Handmade tortilla production in the basins of lakes Pátzcuaro and Zirahuén, Mexico

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ABSTRACT

The Main Map presented in this paper is the result of intensive fieldwork and mapping of 43 rural communities of the Pátzcuaro and Zirahuén basins in central-western Mexico. It shows the presence of handmade-tortilla workshops and considers the natural resources they demand but also their social, economic and cultural significance in the region. An in-depth survey of 111 Hand Made Tortilla Workshops gave detailed information of tortilla production, type of maize and fuelwood volume demanded in this activity. Traditional tortilla production contributes to the conservation of native maize and indigenous agriculture, and it promotes local and traditional food systems. However, it also represents a challenge given that many of these handmade tortilla workshops use open fire stoves which have negative implications regarding health, environment and pollution in rural livelihoods. This map serves as a platform for local and regional actions within a program involved in eco-technologies and sustainable livelihoods.

1. Introduction

Maize is the most important crop in Mexico, grown on 27.6% of its arable land and on 2.8 million landholdings (Appendini & Quijadas, 2016). Maize tortillas are one of the oldest culinary elements of Mexican culture. Mexico is the top tortilla consumer in the world, with an annual consumption close to 11 million tons of maize grain, which represents on average an annual consumption of 79.5 k of tortilla per capita in the rural areas, and of 56.7 kg in the urban areas (Secretaría de Economía, 2010). Tortillas provide energy due to their high carbohydrate content, and are also rich in calcium, potassium, and phosphorus. Moreover, they provide fiber, protein, and some vitamins, mainly A, thiamine, riboflavin, and niacin (SUSTAIN, 1997). The economic importance of maize and tortillas is undeniable.

In the rural sector, tortillas are mostly homemade. It is traditionally a task for women. The grain is soaked in an alkali to make nixtamal before it is milled.1 The resulting dough is brought home and ground to a finer consistency with a metate and then made into tortillas by hand. Fuelwood is used for two of the main cooking tasks: making nixtamal and cooking the tortillas (Masera, Díaz-Jiménez, & Berrueta, 2005). The strong cultural preference for homemade tortillas has largely gone unchallenged in the majority of Mexico’s rural communities (Berrueta, Serrano, García-Bustamante, Astier, & Masera, 2017). Women who make them are called tortilleras;2 they make them for domestic consumption but also to sell in villages and cities (See Figure 1).

Maize source for tortilla production in the rural localities (excluding the main towns) in the Basins of Lakes Pátzcuaro and Zirahuén (BLPZ) is as follows: 58% is for handmade tortilla production, and the remaining 42% is for machine made tortilla. Homemade tortillas use mainly local and native maize (88%), which is family produced or bought from neighbor farmers, and the other rest (12%) is purchased in local grocery stores, and it originates from out of the BLPZ. Machine made tortillas use maize (70%), mainly produced out of the region, and nixtamal corn flour (30%). Maize produced out the area comes from Sinaloa (47%), Cienega de Chapala (22%), and El Bajío (18%). Nixtamal corn flour is elaborated in Zamora and Silao (Orozco-Ramírez, Barrera-Bassols, Astier, & Masera, 2010).

The large market for handmade tortillas has provided a livelihood for tortilleras in the BLPZ region within the Purhépecha Region in Michoacán, México (Astier, 2004). In this region maize diversity, associated with diverse uses and diverse agroecological characteristics of the farms, has recently been documented (Astier et al., 2010; Orozco-Ramírez & Astier, 2017).
That is why a needed study is one that evaluates to what extent the handmade tortilla industry is supporting local economy and conservation of native maize varieties in the region (Orozco-Ramírez & Astier, 2017).

In this region, handmade-tortilla workshops (HMTWs), where tortilleras work can demand more than 25 kg of fuelwood daily (Astier, 2004). That is why several authors see this activity as a cause of public health problems, because women typically spend up to 8 h a day cooking on open fires (Berrueta et al., 2017). During this time and when this activity is done in open fires, these women, and their children, are exposed to high levels of smoke and pollutants. This indoor pollution reaches levels that are much higher that the ones recommended by the World Health Organization (Armendáriz et al., 2008). Also, traditional fires emit several compounds that contribute to global warming such as CO₂, CO, methane, and black carbon (Anenberg et al., 2012; Bailis, Drigo, Ghilardi, & Masera, 2015; Berrueta et al., 2017).

Other authors, however, see this activity as one of the few sources of income in many rural livelihoods in Mexico, and one way in which agriculture; rural livelihoods and native maize diversity are sustained (Astier, 2004; Berrueta et al., 2017; Preibisch, Rivera, & Wiggins, 2002). This is why it has been argued that tortilla making is one of the most important activities in the Basins of the Lakes of Pátzcuaro and Zirahuén (Berrueta et al., 2017; Masera & Astier, 2014).

The main goal of this work is to map HMTWs and their demand for natural resources in the BLPZ. Having this Main Map will serve for identifying risky zones concerning high fuelwood use and high indoor pollution but also, zones of native maize conservation which could have the possibility of creating better condition for more sustainable and healthier HMTWs. This map will be used for supporting policies and programs oriented to incentivize improved stoves and creating alternative markets opportunities that will value agro-biodiversity conservation and artisanal tortillas.

2. Methods

Four methods were used in the research to acquire spatial information and input/output dynamics of HMTW at a regional scale. First, in 2009, to know the quantity of HMTWs, industrial tortillerias, mills, and their sources of maize and fuelwood, in the region we applied a small interview to key informants (authorities and representatives) from 20 communities and towns that had more than 20 HMTWs. We counted 235 HMTW in those localities.

Secondly, having the quantity and the location of the HMTWs we used a non-probability sampling method together with a purposive and snowball methods to determine the number of HMTWs to be sampled (Martínez-Salgado, 2012). We selected women from these HMTWs entirely dedicated to making the tortilla for selling. Therefore, we left out in the sample HMTWs that produced less than 10 kg of tortilla per day, and that worked less than three days a week. We ended up sampling 111 workshops from 19 localities. Therefore during 2008, 2010 and 2011, we applied in depth survey to 111 women tortilleras of this
sample and gained details about production’s dynamic: volume of tortilla production, amount of labor, amount of people depending of this activity in the household, volume of maize and firewood used, sources and type of maize (native or commercial hybrid maize), source of fuel, and place of selling (See survey as in additional material).

The third part of the research design was obtaining the information needed to map all HMTWs’ localities and its inputs/outputs dynamics at a regional scale. In 2017 we visited all the 43 villages and towns and censed 472 workshops in the BLNZ. We also counted maize mills, maize sellers, and industrial tortilla shops per village. For the HMTWs we also recorded sources of maize and firewood, and place for tortilla selling.

Having a database integrating information obtained in part two and part three of the methodology, the fourth part of the research consisted of map construction, which, at the same time, included three other steps. The first step was locating all the workshops’ localities; for that purpose, we used the layer of Mexico and state boundaries (INEGI, 2014) and County vector maps, which include locations (INEGI, 2015a). Then, we looked for the source of inputs for the tortilla making process, and the fluxes were drawn in the map using the Road network layer (INEGI, 2015b). The next step was to illustrate the tortilla distribution flows, which consisted in locate the tortilla buying towns and the tortilla producers’ villages and to connect them in the map. We did not size the arrow according to tortilla volume, because it is not easy to see it in the chart. Finally, we used the Vegetation layer (INEGI, 2013) to show forest and agricultural lands in the area.

Having the information about the total number of HMTWs and its volume of maize used and tortilla production, we estimated 95% of confidence intervals of the total beneficiaries from tortilla handmade production. Using the estimated of tortilla consumption for the region, which is 0.455 kg per person daily (Orozco-Ramírez, 2007) we estimated the total population that is feed with handmade tortilla.

### 3. Results

From the in depth surveys (2008–2011) the volume of maize and fuelwood was determined together with the volume of tortilla production and the people involved and benefitted in in each HMTW (See Table 1). In 2017, a total of 472 HMTWs were recorded in the BLNZ region, distributed in 43 villages. Therefore, we estimated that total daily tortilla production, in the region, was 6230 kg (±9, \( p = 0.05 \)), which required 3757 (±590, \( p = 0.05 \)) kg of maize. The estimated daily tortilla consumption per capita in the region was 0.455 kg (Orozco-Ramírez, 2007); consequently, we estimated that these hand-made tortilla workshops produced daily tortillas for 13,692 people; this is 19% of the total population of Pátzcuaro, the main town of the region. Daily fuelwood used in average in the HMTWs was 20.04 kg (± 12.9) × 472 (Table 1).

From the interview we concluded that most HMTWs used native maize (75.43%) and the rest used hybrid maize all year round (Table 1). As the map shows, hybrid maize comes from other regions, such as Morelia, Guanajuato and Zacapu, which are connected with the largest maize producers in the country, in Sinaloa state.

For each tortillera there are at least two farmers, one wood cutter and another person employed who can be involved in activities such as helping, distributing maize, milling nixtamal, providing other inputs, etc. We estimate that artisanal tortilla making in the region creates a total of 1888 indirect employments; but also, having in average 5.23 (±2.49) economic dependents for each HMTWs, there are 2468 people in rural livelihoods benefiting from this activity.

The Main Map registers zones were HMTWs are concentrated (For example, in San Francisco Uricho and Santa Clara del Cobre with 54 and 70, respectively) and were native maize and fuelwood is highly demanded (See Map). Comparing among municipalities tortilleras from Quiroga and Tzintzuntzan sell more days. Pátzcuaro West and Quiroga also have the larger use of native maize on percentage comparing

### Table 1. Hand made tortilla production and maize and firewood consumption in HMTWs 2008, 2010 and 2011 in CLP.

| Municipalities Units | HMTWs interviewed | Average People in household | Daily average household consumption Docsens | Tortilla for selling days (average per week) | Native maize use % | Average Native maize daily use kg | Average Fuelwood daily use kg | Average Tortillas sold daily kg |
|----------------------|-------------------|-----------------------------|---------------------------------------------|---------------------------------------------|-------------------|-----------------------------------|-------------------------------|------------------------------|
| Pátzcuaro E.         | 16                | 5 (2.42)                    | 3.13 (1.64)                                 | 5.88 (0.72)                                 | 43.74             | 8.48 (4.05)                       | 16.39 (12.49)                 | 14.5 (9.84)                  |
| Pátzcuaro W.         | 26                | 4.65 (1.44)                 | 4.82 (2.62)                                 | 4.27 (2.32)                                 | 88.46             | 6.74 (3.31)                       | 18.81 (9.59)                  | 11.8 (6.84)                  |
| Erongaricuaro        | 12                | 4.67 (1.15)                 | 3.58 (1.38)                                 | 4.67 (1.83)                                 | 66.67             | 6.99 (2.65)                       | 16.67 (11.16)                 | 11.37 (4.33)                 |
| Quiroga              | 17                | 4 (1.94)                    | 3.26 (1.52)                                 | 6.76 (0.56)                                 | 88.24             | 10.64 (13.72)                     | 22.73 (15.55)                 | 16.13 (13.07)                |
| Tzintzuntzan         | 24                | 6 (2.67)                    | 4.33 (1.64)                                 | 6.44 (1.44)                                 | 77.78             | 6.7 (5.93)                        | 24.04 (13.57)                 | 13.16 (10.54)                |
| Salvador E.          | 16                | 6.62 (3.86)                 | 3.87 (2.23)                                 | 5.13 (2.03)                                 | 87.70             | 8.22 (2.76)                       | 19.87 (15.20)                 | 12.41 (7.26)                 |
| **Total**            | **111**           | **5.18 (2.50)**             | **3.95 (2.00)**                             | **5.52 (1.89)**                             | **7.92 (7.08)**   | **20.04 (12.92)**                 | **13.2 (9.18)**               |                             |

Note: Villages sampled: Pátzcuaro East (5), Pátzcuaro West (3), Erongaricuaro (4), Quiroga (3), Tzintzuntzán (2) and Salvador Escalante (2).

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54 M. ASTIER ET AL.
to hybrid maize. Quiroga’s tortilleras have the larger daily average of selling tortillas (Table 1).

The sources of maize and fuelwood for HMTWs differ among villages. Some communities, such as Santa Clara del Cobre are self-sufficient on native maize and fuelwood. Others, such as el Calvario and Vista Bella, which are neighborhoods around the town of Pátzcuaro and have 30 HMTWs all together, have access to the Pátzcuaro market but are dependent on fuelwood and maize from elsewhere, presumably hybrid maize. Others, such as San Francisco Uricho with 54 HTWs, are also close to the main regional markets; they are dependent upon fuelwood from other communities, and at the end of the year when there is a shortage of native maize, some have to purchase hybrid maize that comes from Zacapu and Morelia. Communities that have between 15 and 30 HMTWs are self-sufficient and break even between supply and demand; most of these, i.e. San Andres Tziróndaro, Zirahuén, San Jerónimo, San Francisco Pichátarro, and Tzintzuntzan, trade maize and fuelwood within the village; the exceptions are Tzurumutaro and Vista Bella, which are close to Pátzcuaro and are not self-sufficient (See Main Map).

4. Discussion and conclusions

Maize farmers, under rainfed production, have persisted in many regions of rural Mexico and the CLP (Eakin, Appendini, Sweeney, & Perales, 2015; Orozco-Ramírez & Astier, 2017); the overall pattern demonstrates a resilience and persistence of maize, despite the policy and trade reforms (Eakin, Perales, Appendini, Sweeney, & Perales, 2014). The tortilla is one of the main staple foods and, primarily, hand-made nixtamal tortilla wherein the rural sector represents, at least, 4 million people in Mexico consuming it (CEDRSSA, 2014). Like in the state of Oaxaca, Mexico State, Puebla, Morelos, Queretaro, in the BLPZ region of Michoacán essential fraction of rural people are involved in the native maize-hand-made tortilla food system. Peasant households preferred to use native maize to make tortillas and other maize-based dishes cooked in a traditional way, which for them assured a quality product (Appendini, García Barrios, & De la Tejera Hernández, 2003; Appendini, Cortes, & Díaz Hinojosa, 2008; Appendini & Quijadas, 2016; Carro & Astier, 2014). But traditional tortilla, as this study proves, is also a crucial economic activity for both peasant families and rural women for two reasons. Firstly, tortilla adds value to native maize representing an essential avenue for supporting the production of local maize by small-scale farmers who otherwise would not find a market in these regions (Astier & Barrera, 2009; Berrueta et al., 2017). Secondly, HMTWs provide indigenous women, who have limited access to other income-generating activities, with currency on a daily basis (Astier, 2004; Preibisch et al., 2002).

Given the proven impact of traditional tortilla making on natural resources use and the local economy of rural communities, a more sustainable HMTWs in the Pátzcuaro and Zirahuén basins and other similar regions in Mexico has to be advocated. There are already programs oriented towards making tortilla production more sustainable and efficient, such as wood-saving eco-stoves (Berrueta et al., 2017; Masera & Astier, 2014). Besides, there is a potential to increase the production of native maize within the region to reduce dependence on remoter sources; the area planted to maize in the Pátzcuaro basin has shrunk in the past decade (Orozco-Ramírez & Astier, 2017). This work serves as a platform for local and regional actors involved in this type of efforts.

Traditional tortilla making contributes to the conservation of native maize varieties, and it is a vital source of income for tortilleras’ families, farmers and wood cutters. This activity involves the acquisition of fuelwood and maize and the selling of tortillas which are activities that form part of a local food system that integrates almost all the communities in the region and which benefits many stakeholders.

Having the characterization of the socio-environmental impact of HMTWs, their regional distribution and intensity and natural resources’ offer and demand fluxes. It is imperative that the government creates programs towards the promotion of improved and non-polluting cooking technologies, for the elaboration of tortillas, but also developing an alternative market were hand-made native maize tortillas are differentiated and better valued.

Software

The results from the interviews and census were recorded in an Excel file. The resulted database was then imported to an ArcGIS 10.1, and a raster dataset was also performed in ArcGIS 10.1 with a network analyst’s extension.

Notes

1. The process of traditional nixtamilization (alkaline cooking) is the method utilized since prehispanic times for making maize tortillas. This process of cooking the maize with water and lime soften the kernel. Zatz, Hediger, and Valleroy (1974) reported that the alkaline action of the process of nixtamilization causes physical, chemical and nutritional changes. The outer structure (pericarp) binds calcium almost immediately (Zazueta et al., 2002). This process increases the bioavailability of amino acids and phosphorous and calcium content. It’s especially important because increases niacin availability.
2. These are not the same as tortillerias – commercial establishments that use industrial machinery to produce tortillas.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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