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# Understanding peri-urban maize production through an examination of household livelihoods in the Toluca Metropolitan Area, Mexico

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# ABSTRACT

The rates of urban growth globally continue to rise, especially in small and intermediary cities and periurban areas of the developing world. Communities in these settings share characteristics with rural areas, in terms of continued connections with agriculture, yet with an increasing reliance of nonagricultural employment which poses challenges for policy and planning shaped by dichotomous configurations of space. This study focuses on maize producers in the Toluca Metropolitan Area, west of Mexico City, which is a traditional maize production region that also has exhibited high rates of industrial and residential growth over the last thirty years. We utilize household surveys from three peri-urban communities to create livelihood cluster groups that tease out the value and role of maize production amongst urban growth. The results show that maize plays various roles for households, including an insurance strategy against volatile job markets and for preference in making homemade tortillas. Rural and urban livelihoods in this region are mutually dependent on each other and not necessarily reflecting a linear rural—urban transition, which could lead to the persistence of maize production in the future. The continuing importance of maize in the Toluca Metropolitan Area provides policy opportunities to recognize and support the crop for household and regional food security despite continued urban growth.

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# 1. Introduction

Over half of the world's population is now concentrated in urban areas. Urbanization presents various social and environmental challenges such as concentrated poverty, negative environmental externalities and problems for achieving food security (Redman and Jones, 2005). Particularly in the developing world, urbanization entails regions of dynamic interaction between traditionally rural and newly urban land uses and livelihood activities at the urban periphery or "peri-urban" areas (Tacoli, 2003; Simon, 2008). As concerns grow over the continued loss of agricultural land to urban growth, and the attrition of farming populations to urban centers, it is increasingly important to understand how food production persists in urbanizing regions.

The livelihoods pursued by households in peri-urban areas are composed of production and consumption activities that represent

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0743-0167/\$ – see front matter  $\odot$  2012 Elsevier Ltd. All rights reserved. http://dx.doi.org/10.1016/j.jrurstud.2012.11.001 a fusion of typical rural and urban activities. Peri-urban producers are similar to typical rural producers in much of the world that subsidize agriculture through non-farm income sources (Netting, 1993; de Janvry and Sadoulet, 2001; Reardon et al., 2007). In the case of peri-urban agriculture, however, the proximity to urban centers also can create nearby market demands from consumers that seek out traditional foods (Lerner and Eakin, 2011). Additionally, the tradition and culture of agriculture in a region might encourage some producers to continue planting despite also having stable non-farm income (*ibid*). This study uses the example of periurban maize production in the Toluca Metropolitan Area, to the west of Mexico City, to assess the distinct ways that agricultural identity and maize production persist in peri-urban areas in light of the stressors of urban growth and agricultural policy shifts that undermine its persistence.

Maize is a traditional and iconic crop that continues to be grown by at least 2.6 million people in Mexico (SIAP, 2012), despite the continued challenge of climate variability and soil degradation, the withdrawal of federal supports for small-scale maize production, and the liberalization of maize through the North American Free Trade Agreement. Mexico's ability to produce a significant portion of the maize its population consumes as food has historically been





a strong policy objective (see Appendini, 2001), and has become a new concern in face of rising commodity prices globally (Keleman and García Rañó, 2011). In central Mexico, where the human demand for maize is concentrated, urbanization not only is converting farmland into residential and industrial use but also is absorbing much of the rural labor force in urban labor markets (Appendini and Torres-Mazuera, 2008). Nevertheless, there are other forces at work that may motivate the continued production of smallholder maize in this dynamic context, including the use of maize for household consumption in the form of homemade tortillas when non-farm income sources are scarce or volatile. Additionally, new consumer demand can surface in urban areas as some populations seek traditional foods that can be supplied by peri-urban producers (Barkin, 2002; Appendini et al., 2003; Keleman and Hellin, 2009; Lerner and Eakin, 2011). In other words, the persistence of maize production in peri-urban areas suggests that some households are not in some "evolutionary stage" of modernization (Netting, 1993: 19), and instead continue production for risk aversion, tradition, and food preferences.

In this article, we will review the nature of peri-urban livelihoods and the specific context of peri-urban maize production in Mexico, particularly as it relates to tradition and identity. We then use a cluster analysis to create a livelihood typology that explores the motivations and value of maize production for peri-urban households that produce or have abandoned maize. The results reveal four main livelihood groups who vary in the use and importance of maize in terms of household economic activities. values and preferences. In the diverse strategies observed here, maize plays various roles, shaped by the needs of households and their available assets as they are exposed to urban and demographic change. Our analysis demonstrates the multiple functionality of maize in the urbanizing environment, including as an insurance strategy against uncertain or volatile income sources and for the preference of households for homemade tortillas. Additionally, we find that there is not a linear transition from rural to urban livelihoods in this region suggested by classic Modernization theory (see Rostow, 1960); rather there is a presence of both rural and urban activities that are mutually dependent on each other. The persistence of maize in this expanding urban area indicates a crosssectoral policy opportunity to facilitate and even encourage smallscale production for household and regional food security.

#### 2. Background

# 2.1. Maize and identity in Mexico

Mexico is the birthplace of maize, leading to a long history of cultivation and center for traditional heirloom or *criollo* varieties (Piperno and Flannery, 2001). The indigenous communities in the Mexican highlands developed the *nixtamlization* process, where calcium carbonate is added to the grain while cooking it in order to extract more minerals and make it easier to grind into tortillas (Fitting, 2011). A variety of traditional foods eaten every day across the country are based on this process, either made by grinding maize grain, by using a processed maize flour purchased in supermarkets, or by purchasing products already made through the grain or flour. Although the majority of consumers in Mexico eat tortillas purchased in *tortillerías* or supermarkets, approximately a quarter of human maize consumption in Mexico is in the form of handmade tortillas from household or regional grain (Keleman and García Rañó, 2011).

Maize in Mexico is usually produced in one of two major production systems: irrigated, input-intensive and commercial production mostly in the northwest (35% of total production), or rain-fed, small or medium-scale production in the central and southern highlands (Fox and Haight, 2010; Keleman and García Rañó, 2011). The national government has actively supported commercial agriculture in the north through subsidies for inputs and transportation while support for smallholder production dwindled since the late 1980s, being replaced by welfare programs such as *Oportunidades*, a cash transfer program for women and children (Fox and Haight, 2010). This shift in government support is what Elizabeth Fitting calls a "neoliberal corn regime," which included the liberalization of maize through the North American Free Trade Agreement (NAFTA) and the removal of the National Company of Popular Subsistence (CONASUPO) which provided a guaranteed buyer of grain for all producers. Additionally maize prices shifted from being established by the government to being based on the Chicago Board of Trade (Fitting, 2011).

Approximately half of the agricultural land in Mexico is currently found in *ejidos*, the communal land areas granted to landless Mexicans after the Revolution, starting in 1917 (Johnson, 2001). Each member or ejidatario received a plot for farming, a plot for house building (sometimes the same plot) and access to communal land areas for animal grazing. Many ejidos, especially in peri-urban areas, now have an urban center where most inhabitants live and are surrounded by parcels where ejidatarios still practice agriculture. Each ejido has a governing council (comisariado ejidal) that is responsible for decisions regarding ejido funds, coordination for the harvest, land sales and titling, relationships with municipal and state agrarian agencies, and until 1980, the urban growth and construction of official buildings in the community. Since 1992, when the Mexican constitution was ammended to allow the titling and thus sale of eiido land, the institutional basis for the ejido has been eroded. Today ejidos still exist, albeit with a diversity of tenure arrangements; nevertheless, the degree to which the ejido council is active in local land management and governance varies.

Of particular importance in Mexico is the cultural asset linked to being a *campesino*. The term campesino (literally person of the countryside) refers to a smallholder producer, particularly in the context of national land reform and the creation of ejidos that ended in 1992. The concept of the campesino has been discussed throughout Mexican literature and theory as a specific political class tied to small-scale production which is often related to maize (Warman, 1972; Torres-Mazuera, 2008: 240; Fitting, 2011). Warman (1972) states simply that "it is necessary that a campesino have a relationship with the land in order to cultivate" (116). However, there is a deeper and more political meaning of campesino that is "a distinct social group united by a shared set of political and economic interests as well as by a collective history of oppression" (Boyer, 2003: 3). It can be inferred that as households become less tied to land and more linked to urban areas for employment and lifestyle choices, they are also less likely to identify with being a campesino. Yet the persistence of such cultural ties to land and production may also be a motivating factor for some households to continue to produce, even in rapidly urbanizing regions. Indeed, household livelihoods based on maize production are often subsidized by remittances and non-farm employment, leading to perhaps a reconfiguration of campesino identity (Barkin, 2002; Fitting, 2011).

#### 2.2. Peri-urban livelihoods

The study of household livelihoods has emerged from global concern over poverty alleviation and quality of life, particularly in rural areas of the developing world (Scoones, 1998; Ellis, 2000). Livelihoods encompass the "capabilities, assets (stores, resources, claims and access) and activities required for a means of living" and are influenced by larger-scale political-economic processes and

institutions that are manifested at local levels (Chambers and Conway, 1991: 6; Scoones, 1998, 2009; Bebbington, 1999). The unit of analysis in livelihood studies is the household, which represents the aggregate outcome of intra-household activities among household members (Netting, 1993). Building on entitlement theory (Sen, 1981), livelihood analyses thus illustrate the role and function of specific sets of assets and *entitlements* (the ability to procure food and other goods), and how they interact to meet households needs and achieve desired outcomes.

The assets that typically make up a livelihood strategy include: economic (income sources, credit or subsidies), natural (land, livestock), social (organizations and community networks), physical (material assets) and human (education) (Ellis, 2000: 31–51). For example, a household's land assets and labor availability directly affect the ability to engage in food production. Nonmaterial or cultural assets are equally important as material assets, because they "give meaning" to people's lives beyond material objects that provide a physical necessity (Bebbington, 1999: 2022). Therefore the values that exist within households also shape the ways in which households utilize resources and livelihood activities, such as land-use choices and consumption patterns (Lerner and Eakin, 2011).

Despite the emphasis of livelihood studies on rural areas, the study of urban livelihoods has also started to gain attention, reflecting increasing urban poverty levels worldwide, specifically in Sub Saharan Africa and Asia (Bigsten and Kayizzi-Mugerwa, 1992; Maxwell et al., 2000; Meikle et al., 2001; Rakodi and Lloyd-Jones, 2002). Livelihood analyses in peri-urban areas are beginning to emerge as growth rates in smaller cities and urban peripheries reach or even outpace rates in the world's largest metropolitan regions; scholars in response are describing the linkages and interactions between rural and urban activities and land-uses (Satterthwaite and Tacoli, 2003; Rigg, 2006; UNFPA, 2007). Periurban livelihoods encompass household adaptation strategies for both rural and urban areas, leading to a "complex web of connections" between various livelihood approaches and therefore household behavior and decision-making (Tacoli, 2003: 3). Thus, peri-urban households are subject to a blend of stressors and governed by institutions that are neither fully rural nor urban, which requires a distinct analysis from traditionally rural and urban analyses.

For example, rising land values that are associated with urban growth accompanied with higher prices for production inputs may cause households to sell land, resulting in higher density industrial, residential, or commercial expansion. This construction, in turn, could cause higher amounts of pollution in nearby water sources, which leads to the contamination of agricultural fields during flood season (Eakin et al., 2010). Similarly, the choice of a household to abandon agriculture may adversely impact a household's food security in the future if job opportunities become scarce and they do not have the means to purchase grain or tortillas (Lerner and Eakin, 2011). Young professionals in peri-urban areas may create a demand for local production through a preference for homegrown food, reflecting the ability of values to shape assets and resulting livelihood activities and consumption patterns (Arias, 2005; Lerner and Eakin, 2011; Keleman and Hellin, 2009). A household's decision to continue in agriculture can be related to the decisions of children to remain in agriculture or pursue nonagricultural activities (Inwood and Sharp, 2011).

The decisions of peri-urban households to engage in agriculture are therefore based on various material (i.e. land, income) and nonmaterial assets as well as economic opportunities and cultural identity. The combination of non-farm income sources, educational opportunities, and the traditional value of maize production create a complex base from which to make decisions about agricultural activities in the rural—urban interface. We hypothesize that households with greater land assets and labor would have livelihoods based in agriculture, while households in denser urban areas with less land and more opportunities for non-farm employment would be less tied to food production, demonstrating a rural—urban livelihood gradient. However, the transition from rural to urban livelihoods may not be a smooth, linear process, rather a progression that reflects the hybridity and flux of the rural—urban space where they are residing (Tacoli, 2003).

# 3. Methodology

#### 3.1. Study site

The Toluca Metropolitan Area (TMA), located in Mexico State,<sup>1</sup> was chosen as the study site because of its history and importance in maize production and recent industrial growth and residential expansion (Fig. 1). The TMA is in one of the primary urbanizing regions of Mexico that encompasses several states surrounding Mexico City. Toluca has experienced higher than average rates of population growth since the 1970s, when government policy advocated for the decentralization of industry outside of Mexico City and there was general population movement out of the capital because of the 1985 earthquake and increasing crime and pollution (Aguilar, 1999). Nevertheless, the TMA and its surroundings also encompass one of the major maize producing areas in Mexico State despite increasing urban land conversion and livelihood diversification. Additionally, the flow of goods and services between Mexico City and Toluca is exemplified by the recent highway expansion between the two cities and the growth of the Toluca International Airport (Aguilar, 1999; Montaño, 2011).

Maize production in the TMA is mostly on small to medium scale plots (an average of 2.5 ha per producer (INEGI, 2007)), mostly in ejidos. The national government sponsored programs advocating and often subsidizing green revolution technology in the 1960–70s, resulting in most producers using chemical fertilizer and tractors for their production. However, some elements of production remain traditional, such as the use of heirloom or *criollo* (openpollinated) seeds (in Mexico State only 7% of agricultural land uses modernized or hybrid seeds (INEGI, 2007)). The region is also known for the production of *barbacoa*, which is a roasted sheep dish resulting in household sheep production through much of the peri-urban communities around Toluca (Losada et al., 1998).

Three diverse peri-urban communities were chosen for the livelihood analysis within the TMA based on several characteristics. All communities had populations less than 15,000 inhabitants, which is the threshold for a city according to the Mexican National Institute for Statistics and Geographic Information (INEGI) and National Population Council of Mexico (CONAPO) (CONAPO, 2003). The communities were also found within municipalities that were added to the TMA since 1995 (*ibid*), indicating that they could be considered *urbanizing*, if not entirely *urbanized*. Additionally, all communities were either ejidos or had associated ejidos that organized the agricultural and land affairs. Finally, communities were chosen where there was a personal contact within the local government or ejido to facilitate the fieldwork process by obtaining permission and additional information from the local authorities.

While all three communities were clearly "peri-urban" on the criteria above, they were selected purposely to represent a diversity of community types within a greater peri-urban region. The

<sup>&</sup>lt;sup>1</sup> Mexico State is one of the 32 states in Mexico. It wraps around Mexico City and has the highest population in the nation. Toluca is the capital of Mexico State and is approximately 63 km away from Mexico City.



Fig. 1. The Toluca Metropolitan Area and case-study communities.

variables used to differentiate the communities were population, population density, percent of population employed in the primary sector, and percent of the population that works inside or outside of their municipality. Rural communities, according to CONAPO (Anzaldo and Barron, 2009), have approximately 2500 or less habitants, a population density less than 1000 people/km<sup>2</sup>, and greater than 20% of the population working in the primary sector. Communities that are "transitional" have less than 20% of the population working in the primary sector, a population between 3000 and 10,000 inhabitants, and a population density between 1000 and 3000 people/km<sup>2</sup>. More urban communities have a population between 10,000 and 15,000 inhabitants, less than 2% of the population in the primary sector, and a density greater than 3000 people/km<sup>2</sup>.

Table 1 shows the three chosen communities based on the criteria outlined above. San Francisco Tlalcilalcalpan (SFT) is the most "urban" of all the communities, with the largest population (13,000) and the lowest percent of the employed population working in agriculture (INEGI, 2000). It is in the municipality of Almoloya de Juarez, one of the more agricultural of the Toluca Metropolitan Area municipalities and one that was added since 1995 to the metropolitan area. SFT sits 16 km west of the Toluca city center where buses regularly travel throughout the day, connecting residents to the neighboring industrial and commercial center of Toluca. Despite encompassing a town center supporting over 13,000 inhabitants, SFT is surrounded by and interspersed with small agricultural plots, mostly covered with maize in the spring–summer growing season. These plots often incorporate residences

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Table 1

Communities surveyed in case-study (sou	rce INEGI, 2000	), 2005; data elaborated l	y authors).
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Community	Municipality	Рор.	Population density (pop/km <sup>2</sup> )	Pct. working in other municipality	Distance to Toluca (km)	Pct. primary sector	No. of households sampled
1. SFT	Almoloya de Juarez	13,721	3003	35	14	1	56
<ol><li>Chapultepec</li></ol>	Chapultepec	6111	3527	48	12	15	47
3. Paredon	Almoloya de Juarez	1868	109	No data	25	No data	44

close to the city center (the pueblo) or are ejido plots separated from the corresponding households that are found closer to the pueblo center. According to the president of the ejido council, about 25 percent of the children of farmers remain working the land, while other families either sell or leave the land vacant (SFT ejido President. Personal interview. 9 Oct. 2009).

Throughout the community are informal storefronts selling homemade tortillas, and according to informal interviews the grain used is most commonly purchased locally. These homemade tortillas are contrasted with other mechanized *tortillerías* found in the town center that utilize a machine that prepares the *masa* (dough) and presses the tortillas automatically. Interviews and observations with the mechanized tortillerías revealed that they are more likely to purchase grain in larger quantities that often comes from other regions (i.e. Sinaloa). There is a difference in price between handmade and mechanized tortillas: at the time of fieldwork in 2009–2010 handmade tortillas cost 4–5 pesos per kilogram more than mechanized.

Chapultepec is 15 km south of the urban center of Toluca. This community is a population center (*pueblo*) and serves as the municipal administrative center (*cabecera*), with neighboring ejido land and some interspersed plots throughout the urban zone. Chapultepec is also the name of the municipality which is one of the smaller in the TMA. A higher percentage of the population (15 percent) engages in primary sector activities for income, mostly maize production, livestock raising (particularly sheep for house-hold or local barbacoa production), and working in a large-scale mushroom operation. Its proximity to Metepec, Toluca and Mexico City also make it a viable commuting town for residents to work in nearby industry and other non-agricultural activities. There are several factories within the municipality and in recent years land sales have increased, resulting in subdivisions (Secretaria of Chapultepec. Personal Interview. 27 Jan. 2010).

The economic importance of agriculture to households in Chapultepec has diminished almost by half since 1990: Twenty-two percent of the economically active population in 1990 engaged in agricultural activities compared to 13 percent in 2000 (INEGI, 1990, 2000). According to an interview in the secretary of the ayuntamiento of Chapultepec (municipal head), in the late 1990s people began moving out of agriculture as a main economic activity because of the devaluation of the peso in 1995, rising costs of production, rising land values, and lack of interest from younger generations. As a result, an estimated sixty percent of the community has sold land. This number was also cited by a member of the ejido council.

Paredon is the smallest, most agriculturally based of the three communities that is approximately 25 km northwest of Toluca. This community is one ejido which has been split into three political units: Paredon Norte, Paredon Ejido, and Paredon Ejido Centro. Because each unit is quite small in population, the entire ejido was surveyed and considered as one case. The ejido began its division in 1990 and split again in 2000 because of infighting in the communities and the division of resources being poorly distributed (Delegado for Paredon Norte. Personal interview. 23 Oct. 2009). The bulk of the community engages in agricultural activities (the precise participation is unknown because rural communities were not included as separate units the national census) which includes maize

production, mostly for animal feed that is converted into dairy and milk production (Delegado for Paredon Norte. Personal interview. 23 Oct. 2009). The ejido is divided by two highways that lead to Toluca, enabling community members to commute for work and school activities. The highways also split the political boundaries of the three portions of the ejido, one of which has smaller land parcels and more commercial activity (Paredon Ejido Norte) in comparison to neighboring Paredon Ejido, which is dominated by agriculture.

#### 3.2. Household survey

The household survey was used to collect detailed information about household livelihood strategies, maize production and land uses of the households in the selected peri-urban communities. Households were chosen systematically (every other house) by geographic sections of the communities chosen at random throughout the community by creating sampling clusters with satellite maps (Bernard, 2006: 160). In the case of Paredon, which is dispersed and difficult to reach more isolated homes, we also surveyed ejido members at their monthly meeting with the support of the president of the ejido council. For every residence chosen, the surveyor would briefly describe the project and present disclaimers as outlined by the Institutional Review Board at the University of California, Santa Barbara, including information about the sponsors and collaborators (i.e. local universities). The description also stated that the intended sample was households that still engage or have engaged in maize production; many households self-described themselves as not being landowners or maize producers and therefore were not surveyed. The survey was conducted with household heads, either male or female (depending on who was available). In total, 147 households were surveyed in Spanish and translated by the first author.

The survey contained questions about land assets, farming methods, household demographics, and open-ended questions regarding the value of maize production (or reason for abandonment), as well as several questions about rural identity and possible futures of production. One particular question addressed interviewee's self-identification with being a campesino, while other questions asked if producers would continue in the short-term to produce maize and if they believed their children would continue to produce as well.

#### 3.3. Data analysis

Although the households came from three distinct communities, this analysis treats all households as part of a greater periurban area. The purpose of grouping all households together despite community was to try to uncover distinct household livelihood strategy types in the region, regardless of location.<sup>2</sup> Therefore, a divisive hierarchical cluster analysis was used to develop a household livelihood typology with all households in the sample. Livelihood analysis typically focuses on suites of variables

<sup>&</sup>lt;sup>2</sup> Other studies have similarly used cluster analysis in household samples across a geographic area to create a household typology; see Eakin (2006), Pinchon (1996), Chowdhury (2010).

composing classes of capitals (natural, social, human, economic and physical). In our case, however, given the focus on the specific role of maize in peri-urban areas, we organize the variables in groups reflecting relationships with both maize production and other household variables reflecting ties with urban livelihoods. The cluster analysis started with 22 variables that encompassed four variable groups: demographic (age, education), maize use (tortillas, sale, animal feed), non-farm income (salaried and non-salaried employment, material assets), and production variables (landarea, machinery, inputs) (Table 2).

As is often the case with cluster analyses, the variables spanned the full range of measurement scales (nominal, ordinal, ratio and interval). Most methods of multivariate analysis are designed for data from a subset of measurement scales; either categorical (nominal, ordinal) or continuous (ratio, interval). Gower's formula was used to create a distance (dissimilarity) matrix from mixed categorical and continuous variables (Kaufman and Rousseeuw, 1990). Standard agglomerative and divisive hierarchical clustering algorithms were then evaluated. After several rounds of evaluation, we chose the divisive clustering method and trimmed the dendrogram to create four groups appeared to yield the most natural grouping in the data. A limited sensitivity analysis was also undertaken to assess the leverage of each variable in forming the groups. The leverage analysis was conducted by systematically removing single variable and measuring the similarity of household classifications among the four groups.

# 4. Results

#### 4.1. Cluster analysis

The cluster results yielded four main livelihood groups that were assigned a descriptive name to capture their characteristics (Tables 2 and 3). The characteristics of the livelihood groups were based on median values for continuous data and modes, counts, or percentages for categorical data (Fig. 2). The descriptions are of the livelihood groups below.

#### 4.1.1. Buffering households

The majority of households surveyed (80 total) belong to the Buffering livelihood category, which has a median land holding size of 1 ha. For these households maize is utilized as a strategy to buffer against economic risk or use non-farm income to buffer against the volatility of maize, as is often seen in small-scale households. Most of these households make handmade tortillas while deriving their primary income from non-farm work, although half of the households also sell maize as part of their livelihood strategy. The Buffering households mostly come from the more urban communities of SFT and Chapultepec, with only 13 percent coming from the most rural community, Paredon. The households in general contain little to no livestock production, have a median of number of two income sources per household, and 40 percent of the adults in the households participate in non-farm employment. Half of all Buffering households also sell maize, and according to the surveys the bulk of sales are to neighbors or family members that represent a local demand for grain.

#### 4.1.2. Transitioning households

Many of the Transitioning households (19 of 23) have abandoned maize production and can be considered "transitioning" to livelihoods that rely more exclusively on non-farm activities. Transitioning households are mostly found in the more urban communities of SFT and Chapultepec. This group has the smallest median land-holding size of half a hectare and none of the households make tortillas from home-grown maize, even the households that are still pursuing maize production. Additionally,

#### Table 2

ariables used in the analysis with results by typology §	p. Units describe median number, me	edian percentages, counts, or raw percentages.
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	Unit	Buffering	Transitioning	Converter	Capacity
Community					
San Francisco (1)	No.	38	11	2	4
Chapultepec (2)	No.	32	10	1	4
Paredon (3)	No.	10	2	30	2
Demographic variables					
Household size	Med. No.	5	4	4	4.5
Average age	Med. No.	43.1	42	44.5	42.9
Dependency ratio	Med. No.	0.38	0.14	0.5	0.33
Members high school graduate	Med. %	0	0	0	50
Maize uses					
Still producing maize	%	100	17.4	100	80
Maize for income	%	51.3	0	3	70
Handmade tortillas	%	87.5	0	81.8	20
Grain for domestic use	Med. %	50	75	22.5	0
Grain for feed	Med. %	0	0	76	68
Off-farm income & material assets					
Income sources	Med. No.	2	1	3	3
Primary income salary off-farm	%	38.9	56.5	15.2	20
Primary income non-salary off-farm	%	32.5	34.8	12.1	30
Welfare	%	37.5	26.1	63.6	20
Members off-farm	Med. %	40	50	0	23
Assets	Med. No.	1	2	2	2.5
Agricultural production					
Area	Med. Ha.	1	0.5	3.5	1.9
Animals	Med. No.	0	0	8	6.5
Family labor in fields	Med. No.	3	4	1	2
Tractor owner	%	12.5	30.4	36.4	50
Hired labor	%	48.8	43.5	72.7	100
PROCAMPO	%	42.5	8.7	87.9	70
Primary income livestock	%	2.5	0	66.7	40
Primary income maize	%	12.5	0	0	10

 Table 3

 Description of household typologies.

Buffering	Households who use maize for consumption for tradition, and also to buffer against economic risk
Transitioning	Households that have abandoned maize production but still retain a land-based identity with thoughts of growing again in the future
Converter	Producers with more land and livestock, who grow maize animal feed and get their income from livestock
Capacity	Households that combine maize with other income sources and higher education levels. On average they have more material assets.

these households do not acquire income from maize or livestock production. Nearly all (91%) receive their main income source from salaried and non-salaried employment. The Transitioning households have the smallest median number of income sources compared to the other livelihood groups; roughly half of the adults in the households work off-farm, which is higher than any other livelihood cluster. The median dependency ratio for this group is 0.14, which is significantly lower than the other groups, demonstrating less elders and/or young children in these households.

#### 4.1.3. Maize-converting households

Converter households grow maize in order to convert it into livestock feed, which according to interviews was a strategy for most medium-producer maize growers in the region when the government withdrew guaranteed buying for maize in 1999. The households in the Converter group mostly come from the smallest community, Paredon, although there are households from the more urban communities that fall within this livelihood regime. The Converter households have the largest median land area (3.5 ha) and gain most of their income from converting maize to livestock production and selling meat and/or dairy products. Additionally, 88 percent of Converters receive government production supports (PROCAMPO) and over half receive government social supports such as *Oportunidades* or supports for elders. Despite their greater reliance on agricultural income, Converters rely less on household labor for agricultural activities: a median of 1 family member in addition to the producer assists in agricultural work, in comparison with 4 and 3 family members in the Transitioning and Buffering groups, respectively.

#### 4.1.4. Capacity households

The last livelihood group, the Capacity households, only encompasses 10 households, two of which have abandoned maize. Their investment in human capacity through education identifies them as the Capacity livelihood group; half of the household adults over 18 years old have a high school diploma. The high education levels are mostly a result of the producers' children attending college and sometimes graduate school, but still living at home. In some instances, the producers themselves have a career that required a college or post-college degree and they still continue maize production.

This cluster has very distinct patterns in comparison to other livelihood groups and is more complex to define. It is similar to the Transitioning group in that several households have abandoned maize and most do not make homemade tortillas. Like the Converters, however, the Capacity households that engage in production produce maize mostly for feed and sale, which is combined with several other income sources (over three average income sources, the highest of all groups). Even the two households that abandoned maize production previously utilized it for feed and/or sale, unlike the households who abandoned in the Transitioning group, who were growing for household consumption. Additionally, they have the highest median number of material assets (2.5), such as automobiles, refrigerators, washing machines



Fig. 2. Variable outcomes among livelihood groups. The bold black lines indicate medians or proportions for each cluster. Other lines represent the values for the other clusters. Gray lines are individual household values.

and computers. This small group represents households that are not growing maize for consumption. Rather, maize is an income source combined with non-farm income for a more diversified livelihood portfolio. For households that have abandoned maize, producers have inserted themselves into non-farm employment and in many households children have university education.

#### 4.2. Perceptions from producers

Despite the distinct nature of livelihood strategies and the very different role that maize plays in these strategies, the outlook of households toward the future role of maize was similar amongst groups (Table 4). Thirty percent of the respondents in all livelihood groups stated that they believed their children will continue planting maize, except for the Buffering group, where 52 percent of the respondents believed that their children will continue. One Capacity producer in the smallest community, Paredon, tells his children that "here is better than the city. You can study and also be in the countryside because we're close to Toluca." This comment illustrates the dual-nature of this peri-urban region: a place to study and develop a career while also being a place to plant maize. The sentiment was not shared by other producers, however, who believed that their children's studies were mutually exclusive of engaging in maize production: "They have another outlook, another career. Many are professionals who forget about the land."

At the same time, the respondents generally believed that their children would settle in the community: Seventy percent of the Converters and 80 percent of the households in the other groups stated that their children would stay close to home. Several producers noted that their children stay because they have the possibility of having their own house on the property – "where else would they go?" Indeed, the expectation of family members expanding onto agricultural land and building houses has created a common landscape feature of houses spilling onto maize fields.

All groups similarly identified with being a *campesino*, although the highest positive response was with the Transitioning group, with 87 percent responding positively while 80, 85, and 50 percent identified with being a *campesino* in the Buffering, Converter, and Capacity groups, respectively. The campesino identity persisted in the Transitioning group, despite the fact that they were no longer planting maize. Several producers stated that they "used to plant" or that they "know how to work the land" and therefore retain this identity. In terms of the purpose for planting maize, approximately 45 percent of the respondents from the Buffering and Converter groups stated that they planted maize for tradition and 40 percent for sustenance, whereas in the Transitioning group 67 percent plant (or planted if they had abandoned) for tradition and 30 percent for sustenance. The Capacity households differed from the other live-lihood groups in their reasons for planting maize, which was mostly for sustenance (40 percent) and feed (30 percent), while only 10 percent cited tradition as a reason for planting maize. When discussing the reasons for planting maize, producers most often stated "it is what is planted here" or "it is all we know how to plant", illustrating the long history of maize in the region. Some often referred to the knowledge gained from parents or grandparents that also planted maize, *la herencia*, and passed seeds along for generations.

Despite the options for non-farm employment and pressures to sell land in the region, most households stated that they will continue to plant in the next five years, with the lowest response being 70 percent in the Transitioning group, which also had the highest uncertainty (13 percent responded "maybe"). The fact that seventy percent of the Transitioning group claim that they would plant maize in the future is particularly high, given that the bulk of households in this group had abandoned maize. Some Transitioning households even discussed the idea that the land is not to be sold (*la tierra no se vende*), and when they have time they will start planting again. Buffering, Converter and Capacity groups had a response of 85, 73 and 80 percent, respectively, stating that they would continue planting maize. Several producers commented that "as long as I am still alive I will continue planting".

#### 5. Discussion

#### 5.1. An emergent space

Like many rural areas, peri-urban households employ a diversity of activities in addition to agriculture in livelihood strategies (Bebbington, 1999; Ellis, 2000). The different associations with maize, however, and the way in which non-farm and agricultural activities combine with each other is often unique in these peri-urban households. According to heads of households and maize producers, maize continues to be important for household food security and livelihoods but for different reasons across livelihood group types. The dominant livelihood group, the Buffering households, uses maize mostly for household

#### Table 4

Livelihood group responses to questions on self-identity, perceptions of maize, and future plans in maize production (numbers represent percent).

Question	Response	1: Buffering	2: Transitioning	3: Converter	4: Capacity
Children continue in maize	No	33	52	55	70
	Yes	52	29	29	30
	Not sure	15	19	16	
Children stay in community	No	8	0	13	10
	Yes	82	78	72	80
	Not sure	10	22	16	10
Producer continue in maize	No	10	17	18	20
in next 5 years	Yes	82	70	73	80
	Not sure	5	13	9	
Self-identify with "campesino"	No	20	9	15	50
	Yes	80	87	85	50
	Other		4		
Why plant maize	Tradition	46	67	45	10
	Sustenance	38	29	42	40
	Feed	9	5	9	30
	Other	6	0	3	20

consumption in the form of handmade tortillas, despite income coming from non-farm sources. The activity of engaging in maize production for these households is often a *choice*, as many households could potentially purchase tortillas, and more households state that they plant maize for the tradition of the activity rather than for sustenance. For the 40 percent of Buffering households that get income from salaried employment, the combination of economic need *and* socio-cultural preference encourages households to continue in maize production (see Lerner and Eakin, 2011). Indeed, the cultural value and preference for homegrown maize is often a motivation for maize production even as households and the younger generations transition into more stable employment opportunities that could allow them to purchase tortillas.

However, stable non-farm income is not an option for all households. Conversations with some heads of Buffering households demonstrate that maize often continues to fill a role as an insurance strategy, particularly for some the households that also engage in non-salaried employment. One couple who ran a carpentry shop admitted that "when there is no work at least we can eat," which is what keeps them planting maize in their fields that are prone to flooding. In this case, even the risk incurred by climatic events would not discourage producers from planting, because it can only help them survive the greater risk of income instability; similar results have been found in other areas of Mexico (Preibisch et al., 2002; Eakin, 2006).

Households using agriculture as a buffer also reflect what de Janvry (1981) refers to as "functional dualism": subsistence agriculture subsidizes low urban wages and in this case volatile or unreliable wages (39). One producer surveyed had lost his job and had no other source of income, leading him to dedicate himself full-time to growing maize for sale. He believed there was a market for maize regionally and one had to put in the effort to produce higher yields. Again, instead of non-farm employment serving as an alternative to maize production, agriculture becomes a much-needed back-up plan for volatile job markets (Eakin, 2006). Thus, despite common non-farm employment opportunities in peri-urban areas, there continues to be uncertainty and volatility in non-farm income that often relies on maize as a buffer against economic risk.

The feedback between maize production, a natural resourcebased activity, and non-farm employment is fundamentally a peri-urban phenomenon. Whereas traditional rural households diversify livelihoods to make agriculture more sustainable (Ellis, 2000), peri-urban households in this example tend to use agriculture to make non-farm income more reliable or use non-farm income in order to continue the tradition of maize planting. This feedback between agricultural and non-agricultural activities, although present in rural areas (de Janvry and Sadoulet, 2001), is further facilitated in peri-urban areas by the proximity to urban markets for both non-farm income sources and for access to the demand for agricultural goods, particularly grain and homemade tortillas. For households in this peri-urban area, household livelihood strategies incorporate maize into a variety of physical, natural, social, economic and human assets that in combination provide a more complex picture, where feedbacks occur between rural and urban-based activities (see also Eakin, 2006).

The proximity to urban consumers is a fundamental aspect of the rural—urban interface. Some households surveyed continue to sell maize locally to other households that demand grain because they do not grow it themselves. These local grain markets along with local sheep production (barbacoa) have emerged since the closure of CONASUPO in 1999 which used to buy grain from producers (Barkin, 2002; Keleman and Hellin, 2009; Lerner and Appendini, 2011). In addition to non-farm income, households with livestock (Converters) and households who sell grain (Buffering and Capacity households) have responded to the lack of a government buyer by creating local networks of food production and consumption since many households are without land or have abandoned production and dedicated themselves solely to nonfarm activities. This dynamic highlights an important peri-urban characteristic: the demand from local professionals for traditional foods, fueling some retention of agricultural production.

#### 5.2. The future of peri-urban maize

In observing the outcomes of the livelihood clusters, there are surprising results in terms of the identity and meaning associated with maize. On one hand, most Transitioning households have abandoned production and no household in that group makes homemade tortillas, but this group also had the highest occurrence of self-identification with being a campesino, tradition was or is the primary motivation for planting maize, and many producers still had plans for planting maize again in the future. The strong cultural attachment with the Transitioning households indicates that cultural ties persist despite a movement out of maize production while the presence of their land assets gives them the choice to produce in the future. Relatively strong cultural ties together with the availability of labor and land suggests that the movement out of agriculture in peri-urban space need not be a hard, linear transition but a far more dynamic, non-linear process characterized by a potential for a flux in and out of agricultural activities.

Our analysis suggests that there are multiple pathways in which agriculture and maize persist in peri-urban space, and thus diverse – and potentially co-existing – futures for the crop in peri-urban livelihoods. The Converter households, with the largest tracts of land and who were the most dedicated to agricultural activities were ironically not those who were most likely to identify with being a campesino, nor were they confident of their children's continuation in maize production. Thus while such agriculturally based livelihoods represent a strategy to effectively use available assets (i.e. land) there appears to be significant uncertainty about the future of such activities, given alternative employment for the next generation, rising land values, and declining agricultural supports. Indeed, the mediumscale producers who have been commercially oriented are often most impacted by the withdrawal of government supports to the agricultural sector and therefore switch into other livelihood activities (de Janvry et al., 1995). It was not clear in this casestudy whether the Coverter households represented households with limited options, for whom livestock was the best alternative, or whether the pursuit of livestock was in effect generating sufficient capital to enable greater flexibility in the future. Some Converter households did have children attending nearby universities while continuing to help on the farm in their spare time, demonstrating the ability of livestock production to enable investment in the development human capital. Furthermore, the Capacity households illustrate that the production of maize for livestock and grain combined with non-farm income can be used strategically to maintain more stable livelihoods. In this region, having a more agriculturally based livelihood portfolio can be more vulnerable to local shocks (i.e. agricultural policy) but also can be used strategically to ensure a more sustainable livelihood.

While households with larger land assets logically convert maize into livestock feed, there are several explanations for the persistence of maize in the denser, more urban communities. First, the median land holding for Buffering households is still 1 ha of land, which could potentially provide enough grain for a household's tortilla needs in a year.<sup>3</sup> Conversations with several producers in the field revealed that when land holdings become too small by dividing it among children, the investment needed to grow maize is not worth the effort in producing - as is likely occurring with the Transitioning households. If only one child stays in agriculture, the minimum land size necessary for maize can potentially be retained. Second, assuming households have a preference for home-grown maize, the presence of non-farm income sources can actually enable households to continue in production because they are able to withstand economic and environmental shocks adversely affecting maize. For example, several conversations with households that produce maize for consumption illustrated that they actually lose money planting maize; in other words, they invest in their production through earnings from other sources, which has also been observed in other research from this region in Mexico (Appendini et al., 2003).

The mutual feedback between agriculture and non-farm activities is not only found in this example in the Toluca Metropolitan Area; scholars have acknowledged that urban growth can assist in making agriculture more sustainable in Sub-Saharan Africa as well by creating demand for local goods and providing diverse income sources (Tiffen, 2003; Ellis, 2005). Although non-farm income is present in most rural areas of Mexico and the developing world as a whole (Reardon et al., 2007; de Grammont, 2009), the potential for salaried employment often increases around large urban centers and peri-urban areas which enables households to fund their maize production.

As the Capacity households illustrate, however, the current observed relationship between maize and non-farm income in household livelihoods does not necessarily predict the future of maize production. The decisions of the children of producers have been shown in other studies of the rural-urban interface to be central to farm persistence in the rural-urban interface (Inwood and Sharp, 2011). As one Capacity producer stated when asked of his children's continuation in maize production, "they are from another generation, they dedicate themselves to other activities" There is therefore a distinction between the preferences and desires of current producers (i.e. valuing maize production), and the reality that is associated with the assets and entitlements of the future (i.e. their children's assets). One issue that will arise for the future production of maize in this area is the ability of the next generation to access natural resources, namely land. The process of inheritance in ejidos allows one child or non-familial inheritor to formally receive the land holdings from each ejidatario when they pass away and usually not beforehand<sup>4</sup> (Riveros Fragoso, 2005; Arias, 2009: 194). That inheritor can choose to use the land themselves or allow siblings to use parts of the land. Even if the land is divided evenly between children, there is the risk that the size of land holdings becomes too small to consider farming, as stated above.

The question remains whether peri-urban areas in the developing world are "coupled" agricultural and urban systems in transition toward "decoupling" (Walker, 2001), or endpoints: specific types of space that will persist around dynamic and

growing urban areas. On one hand, the livelihood groups based on information from producers and heads of households demonstrate the diversity of strategies that households employ: using maize as a risk aversion strategy or planting for the tradition of the activity alongside non-farm income, employing maize as part of an agriculturally based livelihood, or engaging in livestock and maize sales in combination with education and non-farm income. On the other hand, the desires of producers (i.e. that they and their children will continue to farm) may not reflect the reality that future generations will abandon maize due to lack of: 1) access to land (natural resources), 2) financial capital or time to invest in production (financial/human assets), and 3) interest (cultural need/assets). If the assets of the next generation enable them to produce maize, then this region can persist as a rural-urban interface that provides a feedback of rural and urban activities, namely maize production and nonfarm income sources.

#### 6. Conclusion

In a region experiencing population growth, pressure toward urban land-uses, and the withdrawal of government supports for small-scale agriculture, the prospect for maize production on a small scale around urbanizing areas seems dim. Indeed, scholars have questioned how to explain the persistence of traditional maize production in Mexico and what the future holds for this production system (Fitting, 2011; Barkin, 2002). The data of these case studies suggest that it would be not only simplistic but also erroneous to assume a linear transition of livelihood and land uses from rural to urban focus in urbanizing areas, as is suggested in traditional modernization development theories. Instead, this analysis has shown that maize continues to be part of diverse and heterogeneous livelihood strategies - each likely to evolve over time in distinct fashions - associated with various asset profiles. Woven through the strategies of all households is a theme of land-based and agrarian identity. While clearly associated with livelihood and production, affiliation with this identity has its own trajectory of change. It is the complex dynamic between rural and urban activities, and often rural activities supporting volatile urban activities, which makes the peri-urban interface unique.

In essence, these peri-urban households exemplify "strategies of diversification" that allow households to maintain a maize-based livelihood (Barkin, 2002: 83). Although this diversification is also found in more rural regions of Mexico, peri-urban households experience more intense pressure to abandon production paired with interesting opportunities to respond to nearby urban demand for maize grain as well as opportunities to fuel production through non-farm income sources. Despite the fact that all of the groups in the typology have distinct relationships with maize production, they all are in some ways or another reinventing an identity combining different livelihood strategies.

The strongest motivation for the future planting of maize seems to be one of tradition and subsistence, instead of for livestock feed and income. For the majority of the Buffering households who use maize for handmade tortillas, maize production is driven by needs and preferences. Subsistence maize is combined with non-farm income, allowing households to pursue other income-generating activities that fuel maize production instead of maize being a central livelihood activity. And the inverse is also true: maize provides an alternative livelihood strategy when non-farm income sources are volatile or scarce. As producers age, however, the transition of land to younger family members provides interesting research opportunities to study how the tradition of maize evolves in younger generations.

<sup>&</sup>lt;sup>3</sup> Some studies of land needs for subsistence households conclude that 2.5-3 ha is enough to sustain a household's grain needs (Eakin, 2006). Conversations with households during this study combined with the data collected show that households consume approximately 1-2 tons of grain a year, which can be produced on 1 ha with yields that on average exceed 1 ton per hectare.

<sup>&</sup>lt;sup>4</sup> After the reforms of Article 27 in 1992, ejido land can be passed to non-family members. Before the reforms were instituted only family members could receive land (Appendini, 2008). One individual can receive the title to ejido rights, but land can be subdivided into "posesionarios" which have a plot but do not possess the other rights of ejidatarios such as voting in the assembly.

While maize production in this peri-urban region contributes to household livelihood security, the emphasis of agriculture policy in Mexico on the most productive farmers eliminates and undermines the importance of small-scale agriculture in this region. For households that have greater land assets and grow maize for livestock feed or sale, there is the potential in this periurban area to use resources strategically to produce a more sustainable livelihood despite the vulnerability of medium-scale producers to agrarian policy shifts. Ironically, the subsistence producers in denser communities may be those that continue the *tradition* of maize in the Toluca Metropolitan Area, which buffers volatile income sources, despite the lack of supports directed toward them.

The growth and presence of peri-urban areas worldwide provide interesting opportunities to think about food production futures and conduct further research. While many areas of the industrial world are reconsidering the potential for urban agriculture, in Mexico it is already a strong feature of urbanizing landscapes. By embracing this reality in policy and planning Mexico could take advantage of a naturally occurring phenomenon: the persistence of small-scale maize production. Several policies could be incorporated, such as providing agricultural capacity building in peri-urban communities that include several generations. The preservation of networks of activities related to maize, such as seed exchange networks, fertilizer sales, and laborers, as well as capacity building for the next generation of land stewards, must be maintained to allow the possibility of future maize production to persist. One major challenge in peri-urban areas is the institutional void that does not address hybrid rural-urban concerns, potentially resulting in a failure in policy to address the specific needs of peri-urban agriculture. Small-scale production for household and regional consumption is already an important aspect of global food security. As the presence of hybrid peri-urban areas increases in Mexico and throughout the world, thinking of urbanizing space in terms of opportunities for food provisioning will be increasingly essential.

Future research could focus on the importance of identity in agricultural production in Mexico, as well as the way that agricultural tradition and identity is transferred to youth. Considering that ejidatarios are aging, there could be interesting opportunities for youth to take advantage of urban markets if they continue to engage in maize production. Some of the anecdotal evidence from this study alludes to this trend. Furthermore, the role of urban consumers in fueling agricultural production could be further explored as markets expand alongside urban population growth in central Mexico. Finally, the livelihood groups generated in this analysis could be applied to other peri-urban regions of Mexico in order to gain a better understanding of the way that livelihoods are constructed and maize is utilized in the rural–urban interface.

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