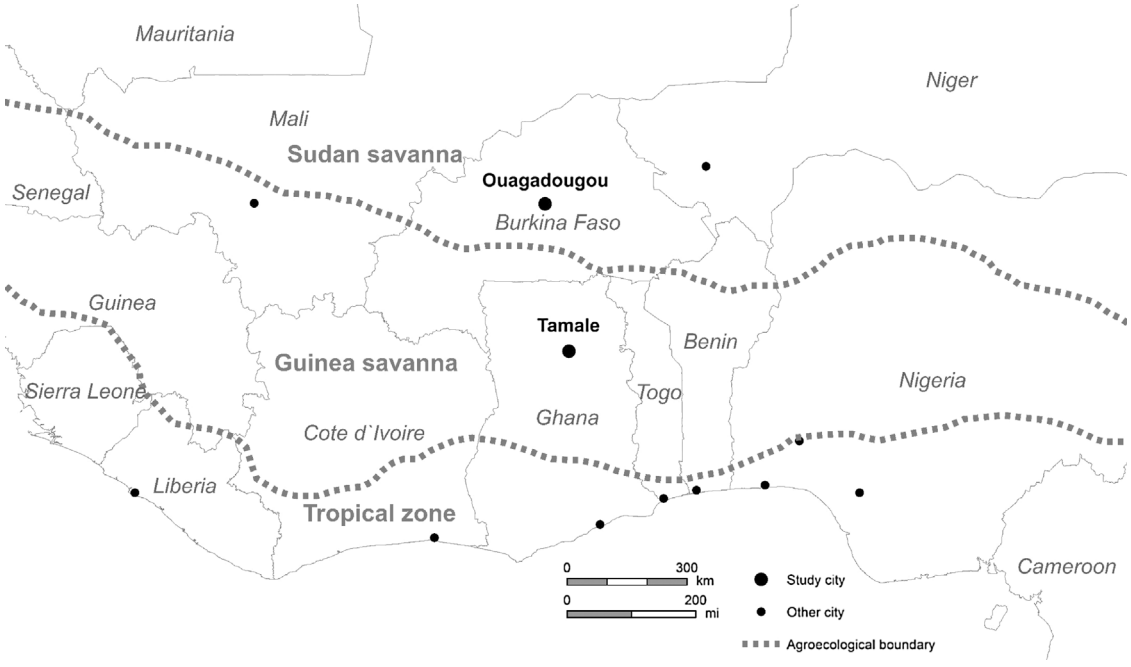

Fig. 1. Annotated map of the study site.
Source: Compiled from White (1983), FAO (1983) and d-maps.com (2017).

assisted by the USA in Burkina's Rural Land Governance Project and Ghana's Land Tenure Facilitation trial, and the World Bank in Ghana's Lands Administration Project. Urbanisation further deepens land markets, with implications for urban planning and for professionals working at the interface of customary and administrative land law (Fuseini & Kemp, 2015; Yeboah & Obeng-Odoom, 2010).

2. Methodology

2.1. Research questions

Our first research question stems from the need to update the database on West African UPA. The second is based on our observations of inter-city differences in the form and function of backyard farms, something less well addressed in existing literature. The last is informed by the practical imperative of our research project on resource use efficiency in West African UPA.

1. How do different types of urban farm contribute to food systems?
2. How do the roles of different types of farms differ between the two study cities and why?
3. What limitations can be addressed in order to enhance resource use efficiency in urban agriculture?

2.2. Methods

We conducted a standardised exploratory survey in Tamale and Ouagadougou between September and October 2013, sampling 513 farmers using a remote sensing-based approach (Fig. 2). We sampled randomly within categories to ensure the validity of statistical analyses, and to try to locate all possible farms within a particular spatial area. Some *ex-ante* categorisation was necessary to structure the data collection process and ensure we captured data on a range of production systems. However, we kept the categories as broad as possible in order to have a meaningful sample size for each category and allow quantitative patterns to emerge.

Urban space can be defined based on several factors, including population, infrastructural density and distance from the city centre (FAO, 2005; UN, 2008). Thus, we defined an algorithm that considered the density of roads and buildings, and used ArcGIS software to calculate the number of minutes taken to reach the city centre from a given point in each city. We divided urban space into concentric rings with different travel times, defining space within 60 min from the city centre as the study area. Within the peri-urban zone between the continuously built-up urban area and the outer boundary of the study area, we randomly selected ten villages from satellite images. Within the urban zone, we identified open-space farming zones using the same satellite images and key informants' expertise, and again randomly selected ten. To locate isolated fields, we divided the city into cells of 50 m^2 using ArcGIS, randomly selecting ten cells having 50–80% built-up area. Within each village, open space or urban cell, we used ArcGIS to randomly place ten points, then selected the nearest field to each random point. In some instances not all ten fields could be sampled, for example if the field was flooded.

We interviewed the farmer cultivating each field. First, we asked them to list each crop grown in that field in the past rainy and dry season. Following Poulton et al. (2008), we designated those a farmer intended to sell more than 50% of as 'commercial'. We recorded sale outlet and irrigation source for each crop, alongside seasonal input use for each field. Secondly, we recorded all crops farmers had cultivated across all their fields in the past year. Thirdly, we collected demographic and socioeconomic household data. Finally, we used Garmin GPS devices to measure the area of each surveyed field.

Enumerators noted sites of interest during quantitative data collection and returned to collect focus group discussion and interview data between September and November 2013, opportunistically selecting additional sites that had not been investigated. We collected data on six themes: general farm system overviews, resource mapping, site walks, marketing, innovation and farmers' suggested solutions to perceived production problems. Participants were also free to introduce their own issues. We addressed each theme in each of the village, open-space and isolated farm settings in both Tamale and Ouagadougou, with 18 encounters in Ouagadougou and 30 in Tamale. We summarised data from each encounter in prose.

Preliminary analysis showed novel results regarding the different spatial organisation and role of isolated and backyard farms in each city, so we began literature-based research to investigate this. Yet a dynamic situation and dearth of accessible information necessitated primary data collection. Therefore, in February 2015, we returned to conduct semi-structured qualitative interviews with three urban planners and historical experts in each of the two locations, alongside 11 of the originally surveyed backyard farmers who were still available for interview (Table 1).

Interview schedules focused on Ouagadougou and Tamale's planning and development histories, as well as respondents' perceptions of backyard farming and patterns found in our data. We used manual '*in-vivo*' content analysis, identifying themes from the data rather than pre-specifying them on a theoretical basis. Emergent themes related to historical planning trajectories, legislation, rural-urban links and plot geometry.

We followed our institutions' ethical guidelines, also considering ethical norms within our disciplines such as obtaining verbal consent.

3. Results and discussion

Sections 3.1–3.5 answer the first two research questions on the roles of different farm types across urban landscapes, explaining statistical patterns seen across all farm types using information from Section 1.1 alongside focus group and interview data. Section 3.5 addresses the third research question on resource use efficiency. Section 3.6 substantiates the answer to the second research question, focusing on differences in backyard farming between Tamale and Ouagadougou.

3.1. Farm characteristics

Fig. 3 shows examples of different types of farm surveyed.

Ghanaian farmers, on average, had larger landholdings than those in Burkina Faso, and, concomitant with the accelerating demand for space in urbanising areas, those in peri-urban areas in both cities had more land than those cultivating urban farms (Table 2). Although backyard and isolated farms had shorter usufruct histories, they were cropped for on average nine years, despite emphasis in literature on tenure insecurity and the resultant need to shift location regularly (Drechsel et al., 2006).

3.2. Seasonal, commercial and gendered cultivation

We collected both dry and wet season production data. In rainy season, in both cities, all village fields we visited were cultivated, as were over 90% of fields sampled in backyard and isolated farms and open spaces. In dry season, fewer than 5% of sampled village fields around either city produced anything. A similar situation prevailed in the urban fields. In Tamale, farmers cultivated fewer than 20% of backyard or open-space fields in dry season. In Ouagadougou, on the other hand, dry season cultivation was strongly shifted towards open-space sites, where 63% of visited fields were cultivated, compared to just 6% of backyard farms. This pattern confirms the importance of rainfall in West African agriculture. Perennial irrigation sources are available to open-space farmers in Ouagadougou (Kêdowidé, 2011), hence their year-round activity. In Tamale, with its lower water table, backyard and isolated space farmers used piped water (Table 5).

Urban farms' proximity to market influences their commercial

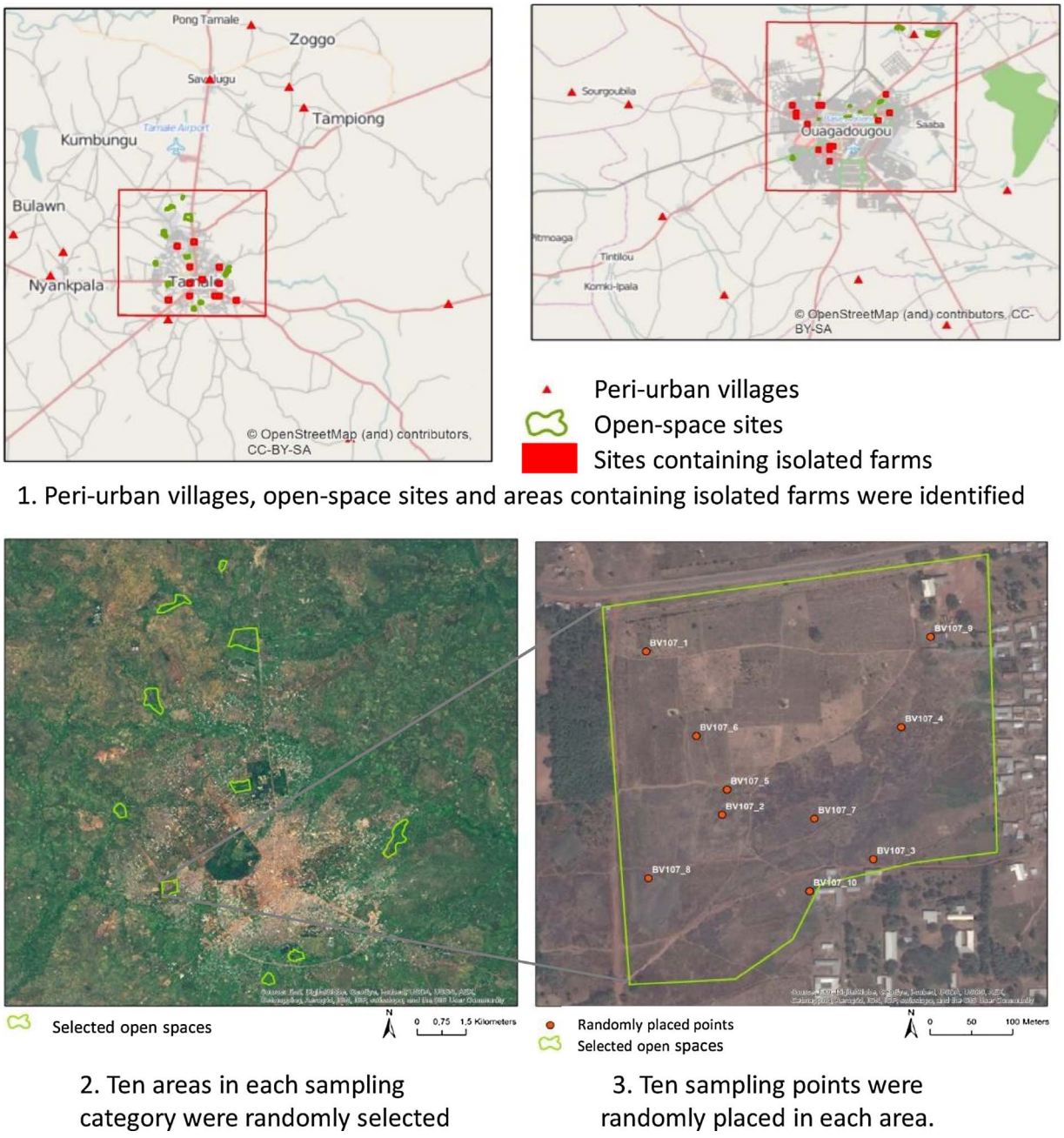

Fig. 2. Sampling strategy.
Source: Bellwood-Howard et al. (2015).

Table 1
Semi-structured qualitative interview respondents.

Ouagadougou	Tamale
5 backyard farmers: 4 female, 1 male	6 backyard farmers: 1 female, 5 male
Officer, department for *Aménagement de Terroir*	Former Tamale Metropolitan and current Northern Regional Town and Country Planning Director
Academic expert on town planning, *Institut Supérieur des Sciences de la Population*	Tamale Land Valuation officer
Planning officer, *Mairie de Ouagadougou*	Secretary and historical recorder of a senior chief in Tamale

nature (Mawoisa et al., 2011), resonating with policy trends (see Section 1.1). Reflecting this, commercial production was almost ubiquitous, except in Ouagadougou's backyard fields in dry season (Table 3). In Tamale, around half the farmers who cultivated in rainy season produced commercial crops, and dry season commercial production was concentrated in urban open-space and isolated farms. In Ouagadougou, commercial production was more heavily concentrated in open-space farming sites throughout the year. Hardly any backyard and isolated space farmers produced commercial crops, whilst just 11% of village farmers did so, in rainy season only.

The data confirm the trend of commercial production in open spaces, resounding to some extent with characterisation of backyard farms as more subsistence-oriented (Addo, 2010; Moustier & Danso, 2006). However, a more nuanced picture emerges at the local scale. Backyard and isolated farms are more plentiful and commercialised in Tamale than Ouagadougou, year-round. Commercial production, although it does not dominate, is also unexpectedly important in

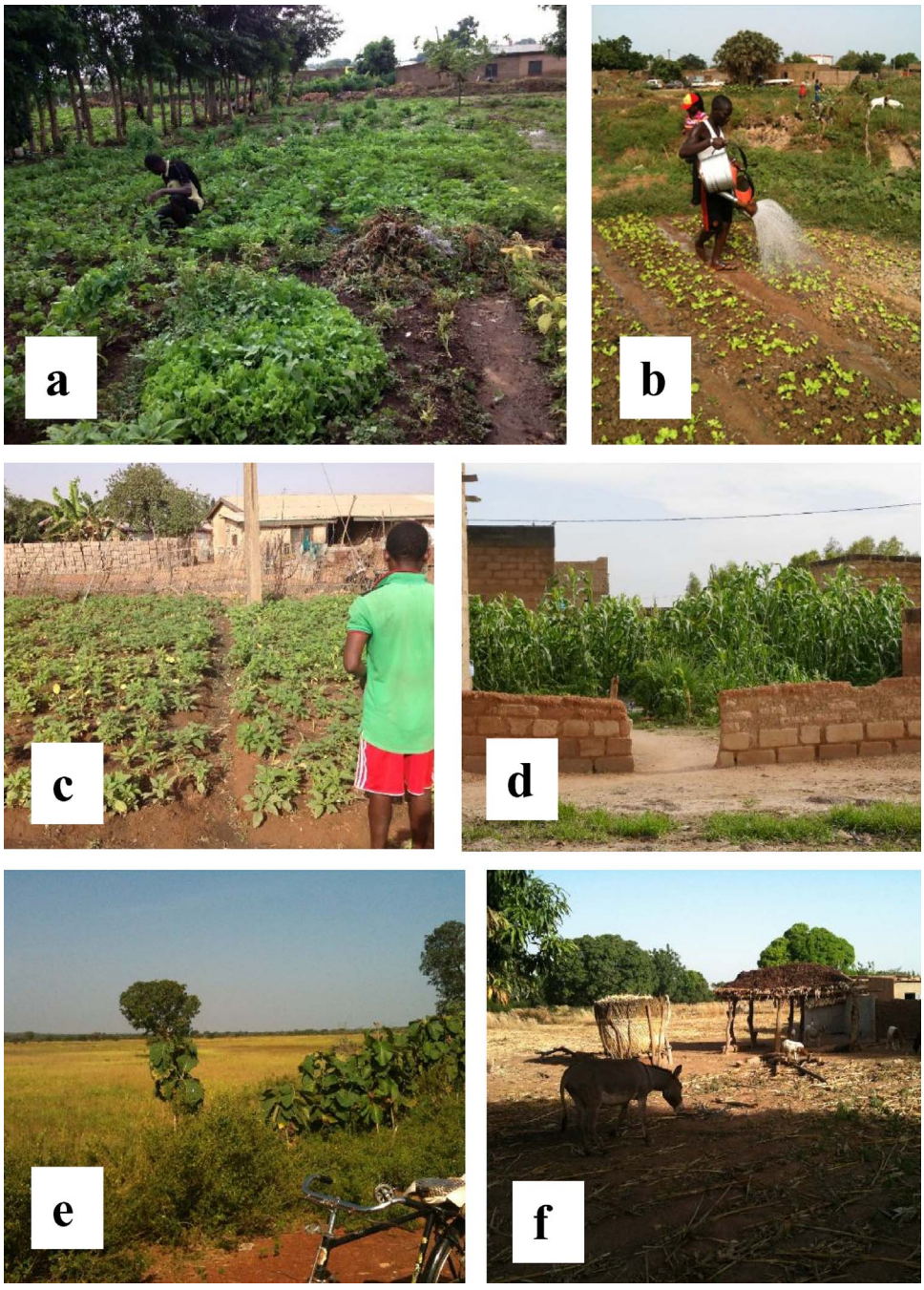

Fig. 3. (a) Open-space site, Tamale; (b) Open-space site, Ouagadougou; (c) Backyard farm, Tamale; (d) Backyard farm, Ouagadougou; (e) Peri-urban village, Tamale; and (f) Peri-urban village, Ouagadougou. Source: Bellwood-Howard et al. (2015).

backyard and isolated space farming in Tamale. Such differences indicate that the expression of urban agriculture interacts with city-specific contexts, to be explored in Section 3.6.

The historically male-dominated nature of commercialisation is reflected in the gender breakdown of commercial farmers. Just over 70% of farmers in Ouagadougou's less commercialised backyards are women, whilst a higher proportion of male than female backyard farmers sell at least 50% of one crop. Similarly, in Ouagadougou's open spaces and villages, a higher proportion of men than women are commercial farmers. In Tamale, men comprise a higher proportion of farmers, and more than half of men and less than half of women sell crops across all locations. Men are also more involved in input markets: a higher proportion of men across all categories tend to use external inputs including purchased seeds, fertilisers and crop protection tools.

Women's prescribed roles in dominant religion could partly explain the lower numbers of female farmers in Tamale than Ouagadougou. In Tamale, 83% of interviewees were Dagbani Muslims. Ouagadougou, on the other hand, is more ethnically diverse, and the Mossi embraced Islam less tightly than the Dagomba in the 17th century (Skinner, 1958): 52% of farmers surveyed here were Muslim. Ouagadougou's longer history of urbanisation and market integration may also have played a role in introducing women to the productive sphere, through marketing as well directly into farming. Tamale farmers hinted that women's productive activity emerged from their reproductive role in the fairly recent past, as wives sold their husbands' produce, as Friedberg (2001) describes for Bobo Dioulasso. Thus, interacting, place-specific characteristics shape how gender expresses: the dominance of Islam was itself initially an urban phenomenon.

3.3. Crop mix

We enumerated farmers growing each crop in wet and dry seasons

Table 2
Sample characteristics.

Ouagadougou				
	Urban isolated space (n = 55)	Urban open-space (n = 96)	Peri-urban village (n = 93)	Test for difference between groups, P (1 = Kruskal-Wallis test, 2 = medians test)
Mean household size	8	9	10	0.006(1)
Mean landholding size (ha)	1.92	0.87	2.98	0.000(1)
Mean visited field size (ha)	0.12	0.04	0.13	0.000(1)
Median number of crops cultivated	3	4	4	0.000(2)
Mean field use duration (years)	9.1	15.2	34.6	0.000(1)
Tamale				
	Urban isolated space (n = 96)	Urban open-space (n = 75)	Peri-urban village (n = 98)	Test for difference between groups, P (1 = Kruskal-Wallis test, 2 = medians test)
Mean household size	9	13	15	0.000(1)
Mean landholding size (ha)	1.81	2.58	5.64	0.000(1)
Mean visited field size (ha)	0.11	0.31	0.47	0.000(1)
Median number of crops cultivated	4	4	5	0.000(2)
Mean field use duration (years)	8.8	18.4	18.9	0.006(1)

on visited fields. Table 4 lists wet season crops grown by over 10% of farmers. For dry season we list the three most common crops, where possible.

In rainy season, maize and sorghum, traditional staples, dominated production in the drier climate of Ouagadougou. To reduce spoilage, these cereals are typically dried alongside okra and conserved for consumption and occasional sale throughout the year. This resonates with patterns described in Dar es Salaam as long ago as 1991 by Briggs (1991), who found that subsistence cassava, maize and banana were the commonest crops grown, and in 1995 by Mwangi (1995) in Nairobi, where maize and beans dominated. The exception to this was the Ouagadougou open-space farming sites, where commercial lettuce and amaranthus cultivation was most common. In Tamale, maize outdid sorghum as a ubiquitous staple, reflecting the moister climate. Marketable tomato and pepper were also important in all sites. Farmers cited specific agroecological reasons for their cropping choices, indicating their mindfulness of the need to use resources efficiently.

> Okra does well. It survives drought better than other crops. So can tomatoes. If you farm tomatoes and it just rains once or twice, it does well…Those two crops, if there's no water, they'll do OK. Tomato is preferable to okra, because it can withstand drought better. (Farmer, Tamale).

In dry season, farmers with access to irrigation in both cities concentrated on profitable leafy vegetables. Whereas backyard and isolated space production almost ceased in Ouagadougou in the dry season, in Tamale it continued, with marketable traditional vegetables. These cropping patterns should be understood in cultural context. Indigenous vegetables grown in Tamale are commonly eaten at home and in food outlets in the Dagomba's signature dish, *saga-tuliga*. In Ouagadougou, the same dish is called *tô*. However, here, amaranthus is used in the common Mossi rice dish *babenda* and lettuce is popular for the dishes that Ouagalais of diverse ethnicities eat in restaurants. Thus, alongside the subsistence strategies of urban farmers there are important commercial production sectors tailored towards specific cuisines.

3.4. Crop marketing

Most farmers who produced for sale sold their goods to intermediaries (Fig. 4).

Many vegetable traders travel to urban farm sites, especially open spaces, to purchase vegetables, due to their proximity to markets and the concentration of farmers that can be found there. This efficient marketing system is another reason commercial farming in these sites is more attractive than in villages and backyards. Farmers recognise the expertise of the mainly female marketers who sell their crops, maintaining this division of labour (Obuobie, Drechsel, & Danso, 2004). This gender specialisation in urban vegetable marketing means that, even when less visible in the fields, women are indispensable to the functioning of urban commercial farming (Friedberg, 2001). In contrast, most villagers must convey their goods to the markets themselves, confirming the aforementioned advantages of an urban location. Backyard and isolated space farmers can sell to consumers, including neighbours. Farmers in all categories described how they cultivated good relationships with particular buyers to guarantee a market. This pattern, recognised across West Africa (Drechsel et al., 2006; Mawoisa et al., 2011), is especially important during seasonal gluts. Despite the marketing efficiencies realised by urban farmers, policy documents have yet to explicitly recognise the particular commercial advantages of UPA.

3.5. Inputs

We asked farmers which inputs they used. Those named by the greatest number of farmers were grouped into categories and disaggregated by city (Fig. 5).

Farming is generally more input intensive in Tamale than Ouagadougou, across all farm types. The more commercially-oriented Ghanaian farmers could be more able to afford inputs, or policy encouraging input use here could have been more successful. However, specific factors also explain the prevalence of certain inputs. Fencing, for example, was used by a large proportion of isolated and open-space farmers in Tamale, compared to fewer than 1% of farmers in Ouagadougou. This reflects the open nature of Tamale's isolated space farm sites (explained further in Section 3.6), which obliges farmers to protect crops from free-range livestock, common in Tamale because the law necessitating their confinement is weakly enforced.

Seasonally disaggregated data helps interrogate the relationship between commercialisation and input use. Using dry season data alone, the only farm category where over 50% of farmers reported using inorganic fertiliser and pesticides was Ouagadougou's open-space farms, where the majority of commercial production was concentrated (disaggregation not shown). In Tamale, wet season inorganic input use was higher. In wet season in Ouagadougou, peri-urban and backyard farming was less input intensive: fewer than 50% of farmers in these groups purchased seed and crop protection inputs, and fewer than 50% of backyard farmers used soil fertility inputs. Although higher proportions of farmers in these categories used inputs in dry season, total

Table 3
Commercial cultivation in different types of farm by city and season.

City		Ouagadougou				Tamale			Total			
Farm type		Urban isolated space (n = 55)	Urban open-space (n = 96)	Peri-urban village (n = 93)	Total (n = 244)	Urban isolated space (n = 96)	Urban open-space (n = 75)	Peri-urban village (n = 98)	Total (n = 269)	Urban isolated space (n = 151)	Urban open-space (n = 171)	Peri-urban village (n = 191)	Total (n = 513)
Wet season	Percentage of farmers cultivating	96.4	93.8	100	96.7	97.9	96	100	98.1	97.4	94.7	100	97.5
	Percentage of cultivators producing commercially	7.6	70	10.8	32.6	48.9	62.5	55.1	54.9	34	66.7	33.5	44.4
Dry season	Percentage of farmers cultivating	5.5	62.5	2.2	26.6	11.5	17.3	3.1	10	9.3	42.7	2.6	17.9
	Percentage of cultivators producing commercially	0	93.3	50	87.7	63.6	100	33.3	77.8	50	94.5	40	84.8

numbers of dry season cultivators in these categories were low, confirming their subsistence nature compared to the Burkinabé open-space farms. These data therefore show what commercialisation policy anticipates: commercial crop growers purchasing and using inorganic inputs.

Farmers generally purchased exotic and improved seed varieties, or obtained them from the Ministries of Agriculture, reflecting modernisation policies. Many reckoned these were better quality than self-reproduced exotic seeds, yet they considered self-reproduction of locally-adapted tropical seeds a cost saving.

Farmers named financial limitations on input supply as a key constraint and emphasised their wish for fertiliser loans and subsidies. This partly explains the relatively low use of fertiliser across the dataset.

3.5.1. Soil fertility management

The importance farmers ascribed to soil fertility management (SFM) inputs merits closer examination of these data (Table 5).

In rainy season, when most subsistence farming occurred, over half of Tamale's open-space and village farmers used inorganic fertiliser, subsidised at source in 2013. Organic amendment use was also higher in rainy season in all other farm categories, although fewer than 50% of farmers used compost or manure. In dry season, the only farmers using many soil fertility amendments at all were Ouagadougou's open-space farmers.

Farmers were significantly more likely to use inorganic fertiliser in Tamale than Ouagadougou, and the opposite was true for compost and manure. Peri-urban Burkinabé farmers showed deep, concrete-lined compost pits, explaining how agricultural extension agents had trained them to produce this input: an indication that Integrated Soil Fertility Management was an objective of Burkinabé extension services. Memon and Lee-Smith (1993) explained such a pattern existed in Kenya because organic soil amendments are often cheaper than inorganics. Indeed, peri-urban farmers cited the cost of inorganic fertiliser as a deterrent to its use. However, urban open-space farmers in Tamale explained that, as commercial farmers, they could afford to purchase inorganics. Practical issues were also relevant: composting consumed time and space and sourcing and transporting manure to farm sites was difficult. Indeed, the intensive use of organic amendments close to West African farm homesteads is documented as a labour- and transport-saving technique across the region (McClintock & Diop, 2005).

A Ghanaian farmer confirmed the implication of this for urban agriculture: 'When you farm around the house there is dirt around the house farm, it doesn't need fertiliser, but the farm away from the house, there is no dirt and stuff so the soil is no longer strong.'

Considering transport costs, it was surprising that a larger proportion of open-space than village farmers used manure. However, this was likely a result of their ability to obtain manure through market mechanisms, more common in Ouagadougou than Tamale. This commercial orientation explains why we recorded higher use of SFM inputs than generally reported: Memon and Lee-Smith (1993) found 33–43% of people in different sites using various types of organic SFM input and just 11% using inorganic fertiliser. Adam (2000) recorded 7% of backyard farmers in Kumasi using any type of SFM input.

3.5.2. Irrigation

The concentration of production in rainy season illustrates the dearth of irrigation facilities, and qualitative data confirmed that this was a major constraint on farming. The literature focuses on water quality and public health (Drechsel et al., 2006), which concerned farmers to the extent that it could affect consumer demand. However, they were more preoccupied with absolute availability, as many had limited access to irrigation.

Farmers identified the irrigation sources they used throughout the year: many irrigate in rainy season to cover dry spells. Irrigation from potentially polluted sources such as ponds and dugouts as well as 'wastewater' characterised open-space cultivation in both cities,

Table 4
Seasonal cropping patterns (percentage share of households provided in brackets).

	Ouagadougou			Tamale		
	Urban isolated space (n = 55)	Urban open-space (n = 96)	Peri-urban village (n = 93)	Urban isolated space (n = 96)	Urban open-space (n = 75)	Peri-urban village (n = 98)
Main wet season crops on sampled fields	Maize (55), okra (53), groundnuts (24), amaranthus (15), roselle (15)	Lettuce (31), amaranthus (30), okra (21), rice (15)	Maize (50), sorghum (46), millet (19), okra (14)	Maize (70), tomato (32), okra (31), roselle (28), pepper (21), amaranthus (16), ayoyo (12)	Maize (59), rice (24), pepper (24), okra (23), roselle (21), tomato (15)	Maize (78), pepper (22), okra (19)
Main dry season crops on sampled fields	(< 2% of any crop)	Lettuce (37), amaranthus (25), cabbage (12)	(< 3% of any crop)	Amaranthus (5), okra (5), roselle (4)	Okra (9), amaranthus (8), roselle (5)	(< 1% of any crop)

Table 5
Percentage of farmers using various SFM inputs.

	Urban isolated space (n = 151)	Urban open-space (n = 171)	Peri-urban village (n = 191)	X^2 P	Ouagadougou (n = 244)	Tamale (n = 269)	X^2 P
Inorganic fertiliser	34.4	70.2	50.8	0.000	44.3	59.9	0.000
Manure	33.1	50.3	44	0.007	47.1	39	0.064
Compost	8.6	9.9	30.4	0.000	25	10	0.000
Biochar/Charcoal	0.7	1.2	4.2	0.046	0.8	3.3	0.064

particularly in Ouagadougou's open-space sites (Table 6). In Tamale, piped water was most popular for both open-space and isolated sites, preferable from a public health point of view, but raising concerns about appropriate use of a limited supply of drinking quality water in a city with a low water table.

Drechsel and Keraita's (2014) overview of irrigated urban agriculture gives the available water sources in various West African cities. However, the list provided does not give the proportion of farmers in each city using each source. Nor does the 2014 book give much data on isolated space farms: for Tamale, it cites unpublished data on open-space sites. Environmental factors are key in explaining the differences in water-use patterns between the two cities: the higher water table in Ouagadougou facilitates well digging. The commercialisation effect mentioned in relation to soil fertility management inputs may also make Ouagadougou's commercial farmers more willing to invest in paying labourers to sink a well.

Farmers innovated to circumvent low soil moisture availability. Some developed simple infrastructure, including irrigation channels, and, in Tamale, invested in standpipes to guarantee year-round water supplies. Simultaneously, they avoided higher commercial rates, irrigating with cheaper domestic water or collecting leakage from water supply pipes. Others used agroecological innovations to improve soil moisture retention. The most common technique was to ridge okra at the end of rainy season and allow residual soil moisture to carry the plants up to three months into dry season. This could be lengthened by mulching or planting crops in a moist location with high soil organic matter.

3.6. The role of backyard and isolated farms in context

The data presented thus far cover the spectrum of urban farming forms in the study cities, revealing striking differences in the role of backyard and isolated space farming between the two cities. A much smaller proportion of backyard farmers cultivating in Ouagadougou were commercial producers. As we stratified our sample *ex-ante* our quantitative data do not demonstrate relative proportions of each farm type within each city. Yet during data collection, we observed that, as well as differing in function, the way these farm types were distributed through the landscape was markedly different between the two cities. Backyard and isolated farms in Ouagadougou were scarcer and smaller than in Tamale. It was often impossible to find ten producers within the residential grid cells pre-classified for enumeration of backyard farms.

We therefore investigated the causes of these differences through primary and secondary data, and develop here a richer picture of the intersection between planning, history, legislation and culture that shapes the different farming landscapes of the two cities.

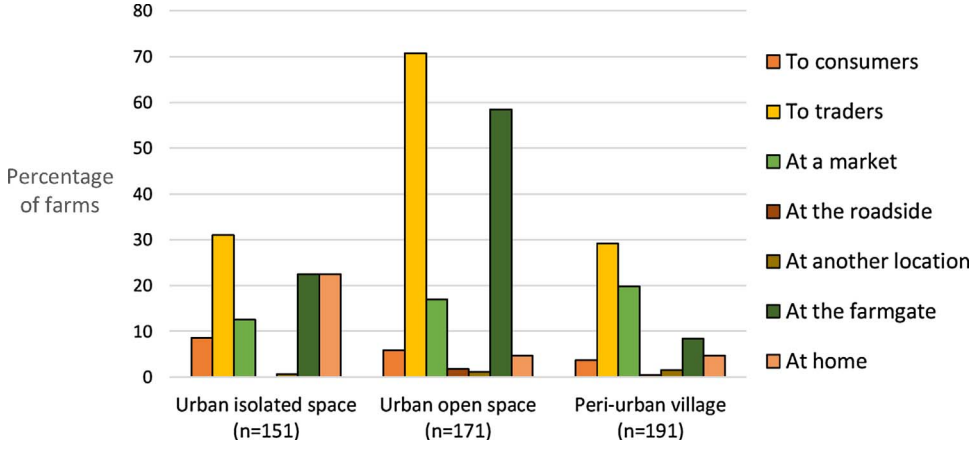

Fig. 4. Proportion of farms selling to different outlets and at various locations.
n.b. In backyard farms, the house is the farmgate, so these categories were combined for urban isolated space farms.

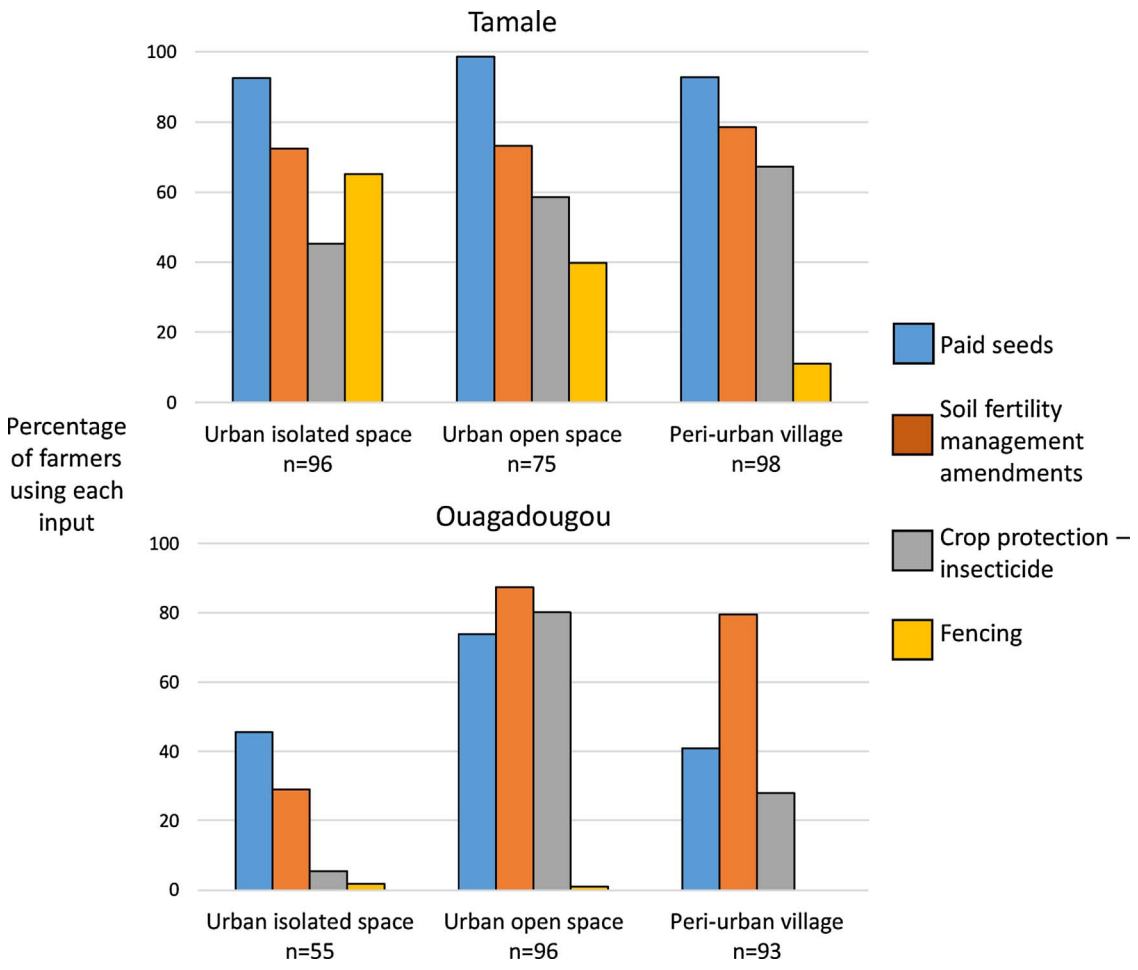

Fig. 5. Percentage of farmers using each type of input on sampled field.

Table 6
Proportion of farmers using various irrigation sources.

Ouagadougou			
	Urban isolated space (n = 55)	Urban open-space (n = 96)	Peri-urban village (n = 93)
River	0	4.2	0
Pipe	7.3	4.2	0
Wastewater	3.6	3.1	0
Pond	0	31.3	1.1
Dugout dam	0	3.1	0
Well spring	3.6	35.4	1.1
Other	1.8	6.3	0
Tamale			
	Urban isolated space (n = 96)	Urban open-space (n = 75)	Peri-urban village (n = 98)
River	1	0	1.0
Pipe	9.4	8.0	1.0
Wastewater	0	5.3	0
Pond	0	0	0
Dugout dam	0	1.3	0
Well spring	0	0	0
Other	2.1	2.7	1.0

3.6.1. Planning trajectories in Ouagadougou and Tamale

Historical land tenure and planning regimes in the two cities have influenced the form and structure of available farming spaces. Both settlements were situated at confluences of international trading routes from before the 12th century, and as they expanded, traditional rulers permitted settlers to establish ethnic enclaves on the city outskirts (Tinguiri, 2013). Ouagadougou, however, expanded much earlier than Tamale. The 15th century capital of the Mossi Empire, it was colonised by France in 1896.

In pre-colonial Ouagadougou, land tenure was managed by earth

priests, and use rights were ordered by people's belonging to first-comer or native lineages, or their integration into social networks (Dim Delobsom, 1932). Colonial French rulers imposed the principle of domainiality, legalising ownership of all land by the colonial state. However, indigenous people used traditional land norms alongside colonial rules to access land. This was often encouraged by colonial officials as part of 'indirect rule', a strategy co-opting and even creating traditional chiefs in order to exert control on populations through them. Mamdani (1996) claims this happened more in rural areas, yet the chieftaincy structures of the Mossi and Dagomba states meant it was viable in our study cities. List (2014) relates how hybrid land governance systems persist in West Africa, with decentralised city governments often implicated.

When Ouagadougou became the capital of French Upper Volta in 1919, governor Edouard Hesling began a redevelopment effort (Balima, 1995). He established wide boulevards in an attempt to avert the perceived threat of disease spreading between '*évolué*' and '*arrière*' neighbourhoods accommodating white and black people respectively (Tinguiri, 2010). This pre-empted contemporary redevelopment and resettlement plans. 'Spontaneously settled' areas were later demolished and residents were re-allocated rectangular plots, in schemes such as the redevelopment of the districts Cité An II, III and IV and Ouaga 2000, and Projet ZACA (*Zone Administrative et Commercial*) (Ouédraogo, 2005). This '*lotissement*' means that Ouagadougou is marked by spatial segregation of different urban forms, where bourgeois, *lotissed* neighbourhoods such as Ouaga 2000 are contrasted with peripheral '*non-loti*' areas. These have not yet been allocated a road, electricity or water infrastructure, and plots are not always rectangular. Therefore, they are more amenable to urban farming.

> The *non-lotis* around the town…over there, there are areas a bit wider where one can find backyard maize farms…I don't know if we can count them in the population of Ouagadougou, but they don't benefit from all the advantages of the city in terms of sanitation, public lighting and other things. (Officer, department for *Aménagement de Terroir*).

Nevertheless, Bervoets and Loopmans (2012) describe how urban agriculture persists through various stages of *lotissement*, from being ubiquitous in *non-loti* areas, as List (2014) describes in Pikine, Senegal, to the scattered phenomenon we encountered in *lotissed* areas yet to be fully developed.

In 1898 Tamale was a settlement of 1500 houses 70 km from Yendi, the seat of the Dagomba kingdom. After becoming the capital of the British Northern protectorate in 1907, a brief commercial boom extended into the 1920s (Dickson, 1969). Urban planning in Tamale, however, did not involve residential rezoning and relocation, as in Ouagadougou, in part because by the time Tamale had reached the population level that would make this necessary, the dominant discourse in planning was one of site services upgrading rather than slum clearance.

> At one time people thought that slums should be cleared to bring about urban development, and they realised that this demolished social structures and networks too… so the second thing was let's do upgrading. Introduce services, access ways, site services. Actually Ward E was to be cleared, at Dakpema area. But later on, World Bank came in talking about development with a human face, sociologists were writing so much. So we did site services, so that area got some roads. Those who were affected were moved from Ward E to Kaladan… given plots. So that area looks very well planned. But we've never done slum clearance. (Town and Country Planning officer, Tamale).

Tamale's first town plans were completed in 1955. An area extending far beyond the current developed area was planned and divided into wards in the 1970s in the first 15-year plan. However, as the Town and Country Planning department was not by then part of the municipal assembly, implementation was weak.

> Town and Country Planning department, those days we weren't well integrated into the district assemblies. All the departments were working on their own… the administrators were concerned with maintaining law and security and that, and the Town and Country Planning was concerned with ensuring development and to provide roads and water and those things, so each person had his own program. It wasn't well coordinated. So that gave challenges for implementing plans. (Town and Country Planning officer, Tamale).

Even by 2015 not all the plots within the planned area had been zoned or demarcated.

Whereas all land in Burkina Faso is state-owned, 80% of Ghanaian land belongs to traditional authorities (Government of Ghana, 1992). Purchasers of a plot need an 'allocation note' from the traditional authority before they can apply for a 99-year lease from the land authorities. Dagomba chiefs find a lucrative opportunity in this confluence of traditional land tenure arrangements and Tamale's current rapid urbanisation. Prices for allocation notes have escalated, and chiefs often engage unofficial surveyors to demarcate plots for sale in areas not yet officially zoned (Fuseini & Kemp, 2015; Naab et al., 2013). These surveyors often omit to plan for interstitial spaces, thus leaving them available for cultivation. Unlike in Ouagadougou, there is no requirement for all plots in a certain area to be sold before another can be zoned. This leads to vacant interstitial spaces between new developments, where both new and old residents farm.

> (L)and is state owned (in Burkina Faso) whereas here it is not. So if for example this is an area where we've said that we will not proceed until it is full: if the land is getting expensive there and the next chief says he wants to develop his land, when competition comes in the land prices will reduce… we have plans for the whole of Tamale, but in reality you can develop land anywhere if you develop the procedures and acquire your land. Because it is in the hands of (chiefs) … (Town and Country Planning officer).

Temporary caretaker farmers may negotiate usufruct arrangements with new landowners who lack capital to develop their plots immediately. They appreciate that farming suppresses weeds and protects their land against encroachment. However, as urbanisation began much earlier in Ouagadougou than in Tamale, more areas there are now fully developed, so fewer such peripheral plots are available for cultivation.

Speculators in both cities leave purchased plots vacant to sell later, in a process reminiscent of that recounted by Djiré (2007) in Bamako. In Ouagadougou, many people purchased suburban plots for property speculation, waiting for *lotissement* to reach that area and raise their value. Some maintained a residence elsewhere, and built a small 'matchbox' room on their *non-loti* plot, hiring this to tenants before selling up or building there.

> They prefer to construct 'matchboxes', little houses like that, and they wait. Maybe three years, four years, five years… So, he'll invest about 500, 1000 dollars and he'll have something worth 10,000 dollars. It's a business. (Planning officer, *Mairie de Ouagadougou*).

Those tenants or another farmer could then farm on the plot. Thus, Ouagadougou's isolated and backyard farms are more in the *non-loti* suburbs, areas we did not sample because of the random allocation of our sampling cells. Because of such speculation, the development plan '*Grand Ouaga*' stopped *lotissement* in 2011, simultaneously designing a green belt around the city.

Conversely, Tamale is still rapidly expanding into peripheral villages. The 1984 population was 135,000, in 2000 it reached 202,317 (Geohive, 2016), and the 2012 census gives 371,351 (GSS, 2013). This has been expressed in urban sprawl rather than a denser settlement pattern: Tamale has experienced a 7-fold increase in spatial extent in the last 30 years (from 9.8 km^2 in 1984 to 71.7 km^2 in 2013 (Erfurt, 2014)). Spaces between traditional compound houses in newly

Fig. 6. Aerial photographs of sampled grids in Tamale (left) and Ouagadougou (right).
Source: Google Earth, DigitalGlobe (2014) .

urbanised zones are still therefore used for larger expanses of crops by long-term residents, forming the 'absorbed peri-urban' farms described by Drescher and Iaquinta (2002). This is the trend hinted at by Smit and Nasr (1992) when they consider that agriculture on the periphery of expanding towns is 'integral' to their food systems. Conversely, Ouagadougou's larger size and more moderate recent growth means that rural areas are farther from inner-city developed zones. Thus, it has fewer backyard farms than smaller towns in Burkina Faso do. Such settlements may in fact bear more similarity to Tamale.

These differential development trajectories are expressed in the urban form of the two cities. In Fig. 6, the isolated spaces between houses in an absorbed village in Tamale contrast with the gridded arrangement of plots in a *lotissed* neighbourhood in Ouagadougou.

3.6.2. Rural-urban links

Respondents considered that the 'culture' of farming is part of many people's livelihoods, especially rural migrants or people whose land has been absorbed by urbanisation. This is more evident in Tamale, a smaller, faster-growing city, with stronger links to the surrounding rural areas. Agriculture, the major livelihood activity in Ghana's Northern Region, was historically a default and subsistence activity for Dagomba people, and continues in the form of backyard and 'absorbed' peri-urban farms.

> Culturally most of the people are farmers. So that farming thing is within them…and some of them come from the rural areas where the main occupation is farming… even if there's a gridline, the small space behind the house, they convert it to a farm. Any available space, (the area) is planned but there are open spaces and vacant plots that are not yet developed and people are farming on it. And then those who have big plots, they may build a bit and farm on the front. It's a culture. (Land Valuation officer, Tamale).

As Tamale expanded throughout the latter decades of the 20th century, flood-prone areas used by such farmers were retained as open-space farms. Drechsel and Keraita (2014) described nine such urban sites, covering an area of approximately 25 ha. In 2015, nineteen urban and peri-urban sites were listed by Bellwood-Howard et al. (2015).

In contrast, market gardening in the ancient Mossi Empire was reserved for providing the nobility with exotic vegetables. Only after 1930, when migration to Ouagadougou accelerated, did normal citizens take up urban farming, and they largely did so in open spaces in order to make livelihoods as new migrants. The first gardens were established in 1957, before the expansion of urban gardening due to the drought and grain shortages of the 1970s (Kêdowidé, 2011). By 2009, a survey carried out by the Commune of Ouagadougou listed 71 farming sites, organized in 28 zones scattered over about 580 ha.

3.6.3. Legislation

Ouagadougou's formal, segregationist planning approach means there is explicit legislation about UPA, which our respondents took seriously. Arrêté N° 97-027/MATS/PKAD/CO, article 18, of 5th November 1997, prohibits farming tall crops in open spaces in Ouagadougou. Some interpreted this as also forbidding backyard farming. Public education on local media has been persuasive: respondents reiterated credulously the risks of mosquitoes and robbers hiding in tall crops.

> People should not cultivate millet or maize because robbers can hide inside it. So it is for their own security… it's a good thing because it would be bad for robbers to do bad things, as it's for security, then it's for a good reason. (Farmer, Ouagadougou).

Citizens can report neighbours who farm in the city to the local government, obliging them to pay a 40,000CFA (€61) fine: one interviewee had been threatened with this. In Ouagadougou, it would have been forbidden to cultivate on some of the interstitial spaces we encountered in Tamale. Therefore, large spaces of uncultivated and undeveloped land are a feature of the Ouagalais landscape. In Tamale, most such spaces are covered in maize in the rainy season and okra or leafy vegetables in the dry.

Town plans for Tamale detailed in the Ghanaian planning ordinance CAP 84, based on the British 1947 Town and Country Planning Act, do not include specific zones for urban agriculture. There is no law against crop farming in Tamale, although CAP 84 states that only flower gardens and farms in settlements below 5000 people may be undertaken without a permit. Attention to the law was less of a preoccupation for respondents in Tamale than Ouagadougou, especially as planning officials recognised that CAP 84 is outdated and anticipated that parliament would soon pass its replacement, the 2010 Land Use and Spatial Planning bill.

3.6.4. Plot geometry and clôturage

The standard size of a plot in Ouagadougou has officially decreased from approximately 600 m^2 in the 1960s to 200 m^2, reducing the cultivable space in a typical compound. With Burkinabé *lotissement*, Ouagalais respondents also considered it important to wall their plot, to signify that it contained a 'proper' house.

> It's cultural. In the villages, even if people don't have the means to

Fig. 7. A fenced backyard farm in Tamale (left) and a *clôtured* residence in Ouagadougou (right). Source: Author, 2014.

do walls with earth, they do it with wood to close their living space more. It's this way of life that people have brought to the town. (Officer, department of *Aménagement du Terroir*).

Another reason for this '*clôturage*' was fear of crime and danger.

If it's in a village, you can just leave your house empty. But I myself was born in Ouagadougou here, I grew up here, and I got married here. And where I was born myself, it was *clôtured*, and I only know that it's not good to leave your house open or empty. For security. (Farmer, Ouagadougou).

When a plot is *clôtured*, the owner often intentionally compacts the soil within. A single structure is more amenable to construct than a traditional compound house in these modest enclosures, so the compacted floor characterising the compound of a family house has become the yard within the *clôture*. This leaves less room for cropping unless an area is specifically broken through.

Conversely, there has hitherto been no trend of walling urban plots in Tamale (Fig. 7). People building traditional houses here have walled only the compound, leaving space for a farm that spills over onto other plots. People historically built self-contained houses within a plot without walls, having the same effect, although some have now started to wall entire plots. A further effect of *clôturage* is that farms are concealed from passers-by. In Tamale, backyard and isolated space farms are visually exposed, generally being fenced from animal damage with sticks rather than bricks: Ghanaian farmers complained about the high cost of fencing materials, and are unlikely to invest in permanent brick walls on land that may not belong to them. This means that marketers can easily make opportunistic purchases. Spatial form thus facilitates the main way women engage with UPA in Tamale.

These reasons help explain the greater abundance of commercialised isolated fields in Tamale than Ouagadougou. Memon and Lee-Smith (1993) use a similar historical approach in their analysis of Kenyan urban agriculture. They invoke the influence of Western colonial ideas of rural–urban divide and concern with preserving sanitation in urban areas designated for settlers. They also mention the influence of rural plantation agriculture, which required a migratory urban workforce. Similarly, Briggs (1991) invokes the political and economic history of Tanzania when describing subsistence agriculture in peri-urban Dar es Salaam as a response to decreasing rural-to-urban food flows. Legislation has reflected an anti-agriculture stance in cities other than Ouagadougou: Kutiwa et al. (2010) and Mwangi (1995) note ordinances against urban cropping and livestock in Harare and Nairobi, the latter for the same reasons as in Ouagadougou. Our study confirms the value of such geographically and historically contextualised approaches for the analysis of urban agricultural landscapes.

4. Conclusions

This paper started by asking questions about the roles of different types of farm in the study cities and their contribution to urban food systems. Results confirm that there are important differences between various types of urban and peri-urban farm across urban landscapes. Peri-urban villages around both study cities largely retained traditional practices, cultivating subsistence crops in rainy season. Commercialisation in urban sites was concentrated in open-space farms, especially in Ouagadougou. Dry season production especially was geared towards commercially viable crops in these zones. In Tamale, in contrast, isolated farms had an unexpectedly important commercial side.

The significance of these results emerges when they are considered in geographical context. Urban history, by influencing urban form, shapes the relative importance of various types of agriculture across landscapes. This influences the role of farming in urban livelihoods in a given city. Isolated backyard farms in Tamale attract sales as the crops are visible to perambulating marketers and consumers. Thus, a Ghanaian farmer's ability to purchase fencing materials to encircle an undeveloped area between houses lets them contribute not only to subsistence but also to commercial food production, in a fashion impossible in Ouagadougou. The existence of such spaces is partly a characteristic of a certain stage of urban development, alongside a particular planning and tenure context. The farmer's confidence to undertake this endeavour stems from the legislative situation. Such isolated space farming therefore substitutes for food expenditures as well as generating income in that particular landscape. Our detailed quantitative data facilitated these observations, extending the existing literature mostly dealing with East Africa.

Our final research question related to management for enhanced resource use efficiency. Farmers had taken advantage of one of UPA's key opportunities, proximity to input and output markets, and made location-specific decisions about how to use labour and financial resources efficiently. They generally concentrated commercial production in sites with good input and market access. Sections 3.1–3.5 could appear to suggest that Ouagadougou's backyard farmers could efficiently increase food production for their households and the market. However, Section 3.6 showed that the deep-rooted reasons for the form of these backyard farms means that effecting change in their function would be more than a technical task, involving structural changes on planning, legislative, cultural and architectural levels.

Our results indicate that a focus on irrigation and soil fertility management may be equally important and possibly more immediately practicable. Poor water supply constrains farming across both locations. Farmers innovate to tackle this, but still need improved irrigation infrastructure. Tamale farmers rely on expensive piped water, less appropriate in situations of water shortage. In Ouagadougou's open-space zones, lettuce, eaten raw, is a major crop, yet farmers primarily use potentially polluted irrigation sources. Planning and research could usefully focus on provision of cheap, clean, perennial irrigation water, and improving soil quality so that it retains moisture effectively.

Farmers have had more success with soil fertility management. Commercial and subsistence farmers, especially in Ouagadougou, used organic amendments, and commercial farmers also use appreciable

quantities of fertiliser, especially in open-space farms. As across Africa, fertiliser costs and the difficulty of accessing animal manure remain major challenges. Thus, infrastructural and financial constraints limit the use of conventional and agroecological inputs, which could help address soil moisture concerns. A research focus on cheap, portable organic amendments could help. In particular, efforts could build upon soil management methods, such as mulching, that improve both moisture retention and fertility.

Overall, urban farming is fulfilling part of its potential to contribute to food systems in these two cities. Commercial farming is dominated by open-space sites. However, urban planning needs to acknowledge the importance of backyard and isolated space farming: with better access to water and soil health amendments it can play an important commercial as well as subsistence function. The extent to which this is possible is shaped by a city's historical, legislative and planning context.

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