Urban agriculture and sustainable urban landscape. An applied research on two case studies (Madagascar and Senegal)

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Abstract: In developing countries, like in Madagascar and Senegal facing high rates of urbanisation, urban agriculture is progressively taken into account in urban planning. To produce knowledge on this largely unknown activity and to help to design its place in urban landscape, two researches have been done with numerous surveys of farmers and of other stakeholders. We analysed the urban agriculture functions and its internal and external sustainability. With these tools and in straight relationships with urban planners and decision-makers, it was possible to discuss the types of production systems and zones where agriculture should be preserved to contribute to sustainable urban landscape.

***Keywords** : Urban Agriculture, Landscape, Multifunctionality, Sustainability, Madagascar, Senegal*

Introduction

Urbanisation is a world-wide phenomenon: if more than 50% of the world population is living now in cities (Véron, 2007), the rapid growth of towns concern specifically developing countries. Their annual urban growth rate is 3.6% between 1950 and 2005, compared to only 1.4% in industrialized countries (Mougeot, 2005). Urban growth in southern countries is scarcely well planned, because of the lack of adequate infrastructures, of financial means, and because of fast and uncontrolled migrations from rural areas. Urban planners' priorities in these poor countries are less the landscape maintenance than the ways to contain the increasing informal habitat, to improve the offer in transportation or other basic services (health, education, security) and to manage the waste production (Parrot *et al.*, 2008). Nevertheless, southern cities, especially in Africa, are also remarkable for the spatial importance of agriculture near and even inside the cities. This Urban Agriculture (UA)[1] often occupies a significant part of urban and peri-urban spaces and faces a strong duality between the rapid and often uncontrolled consumption of land by urban activities (Zeng *et al.*, 2005; Rural, 2006) and the conservation of land for agricultural production: in fact, UA in poor countries is often increasing in terms of total production (Cour, 2004) and has to pursue this movement to face the food demand of urban dwellers (Mougeot, 2005), especially in perishable products like vegetables (Moustier & Danso, 2006 ; Weinberger & Lumpkin, 2007)[2].

Thus, the place of agriculture in urban development is a complex question for urban planners. As previously experimented in some Canadian cities (Bryant, 1995), urban farmers are becoming stakeholders in the city, and their interactions with other urban stakeholders determine the evolutions of urban and suburban spaces. Urban agriculture progressively became a specific topic for researchers too, in northern and southern countries (Bryant & Johnston, 1992; Bryant, 1997;

[1] Among the numerous possible definitions (Moustier & Fall, 2004), we selected the following one "the agriculture located inside a city or on its periphery, whose products are at least partly destined for the city and for which alternatives exist between the agricultural and non-agricultural uses of resources (land, labour, water etc.)" (Moustier & Mbaye, 1999)

[2] in most of the southern countries, the lack of infrastructures and/or of refrigerated vehicles does not facilitate the fresh food transportation : so the proximity production of vegetables, milk, eggs and so on is an important part of the urban consumption, from 60 to 100 % for vegetables for example in African towns (Temple & Moustier, 2004)

Mougeot, 2000; Bontje, 2001; van Veenhuizen, 2006). One of the main issues of these researches is to analyse the roles of UA in the sustainable development of towns (Monédiaire, 1999; Fleury, 2005; Sullivan & Lovell, 2006), with an operational objective to help urban planners to take into account UA in their land use policy.

In this contribution, two case studies are analysed, to show how an interdisciplinary approach on Urban Agriculture would contribute to design urban landscapes, by helping to decide why and where integrate "agricultural green" in the city. Firstly, we will explain the contexts and the key concepts of "multi-functionality" and "double sustainability" of agriculture to provide a method of operational approach to UA (1). Secondly, we will show how concretely interacting with urban planners contribute to think the maintenance of UA and what are the types of incentives that could be taken (2). But UA evolves per itself too, and we will see thirdly how innovations in UA would at turn contribute to design new urban landscapes (3). We finally question how these "southern" experiences could be useful to renew the relationships between sustainable urban landscapes and agriculture in European countries.

Urban landscapes and urban agriculture: A research approach

Some southern main towns have recently developed approaches and incentives to take into account UA in the strategic planning of urban development (van Veenhuizen, 2006; Dubbeling, 2009). In our two case studies, Antananarivo, capital of Madagascar and Dakar, capital of Senegal, this is yet an emerging attitude. Nevertheless, new urban plans (respectively "Plan Vert – Green Plan" and "PASDUNE and PDAS[3]") explicitly refer to UA as a main component of urban landscape.

The contexts: Antananarivo, Dakar and the "green Plans"

Antananarivo (18°55' South, 47°31' East) is a tropical mountain city of 1.7 millions of inhabitants in 2006 and 3 millions foreseen in 2023. The habitat has been traditionally concentrated on the hills and mountains, leaving the valleys and lowland areas to agriculture. Nevertheless, recent urbanisation progressively reached the traditional rice plain and the lowlands inside the city. Today, agriculture is present up to the city centre (Fig. 1a,b), where it still occupies some urban lowlands, the main part the flooded surrounding plain (with recently rebuilt hydraulic infrastructures) and the suburban hills. Agriculture accounts for 43% of the 425 kms² of the urban district and 15 to 18% of its inhabitants have at least partially an agricultural activity -22 to 75% of the inhabitants depending on the suburbs - (Rahamefy et al., 2005). However, UA remains a poorly known activity. In Dakar, capital of Senegal, 2.4 millions of inhabitants on 550 km², the annual rate of population is 4%: the agro-ecological zone of the Niayes, along the northern coastal fringe, is very favourable for agriculture. Some Niayes are located inside the Dakar district, representing the most part of Dakar Urban Agriculture, as well as one of the most built areas in the past decades (Fig 1c).

Figure 1. Urban agriculture in Antananarivo (a, b) and in Dakar (c)

[3] PASDUNE: Program for planning and saving Niayes and green areas of Dakar.
PDAS: Managing and saving Plan.

In both cities, specific landscape plans have been recently adopted or are in course. In Dakar, the PDAS aims to develop and save from urbanisation the Great Niaye of Pikine in the near suburbs of Dakar (central arrow on figure c). In charge of the Direction of Landscape and Urban Green Spaces (DPEVU) which is under the authority of the Ministry of Urban Affairs and Land Use, it was elaborated in 2004 and coupled with the Urban master Scheme of Dakar, with the design of protected agricultural zones (Ba, 2007). In Antananarivo, after decades of unplanned growing, a service of the Ministry of Land Use, Agetipa, was in charge of a new urban scheme for Antananarivo, published with the technical aid of the BDA in 2004. In 2006, this new scheme was enriched with a "Green Plan": one of its main topics is to recognize and protect urban agriculture as a main component of city identity, as well as saving other elements of the local historical heritage. Thus in both cases, UA is no more ignored by urban planners, at least on the paper. The deal is then to reconcile the necessary urban growing and UA protection. For helping to solve this apparent contradiction, we mobilized a common methodology based on the following concepts and hypothesis. The mobilized means were nevertheless quite different: a pluri-annual and interdisciplinary project in the Antananarivo case called ADURAA[4], was conducted between 2003 and 2007 by 7 Malagasy and French researchers in agronomy, economy, environmental chemistry and geography, in straight relationship with the Urban Development Agency called BDA and with the participation of a total of 23 students (Aubry et al., 2008). The aim was to supply knowledge about UA (in this case and more generically) and its sustainability (see below), and to support the concrete decision-making of the urban development agency involved at the same time in the revision of the urban planning scheme. In Dakar, the situation was more exploratory, with one PhD in agro-economy, with an objective of building methodological tools of urban agriculture knowledge more than supporting directly operational decisions. But, as shown above, the government was conducting a reflection on the joint planning of these areas since the early 2000s and the DPEVU was assisted by three consulting firms in this project.

Hypothesis and concepts: multifunctionality and double sustainability

We make the hypothesis that Urban Agriculture may be included as an element of urban landscape. That means that agriculture is preferred as land use compared with another use like houses or other urban infrastructures building if, and only if:

(i) Urban dwellers and planners recognize that UA has, for the urban life and development, *specific functions that cannot be easily substituted*. In fact, the functions of agriculture are always multiple: food production (Ezgabhier *et al.*, 1994, Smith *et al.*, 1996, Snrech, 1997), environmental functions (prevention / risk absorption, contribution to clean up the city by using its wastes), landscape and socio-educational functions etc. (Dreschsel *et al.* 1999; Temple & Moustier, 2004). The multifunctionality is then particularly frequent in UA (Donadieu & Fleury, 2003) but its recognition by public policies is highly variable (Laurent, 2002), particularly in the South (Losch, 2002). Then, our research consisted in analysing the different functions assumed by UA.

(ii) Agriculture contributes to urban sustainable landscapes, which mean landscapes where "ecology, economy and well-being are balanced and strengthen each other". To reach this aim, UA must be itself "sustainable". This has for us two meanings:

(a) an *internal sustainability* only due to the conditions of production in farms and in food supply chains (are they economically viable, socially liveable, what resources do they use, are these resources renewable or not?);

(b) an *external sustainability* related to projects of "the City" (its planners, residents, etc.) on agriculture spaces; for example, an economically viable and environmental friendly agriculture may be condemned by priority given by urban planners to infrastructure for the town on the same space. These situations are very important to identify because building on an agricultural space is largely not

[4] for Analysis of the Sustainability of Antananarivo Agriculture, a research project funded by the French Ministry of Foreign Affairs, program CORUS (2003-2007)

reversible. Conversely, urban planners may wish to maintain, for example for landscape reasons, agricultural areas where farms are not viable per se.

The overall sustainability of an urban agriculture may be approached by a classification taking into account both its internal and external parts. The first one implies to study in detail the diversity of UA farms, the second implies to know and deal with urban authorities what are the planned projects on agricultural spaces. These two concepts of sustainability and multifunctionality seem particularly relevant in the case of urban agriculture (Fleury, 2005). Indeed, we assume that the conditions of maintaining agriculture in or near the city are related primarily to the functions that non-farmers (planners, residents, etc.) recognize to this activity: food supply for the city, preventions of risks, landscape preservation, recreational and educational aspects etc. Often combined, these functions, when recognized, can lead urban dwellers to preserve agriculture *in situ* and are a key issue for better reasoning agricultural land use in the urban extension (van Veenhuizen, 2006).

A brief review of the methodologies used in the two cases studies

In both cases, detailed surveys of farmers were made on a sample chosen to represent the different geographical sites of the town and/or the different types of production systems: 250 surveys were made in Antananarivo, in 9 different sites (plain, hills and lowlands, inside the city, at the near neighbouring of the city). In Dakar, 180 farmers in 4 main sites (Intra Urban or I, Intra Urban with Niayes or IN, Suburban with Niayes or SN and Periurban or P) were surveyed, as well as other stakeholders (see below). UA was very little known in both cases, no statistical data pre-existed on farmers and production systems. In each farm, internal sustainability was qualified through the estimation of the family income compared with the mean urban salary, the life conditions as appreciated by farmers and their insertion in social networks, and the type of resources they use (water, agricultural inputs).

This on-farm study was carried out meanwhile the understanding of urban dwellers and planners' conception about UA. It was done on two different ways: in Antananarivo, as our study was contemporaneous of an urban plan revision, we directly participated in its elaboration by interacting with the BDA. In Dakar, as it was not the case, we made specific surveys with urban planners (6) and elected people of the different districts of Dakar (13) and managers of the agricultural policy (8); a sample of consumers (60) and of sellers (30) was also surveyed in the principal urban markets of the city. The aim of these surveys was to make the stakeholders express their perceptions of the different functions of agriculture in the Niayes and their vision of its future. In both cases, our first research product was a typology of farms, built by crossing their agricultural production systems and their global activity system. Indeed, the proximity of the town often induces for farmers' family the opportunity to have frequent extra-farms activities (from the direct selling of agricultural products to the employment in factories and/or urban services sector). A common trend was the high diversity of production and activity systems in UA. For example, in Antananarivo, 38 types of production in three activity systems were found in the 9 agricultural sites, with a base on market-gardening or in rice production, and more than 60% of double activity. In Dakar (Ba, 2007), 57% of farmers live only from agricultural activities and 15 different production systems were identified, with some localisation preferences (Table 1): some of them using no soil are in the Intra Urban zone (I), the Niayes zones (IN and SN) are mainly occupied by market-gardening and orchards even if we found large farms of this type in the P zone; bovine cattle is only in the SN or P zones and flowers are in the P zone (with large farms destined to exportation) or in the I and IN zones with at reverse very small farms (less than 1000 m^2) destined only to local market.

Table 1. Classification of production systems in Dakar

Legend I: Intra Urban, IN: Intra Urban with Niayes, SN: Suburban with Niayes, P: Periurban. MarKGard : Market gardening farms, Orch : Orchards

Production systems without soil use		**Production systems with soil use**		**Specific production systems**
Pure (only I)	***Mixed (I, IN)***	***Pure (IN, SN)***	***Mixed (SN, P)***	***Pure (I, IN, P)***
Microgardens (MJ)	MJ-Livestock	Market gardening	MarKGard-Orch+ Cattle +MJ	Flowers (I, IN, P)
Livestock (sheep, goats, chickens)		Orchards	(MarKGard-Flowers) + Orchards	Fishing (IN)
		Rice production	(Flowers-Orchards-MarKGard) + Cattle	
		Specialised Livestock (bovine or chickens or pigs)	(Cattle-MarkGard) + MJ+Orch+Flowersi	
			2 to 3 Livestock	
			(MarkGard-Fishing)	

How these researches affect the design of urban landscapes

A better knowledge of these production and activities systems of Urban Agriculture is a necessary first step. But a deeper discussion of sustainability and functions is necessary in straight relationship with urban planners to understand how UA contributes to urban landscape and to help to design the future landscapes. In both cases, we discussed with urban planners some emblematic production systems and/or production sites, on the basis of our surveys and sustainability diagnosis. Because of the straighter relationships with urban planners in Antananarivo, we will focus on this case to explain the influence of this knowledge upon their decisions. In the Dakar case, we will chiefly mention our comparison of functions of UA between stakeholders.

Antananarivo: preserving some agricultural sites and production systems

Three different cases of decision-helping on UA place in urban landscape

During the revision of the Urban Director Plan in 2004, we shared with BDA the future of three specific agricultural zones, using our analysis of functions and of double sustainability (Table 2).

Table 2. Diagnosis of sustainability and recognized functions of agriculture in three sites and farming systems in Antananarivo

Legend: IS: Internal Sustainability, ES: External Sustainability. Notation: – very bad, - bad, + little, ++ medium, +++ very good

Zone and System	**Internal sustainability**			**External sustainability**		**Balance**	**Remarks**
	Economic	***Social***	***Resources***	***Recognized functions***	***Urban projects***		
North Plain Rice Systems	+(+) external activities	+++ but habitat	++ good water use but bricks	1.Environment (buffer zone against flood) 2. Landscape 3. Alimentation	No precise projects	IS ++ ES +++	
South Plain Rice Systems	+ external activities and direct selling	- unhealthy environment	- polluted water, numerous bricks	None	Industrial zone, roads, buildings (offices, housing)	IS – ES --	What future for farmers?
In-town Valleys Watercress systems	+++	++	- polluted water	1. Alimentary 2. Environment (flood risks, water de-pollution) 3. Social (work for farmers)	Roads and / or Housing But flood risks	IS ++ ES +	Sanitary problems?

- The *northern plain of Antananarivo* (some 2500 ha with at least 5000 farms) is mainly occupied by production systems which combine on the same field along the year: (i) rice production between July-August and December-January, (ii) fishing and ducks and goats rearing valorising the water presence after rice harvest, (iii) bricks production from the clay soil of the rice fields, for some systems only, when the drainage is over, between May and August (Fig. 2).

Figure 2. The northern plain land use along the year in Antananarivo

Most of these farmers have another activity, often salaried works in Antananarivo factories or shops. Our functions analysis showed that (i) *farm's productions are essential for family's survival*, with domestic consumption of rice, of some fishes and ducks, eggs or chickens. On an economical point of view, rice is scarcely sold (only the biggest farms can yearly sell a part of their production) but animal productions and bricks selling, when present, contribute to the family income: however, it is generally insufficient (most of the farms are less than 1 ha) and the external income is necessary for domestic budget. *Local rice production has an important function in food supply of the town as our results show*: 14 to 18% of the about 175.000 t consumed yearly in Antananarivo come from UA and help to regulate the market at times (December to March) where other sources of rice (other regions, importations) are deficient (Dabat *et al.*, 2004, 2008; Minten & Dabat, 2006). On an agronomical point of view, if the yields performance are still low (1.5 to 2 $t.ha^{-1}$), *there are obtained without using any chemical input, and they are higher when the rice fields receive some urban domestic liquid wastes,* which is frequent in a town with very poor infrastructure of water treatments. *The role of protection against inundations of this rice plain is very important:* rice systems are conceived by farmers to be harvested before the tropical storms and hurricanes season (February-March) and rice fields then serve as very useful buffer zones to absorb rainfalls. This productive and hydraulic role is even so endangered when bricks are made on rice fields, because of the perturbation of hydraulic regime by bricks holes and suppression of the most fertile soil layers. We classed the internal sustainability as medium: limited agronomic and economic performances of farm productions are balanced by the fact that rice production is socially well accepted, as a refuge and traditional value for families, and fields are often a familial heritage. The liveability for some farmers could be improved, particularly with regard to housing. In terms of resource use, water is scarcely a problem in the rice area, only bricks making are a negative element. The exchanges with BDA concerning this northern plain resulted that the agency had a good perception of the "buffer zone" role of this plain to protect the city against water damages. The agency was interested to discover the economic and food supply roles of this agriculture and insisted on a new point: *the northern rice plain is very important on a landscape point of view.* In fact, it is the first view one can have when he/she arrives from the airport; it is the main element of the identity of the town, as it was the historical reason for what the Malagasy Kings chose this site to build their capital in the mid-16th century. So, for all these reasons, BDA had very few new urban projects of infrastructure on this plain and we can consider the external sustainability of this plain as very good.

- In the southern plain, rice systems are technically very similar, but in this site, was set up the first industrial zone of Madagascar: our study showed that rice production is very low at the neighbouring of the factories, and even the economic results of agriculture are lower than in the north plain because the rice yield is very affected by industrial discharges: all farmers have other activities, as in

the industry. This agriculture poorly contributes to town food supply (only with some chickens or ducks directly sold to the factories employees). On a social point of view, these zones concentrated a lot of problems: industrial pollutions, numerous abandoned rice fields attracting mosquitoes that transmit malaria, many health problems including access to drinking water. As for resources, the use of rice fields to make bricks is very frequent and the main source of agricultural income. Thus, internal sustainability of this agriculture is very low. On the BDA point of view, this plain has no more landscape interest and at reverse, it could be economically interesting to go on with industrialisation and infrastructures. Thus, urban projects are more numerous here: extension of the existing industrial area, residences, roads etc. Our results also emphasize the health risks of agricultural production in these conditions.

- Inside the city's lowlands, some specific farming systems are based on watercress production: very appreciated by Malagasy consumers, watercress often replaces the previous rice production (Fig. 3) by better valorising the high level of nutriments in the water inside the town.

Figure 3. An intra-urban lowland with watercress.

Our analysis showed their income is correct for farmers, so they often have no other activities, even on very small areas. At least 90% of the watercress consumed in Antananarivo comes from UA production, made on 37 spots in the city for a total area of around 7 ha and with some 340 producers: the food supply function for the city is thus very important and the economic internal sustainability is high. The liveability and social acceptability of these watercress systems are strong, but they contribute to water pollution through the use of insecticides. Our project showed that if they "valorise" urban grey water, this could lead to some hygienic problems. A new research program (Qualisann, 2008-2010) intents now to quantify the risks for human health of organic pollution of the watercress along its production and commercial chain. The production in lowlands has also a role of buffer zone against flooding, with downstream rice production, as our results showed: a valley of 287 ha stores for example 850 000 m^3 of rain water, which means three successive days of heavy rains. These facts argue for limiting in these lowlands infrastructure projects like roads or housing.

Then, if internal sustainability of watercress systems is relatively high, in terms of external sustainability, our exchanges with BDA showed that urban projects are frequent in the lowlands. Nevertheless, the authorities are still in the expectative to decide: on the one hand, they are worried by possible risks for human health, on the another hand, they recognize the high contribution of watercress and rice lowlands systems to feed the city, their contribution to absorption of flood and sometimes their landscape role: typical green spots inside the centre of the city.

What types of decision or incentives have been taken by urban authorities?

Decisions on Land use in Antananarivo have been largely inspired by this analysis:

In the northern Plain, it was decided in 2004: (i) the creation of a protected agricultural area of 2000 ha of extension so as to recognize its role of a buffer zone: rice farming systems are considered as the most effective and cheapest way to achieve this protection role (Rahamefy *et al.*, 2005), (ii) the suspension in 2004 by the mayor of Antananarivo of the embankments, decision still in force today, (iii) the landscape function of this northern plain is recognized through the creation (in course) of a

"living museum of plants" by the Green Plan which incorporates the existing farms: the idea is to conceive footpaths so that inhabitants and tourists could travel and glance through this very nice landscape, have information about rice production, and buy some crafts.

Conversely, the southern Plain agriculture is heavily "sacrificed" to urbanisation: the authorities consider that they can pursue, in these zones of low agricultural sustainability, the construction of industrial infrastructures and housing. To alleviate the problem of discharge of industrial effluents, a project of collective purification station at the exit of a major industrial area is underway. The status of bricks making in the plain rice, whether north or south, is not yet decided: the local authorities, aware of its role both in urban construction and for farm household income, do not want to definitively ban it, while regretting its impact on destruction of farmland and the disturbance of water regime. As far as we were informed, only one municipality near Antananarivo made a clear choice, by zoning bricks-making permits, these latter being authorized only near an important road in construction, but not elsewhere.

Road projects in some watercress systems lowlands are still on standby. Flood and erosive risks or even landslides on future roads are not neglected, and otherwise, the authorities are reluctant to sacrifice the watercress farms because of their multiple functions (food, economic and environmental). On some cases, urban projects of infrastructure are being revised: in addition to former reason, landscape continuity of this in-town valley with a new urban park development was evoked to justify this decision.

In Dakar, various pressures on the Niayes production systems

All the interviewed stakeholders consider that urban agriculture has an alimentary function and mainly for fresh products, even if this function is not easy to quantify[5] (Fig. 4). This is the main function for farmers, sellers, consumers, urban planners and agricultural officers, but only the second one for elected people. These latter, excepted one of the periurban zone, firstly consider the function here described as “green lung”, also put in good place by farmers of the Intra Urban Niayes: they are those who mainly receive the visit of urban dwellers, who are more conscious of the attractive role that the landscape their agricultural activity offers for the city. All urban planners also consider the “green space function” as important, but in second position behind the alimentary one.

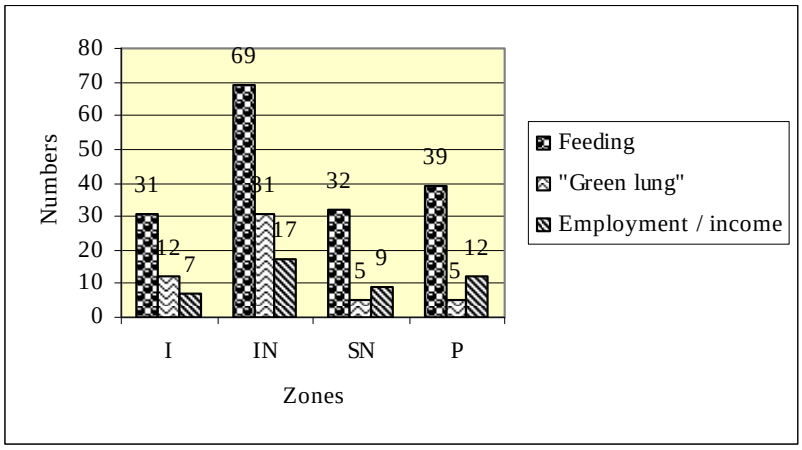


Figure 4. Perception of the functions of the Niayes according to farmers

For some production systems, the qualitative results of internal and external sustainability are given on Table 3. Most of the production systems have good or very good internal sustainability, notably on an economic point of view for farmers. Market-gardeners are always considered as useful for feeding the city but on the intra urban Niayes, there is a lot of possible urban projects in

[5] The fresh fruits and vegetables products consumed in Dakar and grown in the four zones represent at least 60% of the total consumed (Temple and Moustier, 2004; Ba, 2007)

contradiction with the "green lung" function recognized to these specific zones. The use of resources is a problem too: a lot of farmers used grey water in the IN zone, with possible health effects but, they now have the possibility to use the treated wastewater from sewage treatment plant water located in the IN area. Farther from the city, the problem is more the insufficient access to water: farmers must irrigate in the night and have quotas beyond which the price of the cubic meter of water is higher. Another problem is that livestock are not desired by urban planners inside the city, but nobody succeeded to expulse them because they have a great economic and traditional function.

Table 3. Classification of internal and external sustainability for some production systems in Dakar

Legend: I: Intra Urban, IN: Intra Urban with Niayes, SN: Suburb an with Niayes, P: periurban. MarGar: : market-gardening Farms. Notation: - bad, + little, +++ very good.

Production system	***Zone***	**Internal Sustainability**	**External Sustainability**	**Main Problems**	**Remarks**
MarKGard	***IN***	++	+	Water quality	Urban projects
	P	+++	++	Water quantity	-
Livestock	***I***	++	-	Odours	Health risks?
Flowers	***I***	++	?	Land tenure	
	SN, P	+++	+++	Water quantity	Exportation

The case of Flower production is especially interesting to consider on a landscape point of view: in P zone, we surveyed a great farm of 20 ha chiefly destined to exportation and local hostel supplying. As for the large market-gardening and orchards' farms located in this zone, it has no other problem of sustainability than the access to water and has adopted the solution of drip irrigation. In the IN area, flower producers are mainly immigrants from the rural groundnut area, installed without authorisation in all the pieces of land they can find: road fringes or rings, flooded zones outside the rainy season. Their internal sustainability is medium (good economically but none of them has a real right on the land he uses) but for their external sustainability, urban planners and elected people have a dilemma: intra urban flower producers are sometimes only considered as "squatters", but the majority of these stakeholders join the consumers to consider that they contribute to "green" the city (Fig. 5)

Figure 5. A Flower producer on a road ring in Dakar

The incentives that are taken or could be taken to preserve the accepted forms of urban agriculture are very diverse: recently the local authorities prohibited the use of grey water by market-gardeners, building treatment plant wastewater. The problem is now for farmers to "compensate" technically the supply of nutrients by the previous water, which was free of financial charge, by organic and/or chemical sources of nutrients, expensive and/or polluting. Then, to better accompany these farmers that the city wants to keep in function, it is really necessary to supply them a real technical support. For the intra Urban flowers producers, the authorities face a legal problem which is now in discussion: to recognise the legality of their land occupation on municipal or collective sites.

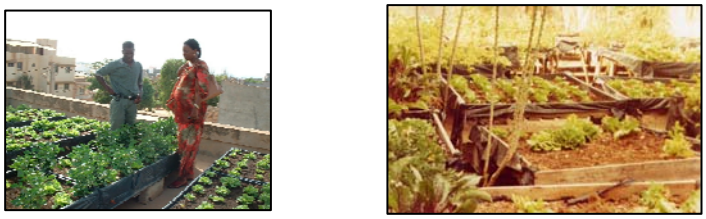
When UA evolution shapes urban landscapes

In the previous examples, the deal was mainly to preserve agricultural areas against urbanisation. But Urban Agriculture is also a spot of very innovative forms which may at their turn change urban landscape.

Dakar: the Micro-gardens turn the town green again

At the beginning of this century, a development program took place in Dakar to contribute to a better nutrition of the poorest families, chiefly alone women: the innovative forms of micro-gardens was developed by the FAO and then from 2004 to nowadays, by a Milan-Dakar cooperation (Ba & Ba, 2007). A Microgarden consists in a no-soil cropping system on every type of container (table, tyre, buckets) placed on the balconies, the roofs, the terraces, hanged on walls, scholar or Town Halls yards etc. (Fig 6). At the beginning of the development action, only a few hundreds of women were concerned, chiefly for self consumption. The Fann hospital and some kindergartens have their micro-garden to improve the diets of patients and children. Nowadays, some 7500 micro-gardeners exist at least in Dakar, their production is mainly lettuce, leafy vegetables and aromatic plants and a majority of this production is sold in the urban markets.

Some legally constituted groups of economic interested exist now and we show that: (i) these forms of market-gardening are highly sustainable in economic terms, (ii) they are considered by consumers as great quality produces because they are not produced with grey water (iii) an analysis of the ITA (Institute of Food technology) on the nutrient composition of vegetables from micro-gardening shows that their calcium and C vitamin value is higher than the one of vegetables from the market-gardening, while their composition in iron and phosphorus is likely the same (Tall, 2006).



a b

Figure 6. Micro-gardens in Dakar: visual aspect of a roof in Dakar (a) and containers (b)

An emerging function could be now added: they contribute to “green” the city. It seems that the local authorities are now conscious that these new forms of urban agriculture could be very positive for the sustainable development of the city itself. The phenomenon is changing very rapidly and had for two-three years now, switched from the status of “agriculture of the poor” to the status of an economic and ecological form of urban agriculture: even traditional market-gardeners outside the city are now developing micro-gardens to complete their “on soil” production.

Antananarivo, an institutional recognition of UA

In the Malagasy capital, the recognition of UA as a part of the urban landscape is in course, as it is the case in various African countries (Cissé *et al.*, 2005). After the Green Plan of 2006, a direction for “green areas management and urban agriculture” was created in 2008 in the municipality services. This new direction focused its work on two major points: rehabilitation of a so far neglected municipal rice field in the north plain (14ha) (Fig. 7) which totally changed the local landscape, and contribution to the redesign of a lake city, the Marais Masay, whose edges are occupied by intra-urban market-gardening farms.

Before 2007 After rehabilitation in 2008

Figure 7. The recuperation of a municipal field in Antananarivo

Last but not least! In September 2009, despite of a political crisis involving directly the President of the country and the ex-mayor of Antananarivo, the city authorities requested a joint action of the research project ADURAA and the RUAF Foundation (the international network of Resource Centres on Urban Agriculture and Food Security) to help them to define strategic planning of agriculture in Antananarivo. A platform of different stakeholders on urban agriculture was constituted and a previous FAO project to support urban agriculture has been revisited. Among the very next projects: (1) the development of a "low space no space" demonstration program in a urban lowland, with the example of Dakar Micro-gardens (cooperation south-south), and (2) a collective reflection on how to supply the emergent scholar canteens: for the moment 5 experimental canteens work with local agriculture to contribute to a better food supply for children and a better scholar frequentation (Sonnino & Morgan, 2008). The aim is to maintain and even develop in the city an agricultural productive land use.

Discussion and Conclusion

The methods we use in both cases to produce knowledge and operational tools about urban agriculture are not similar but they both lay on the concepts of double sustainability and analysis of UA functions. These methods help planners to recognize the different roles of UA in a developing country's growing town: The aesthetic landscape function is never the main one, but various functions, according to the diversity of production and activities systems and the diversity of geographical specificities, can justify in some cases, for planners, the maintenance of an agricultural use of the land even inside the city. These functions are economic, food supply, employment – to face urban unemployment, urban drift –, preventions of environmental risks (flood, erosion), valorisation of urban wastes, reducing ecological print of the city: thus, the role of urban Agriculture in urban landscape is exactly on the same wavelength of a "sustainable landscape" as defined in this workshop, where economy, ecology and social well-being are taken simultaneously into account. We then showed that our hypothesis that Urban Agriculture may be included as an element of urban landscape if its functions are demonstrated and if it is globally sustainable. For research, both cases contribute to demonstrate the role of urban agriculture case studies to enrich concepts like sustainability, diversity or multifunctionality, even if we develop these research aspects in another publication (Ba and Aubry, 2010).

A necessary condition for reaching operational results is the straight relationship with urban planners. The success of this relationship in the Antananarivo case is due, as we analyse now, to four main points (i) Urban planners, clearly identified in a specific agency, were included as partners *since the first steps of the project*, even its preparative phase. Some production systems and/or sites were clearly chosen with them[6] (ii) *frequent meetings* (at least four per year) were organised with them, facilitating the exchange of information, and they were *directly implicated* in the training periods of some of our students (iii) the *multidisciplinary* program ADURAA allowed to bring them information about diverse points of view (economic, agronomic, environmental, geographical), which represented for them a real "added value" (iv) the revision of the urban scheme was *exactly concomitant* with the beginning of our project, even if this was a hazard effect: the necessity for urban planners to decide about the future of 43% of the territory (the local agricultural land use) certainly facilitated their interest for our work, as our access to their urban projects. The fourth condition is obviously specific to this context, but the three previous ones can be reached in other cases and can be considered as necessary conditions for the relationship. The role of interdisciplinary approach must be specifically underlined as a necessary way to design the role of urban agriculture in the urban landscape development: we showed that the landscape function of urban agriculture is scarcely the main one to be considered, and then the researchers' capacity to lighten the other functions of this agriculture seems logically important. But building interdisciplinary projects needs to identify diverse competencies at a local scale, to facilitate their collaboration and to ensure their pluri-annual means for study: looking for the fund support is not an easy task, neither coordinating

[6] For example the distinction between north and south rice plain

the whole project. In the Dakar case, the size of the research project was not the same, neither its approach: but these first results lead to consider that an interdisciplinary approach could be useful for urban planners' decision making.

One of the questions is the delimitation of the pertinent scientific fields to develop in such a project. In the Antananarivo case, it could have been very useful to rely on specialists of animal sciences, because of the role of cattle in the majority of agricultural systems, and on hydrologists because of the importance of the water regime, functions, and dynamics in this context. Unfortunately, despite of efforts, it was not possible to include these fields in the project: this is a real limitation for our results, in the context but also for the more generic topic of urban agriculture functions. On another hand, even if the landscape function is not the main one, the participation of landscape specialists would be very useful in all these type of projects! In Antananarivo, the implication of a landscape architect in the continuation of the urban scheme partially helped us to overcome this limitation.

Nevertheless, the last step for the recognition of urban agriculture as a component of sustainable landscape is that the elected people will turn applied research results into land use decisions. If this aim was partially reached in Antananarivo, the building of the platform on urban agriculture is in course but very slower than previewed in 2007! Nevertheless, we think that the two presented case studies represent a worldwide movement: as RUAF shows in recent communications (Dubbeling, 2009), some 20 cities around the world as different as Beijing, Amsterdam, Bulawayo (Zimbabwe) or Rosario (Argentina), are designing urban schemes taking explicitly into account the various functions of urban agriculture. Obviously, these functions vary according to the country (its level of industrialisation, for example), but maintenance or development of agricultural land use inside and near the city is always a main topic.

Another point may be underlined: this movement of 'recognition' of UA is not only reserved to poor or developing countries. Projects are ongoing in Europe, with a special mention for the Netherlands, where multifunctionality of agriculture is entirely assumed by the Ministry of agriculture. Some other 'developed' countries or regions are trying to support or promote urban agriculture: it is the case in the Ile-de-France Region, where the recent regional director scheme defines strictly protected agricultural zones and favour the set-up of new farmers (chiefly in short supply chain with urban dwellers, see Petit *et al.* communication in this seminar). Interdisciplinary research and methods conceived in southern countries could then be useful to study these European contexts; a form of south-north transfer of knowledge?

More generally, we can make the hypothesis that the conservative landscape function of agriculture is much higher for urban areas land use than for rural areas. In the latter, agriculture is often charged to change the "natural landscape" while in the city, agriculture has the advantage of protecting the land from the irreversible effects of urbanization.

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