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Agrarian Winners of Neoliberal Reform: The 'Maize Boom' of Sinaloa, Mexico

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While the detrimental impact of neoliberal policy on Mexico's maize smallholders is well researched, little attention has been paid to the rise of maize in the northern state of Sinaloa. Sinaloa's entry into maize has restructured the geography of national supply, and generated a new national confidence in white maize self-sufficiency. Using semi-structured interviews and secondary data, we document the primary social and political drivers of Sinaloa's maize boom. Local actors trumpet Sinaloa's response as a success story of entrepreneurship and technological innovation, while simultaneously appropriating the language of food sovereignty to justify preferential entitlements in public investment. Our analysis confirms interpretations of neoliberalism as a political project, illustrating how existing natural, social and political capital held by specific interest groups can be leveraged and reinforced through private–public partnerships to mould national policy and investment, and the potential vulnerabilities that may emerge from this process.

Keywords: agriculture, maize, Mexico, neoliberalism

INTRODUCTION

The past two decades of research on neoliberalism and associated 'free-market' reform programmes in Latin America have repeatedly confirmed that 'actual existing neoliberalism' (Brenner and Theodore 2002) often looks quite different from the policy ideals articulated in the Washington Consensus (Williamson 1993), or by Milton Friedman or other prominent theorists associated with the dissemination of neoliberal thought in approaches to Latin American governance. Broadly speaking, neoliberal economic and political thought focuses on deregulation and decentralization of decision-making, and privatization and the 'unfettering' of market transactions and the promotion of free trade in order to generate growth and prosperity (Harvey 2005; Liverman and Vilas 2006).

For agricultural policy in Latin America, the embrace of neoliberalism has typically entailed restructuring and reconciling sector programmes to be reflective of macroeconomic neoliberal

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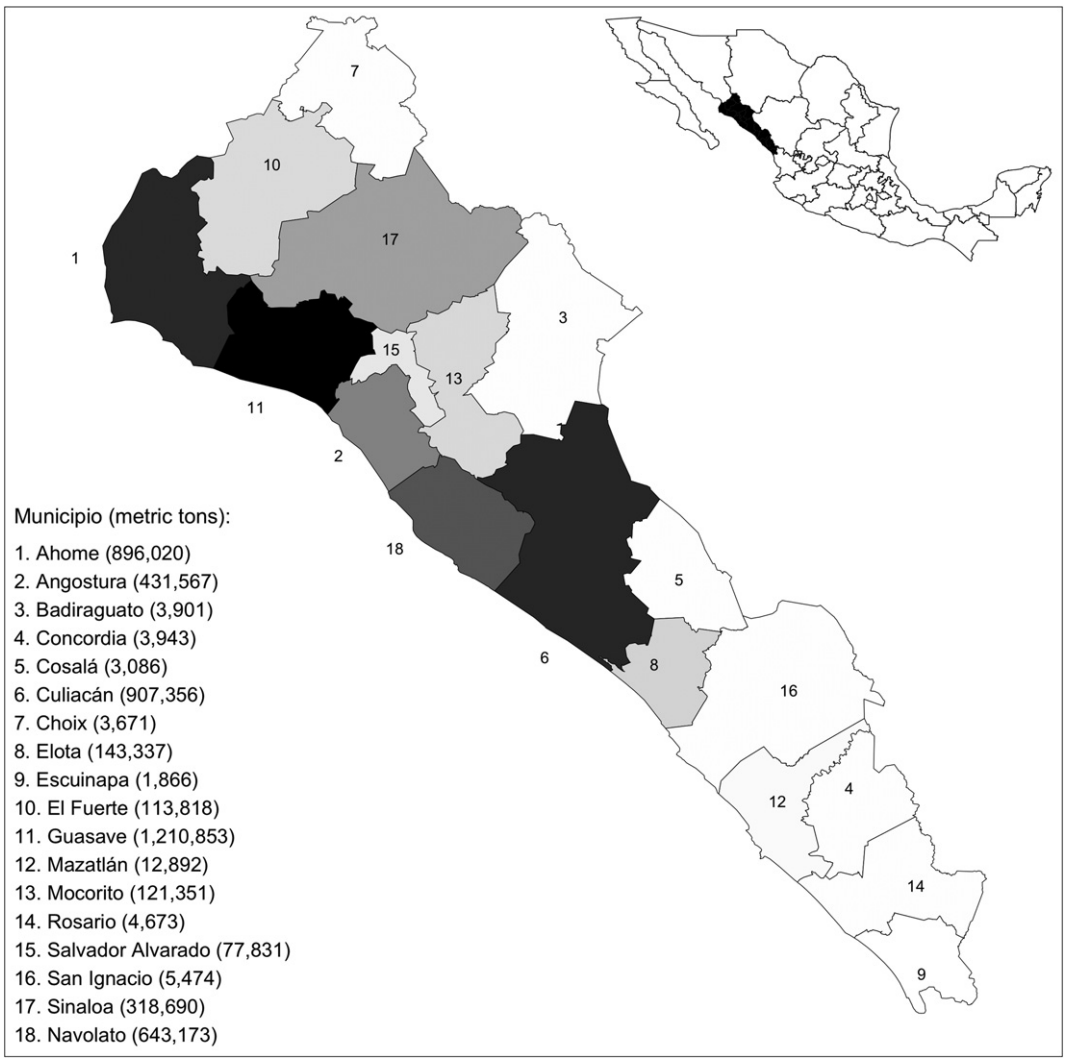
principles and objectives, rather than the development of a separate 'neoliberal' agenda for agricultural growth and productivity (de Janvry et al. 1997b). This effort of restructuring has meant significant reform in the role of the state in farm and rural policy across Latin America: from a relatively activist role in setting prices, promoting specific product growth, and subsidizing access to finance and inputs to one in which the state is primarily focused on facilitating market transactions and intervening where markets fail (de Janvry et al. 1997b). Thus, in practice, the era of neoliberalism has not necessarily been characterized by less government (although state retrenchment has widely occurred) but, rather, the 're-invention' of public-sector relationships to private actors and civil society through diverse and often complex processes of 're-regulation' (Snyder 1999, 2001; Martin 2005; Radcliffe 2005). The reorientation of agricultural policy has had distributive implications: some populations have found new opportunities to prosper and excel, while others have struggled to maintain relevance and position in changing domestic and international markets (Thorpe 1997; Spoor 2000; Liverman and Vilas 2006). Neoliberalism was in its heyday in the 1990s. Nevertheless, the legacy of the institutional reforms of that decade continue to shape development processes today – particularly in relation to which actors have been able to use the opportunity of structural reform to actively participate in and shape the evolution of policy processes, and which actors have not.

Maize (*Zea mays*) has been the key protagonist in Mexico's three-decade engagement with neoliberal ideas, policy and processes. Maize is an iconic crop in Mexico, traditionally valued for its cultural, political and social symbolism and history as much as an economic commodity (Warman 2002). By all accounts, the decade of the 1990s was pivotal in Mexican agrarian history, as Mexico moved rapidly to dismantle some of the entitlements and interventions that had long characterized the agricultural sector, in favour of an explicit emphasis on trade, commercialization and agroindustry (Rello and Pérez 1996). The scope and implications of the overtly neoliberal shift in the orientation of macroeconomic policy, and the implications for the agricultural sector and for rural populations, have been the subject of continual discussion and analysis (e.g. Liverman and Vilas 2006), with the vast majority of accounts documenting the negative impacts that the policy reforms have had on smallholder livelihoods and prospects for smallholder maize production (e.g. Hewitt de Alcántara 1994; de Janvry et al. 1997a; Cornelius and Myhre 1998). Much of the literature has specifically focused on the combined impact of domestic policy restructuring, the North American Free Trade Agreement (NAFTA) and increased maize imports from the United States (USA) on Mexico's maize system, documenting the input/output 'price squeeze' that many smallholder producers faced in the 1990s as federal input subsidies were redesigned, and the government reduced credit and marketing opportunities for small-scale grain farmers (de Janvry et al. 1995; Eakin 2006). Increased migration and 'feminization' of the countryside (Preibisch et al. 2002; Appendini 2010), land abandonment and forest transition (Klooster 2003), enhanced livelihood sensitivity to environmental shocks (Eakin 2006) and erosion of agrobiodiversity and cultural practice (e.g. Nadal 2000) have all been associated with this era of policy reform.

Nevertheless, over the same era (1990–present) the volume of maize grown in Mexico has increased by 67 per cent and the national area planted in maize has been relatively constant (Sweeney et al. 2012). According to the most recent census data, approximately 27.6 per cent of agricultural land in Mexico is farmed in maize, and nearly 2.8 million farmers – largely smallholders with less than 5 ha – are dedicated to the crop (INEGI 2011; Appendini 2012). From negligible maize production in the 1980s, the north-western coastal state of Sinaloa (Figure 1) now supplies nearly a quarter of the country's white maize (SIAP 2010). High-yielding maize is now a monoculture in the state, occupying as much as 90 per cent of the planted area in some

Figure 1 Average annual maize production in Sinaloa from 2005 to 2009, by *municipio*



Source: Authors' calculations based on data from INEGI (2011) and SIAP (2010).
Note: The greyscale colours shown in the figure vary continuously with the maximum of 1.2 million metric tons shaded pure black and 0 output as pure white. Intermediate values of output as represented in the inset table are continuously scaled to grey tones between those two extremes.

irrigation districts. Although many scholars anticipated that there would be a heterogeneous landscape of winners and losers from the 1990s reforms (e.g. Calva 1991; Appendini and Liverman 1994; de Janvry et al. 1995), few anticipated the degree to which a small segment of the nation's producers in a particular geographical region would engage in the maize market. Sinaloa's expansion in maize has been documented by local scholars (see Aguilar Soto 2000, 2004, 2007, 2010; de Ita Rubio 2003; Trujillo Félix and López Cervantes 2007; Aguilar Soto and López González 2009; Aguilar Soto and Solorza Luna 2009; Gaxiola Carrasco and Trujillo Félix 2010),

but its story is not widely known beyond its borders, and the implications of its emergence as a dominant player in the maize supply have been largely unquestioned.[1]

In this paper, through the analysis of in-depth expert interviews and secondary data, we document the primary social and political drivers of Sinaloa's dramatic entry into irrigated maize production, and the implications of Sinaloa's new role as one of Mexico's primary sources of maize for the country's food supply, as well as for Sinaloa's farmers. We use these data to illustrate how some farmers in the region have positioned themselves in support of the neoliberal agenda, while simultaneously appropriating the language of food sovereignty and security to justify preferential entitlements in public investment and policy. Our analysis confirms interpretations of neoliberalism as a political project (e.g. Krippner 1997; Snyder 2001; Larner 2003), illustrating how existing natural, social and political capital held by specific interest groups can be leveraged and reinforced through private–public partnerships to mould national policy and investment. Our analysis also highlights the incipient dangers in this process: not only in terms of the emerging negative externalities associated with this concentrated investment and production, but also, via increased dependency and inflexibility, for the private actors themselves.

First, we briefly review the national policy reforms that preceded Sinaloa's entry into maize, noting that other scholars have covered this ground extensively in this and other media (e.g. Barkin 1987; Gates 1988; de Janvry et al. 1995; Appendini 2001; Yuñez-Naude 2003). We then describe the agricultural past and present of maize farming in Sinaloa and the methods of our project. We present the results of our expert interviews, featuring the primary drivers of change that were identified by the interviewees and how the interviewees viewed the implications of Sinaloa's entry into and dominance of Mexico's maize markets. We conclude with an analysis of the perspectives emerging from the interviews in light of the published literature, and explore the meaning of Sinaloa's participation in the maize sector for Sinaloa's agricultural resources and infrastructure, for its farmers, and for Mexico's maize system.

BACKGROUND

Mexican Agricultural Policy, 1930–1990

Mexico's agriculture sector is essentially bimodal: commercial farms and semi-subsistence smallholders exist together. Historically, these sectors have been subject to distinct policy goals and programmes (Gates 1988; de Ita Rubio 2003). Over the course of the twentieth century, this duality both generated and reinforced tensions in policy circles between the recognition of maize as a cornerstone in rural livelihoods and food security, and the belief that maize farming – inextricably linked to impoverished rural households – was an impediment to improved agricultural-sector efficiency and productivity in Mexico. In the decades following the land distribution era of the 1930s, the federal government provided *ejidatarios*[2] support in the form of subsidized access to critical inputs (seeds, fertilizer and credit) and markets through

[1] Although not the focus of our research, it is worth noting that the El Bajio region of Mexico (Jalisco, Guanajuato) also significantly increased maize production during the same time period, though not to the same extent as Sinaloa (Sweeney et al. 2012).

[2] *Ejidatarios* are farmers who were allocated usufruct rights to land for communal use, individual cultivation and residential settlement in agrarian communities called *ejidos* as part of the land distribution programme following the 1910 Mexican Revolution. With the reform of Article 27 of the Mexican Constitution in 1992, *ejidatarios* were given individual title to the individual plots of land that they farm, marking an end to the Agrarian Reform period.

programmes administered by the Secretary of Agriculture (SARH, or the Secretaría de Agricultura y Recursos Hidráulicos, which in 1995 became SAGARPA), BANRURAL (the National Rural Credit Bank) and the Compañía Nacional de Subsistencias Populares (CONASUPO, National Company of Popular Subsistence) (Myhre 1998). Rural–urban migration was relatively controlled, and the ruling party, the Partido Revolucionario Institutional (PRI, Institutional Revolutionary Party) was guaranteed a strong base of political support in rural areas. In the early 1980s, flush with 'petrodollars', the Portillo administration (1976–82) diverted substantial resources to rural areas in the context of the Sistema Alimentario Mexicano (SAM, Mexican Food System) policy, aiming to boost smallholder yields and, through smallholder productivity, achieve national food self-sufficiency (Fox 1993).

Mexico's economic crisis of 1982–3 put an end to SAM, reversed the more populist import-substitution policies of the prior decade and set the country on a different, neoliberal track towards increased market engagement, export promotion and state retrenchment (Appendini 2001). In 1986, Mexico became a full member of the General Agreement on Tariffs and Trade (GATT), as a precursor to signing NAFTA. This move was intended to enhance access to international markets for Mexican exports and reversed previous decades of 'traditionally protectionist trade policies' (Gates 1988, 298; see also Aguilar Soto 2010). In 1990, the Salinas de Gotari administration (1988–94) started the Agricultural Modernization Program, which singled out the most competitive farmers for support, and promoted the crops for which Mexico was thought to have a comparative advantage in international markets (Eakin 2006). Maize, at that time largely associated with low-yielding smallholders, was not one of those crops.

With the stated goal of reducing the government's involvement in agricultural markets, the federal government eliminated price guarantees for most crops and restructured some input subsidies, eliminating others (de Ita Rubio 2003). Subsidized credit for small-scale producers and public investment in research and extension were also curtailed in favour of facilitating, through subsidies and guarantees, private-sector provisioning of agricultural services for competitive farmers (Myhre 1998). A new seed law was adopted in 1991, increasing the opportunities for private-sector and multinational participation in maize seed development and dissemination. By 1992–3, the private sector accounted for 91 per cent of seed sales (López-Pereira and Garcia 1997). CONASUPO's role as the government's intermediary in the maize market was gradually diminished over the 1990s, until its closure in 1998 (Yuñez-Naude 2003). The government reworked the price structure for maize in the 1990s to track international commodity prices, and over this period, maize prices declined in real terms (Fritscher Mundt 1999; Peña Ramírez 2004).

While many direct subsidies and price supports were eliminated, a new suite of agricultural programmes was initiated in the 1990s, redefining the role of the public sector in agriculture and rural development. The Programa de Apoyos Directos al Campo (PROCAMPO, Direct Field Support Programme), which provides direct payments to farmers for acreage planted in any of nine basic grains (including maize), was established in 1994, with the stated objective of easing farmers' transition from being semi-subsistence maize and bean farmers, to competing in the international market in specialty crops or products of higher value (Gómez Cruz et al. 1993). Although the programme was intended to be phased out in 2008, political pressure has transformed it into an entitlement programme of indefinite duration.

With a focus on programmes that facilitate farmers' participation in competitive markets, the public sector's involvement in agriculture has in many ways become more complex, diffuse and subtle, as the public sector works with and through private-sector agents to achieve the goal of a more 'modern' and entrepreneurial agricultural sector through instruments compatible with

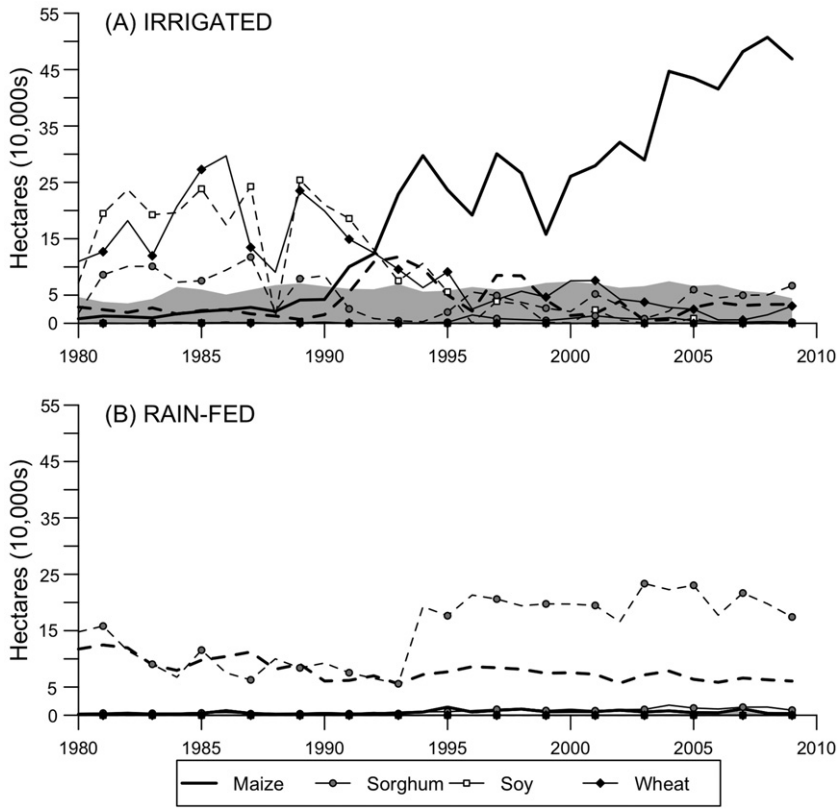
market principles (de Janvry and Sadoulet 1993; Snyder 2001; Appendini 2008). Over the past two decades, public investment has shifted increasingly towards supports for facilitating market transactions and commercialization (Myhre 1998; Appendini 2012). The public agency Apoyos y Servicios a la Comercialización Agropecuaria (ASERCA, Support and Services for Agricultural Marketing) was established in 1991 to support commercialization in formal commodity markets, the cost of transport and machinery and the abatement of market risk, and has become the most important policy tool in the sector. Many of ASERCA's programmes are tied to the volume of the agricultural commodity that is produced or marketed through formal channels. Support for maize commercialization now represents between 45 and 55 per cent of federal resources allocated to support crop marketing in ASERCA's budget (Appendini 2012). Another ASERCA programme, Ingreso Objetivo (Income Guarantee) guarantees a minimum income from commercial maize sales. In 2005, support for maize growers represented 53 per cent of the total budget for this programme, although in 2006 high commodity prices made maize farmers ineligible for this support (Appendini 2012). ASERCA has also provided subsidies for commercialization of maize harvests in futures markets, or through producer–processor contracts, primarily through the programme Compras Anticipadas (Future Sales, initiated in 2006–7, operational until 2010) and Cobertura de Precios (Price Insurance) (see Appendini 2012). This latter programme underwrites the cost of contract insurance between farmers and commercial buyers such as Cargill, Maseca, Minsa and Sabritas – all large corporate players in grain processing, tortilla manufacture or snack food production. In 2009, this latter programme was the most important single programme of federal funding for commercial maize farmers aside from PROCAMPO (Appendini 2012).

Sinaloa's expansion in white maize began in the early 1990s, coincident with Mexico's shift in macroeconomic and sector policy (see Appendini 2012). The dramatic change in Sinaloa's agricultural landscape and output provides an important yet poorly documented counterpoint to the wealth of literature documenting the difficulties that the agricultural reforms posed for maize farming in the rest of the country (e.g. Escalante and Rendón 1987; Collier 1994; Eakin 2006; Fitting 2006; Carton de Grammont 2009). Sinaloa's entry into maize farming is indicative of a change in the national structure of maize provisioning: the 'who, how and where' of Mexico's national maize supply and demand. In the next section, we provide an introduction to agriculture in Sinaloa, before introducing the perspectives of state experts and stakeholders on the drivers and outcomes of Sinaloa's maize boom.

Agriculture in Sinaloa

Sinaloa's geography has long been considered ideal for intensive agriculture. Much of the eastern half of the relatively long state (Sinaloa runs 656 km north–south along Mexico's central Pacific coast; Figure 1) falls within the rough and inaccessible terrain of the Sierra Madre Occidental Mountains. However, the coastal plain is largely flat, with a sub-humid climate that is ideal for year-round production (Schmidt 1976). Eleven rivers flow across the state from the Sierra to the coast, providing the surface water that has fuelled intensive, commercial agriculture for over a century. In the 1930s, the federal government invested in new hydraulic infrastructure, finishing in 1948. Large-scale vegetable commodity production was a significant source of private investment in the 1940s (Ortega Noriega 1999). Production expanded in the 1950s and 1960s, and Sinaloa became a major competitor with US producers in irrigated vegetables (Schmidt 1976). In the centre and north of the state, commercial grain production (wheat, soy, rice and sorghum) also has a long history. With the neighbouring state of Sonora, Sinaloa is considered among the greatest successes of the Green Revolution (Wright 2005).

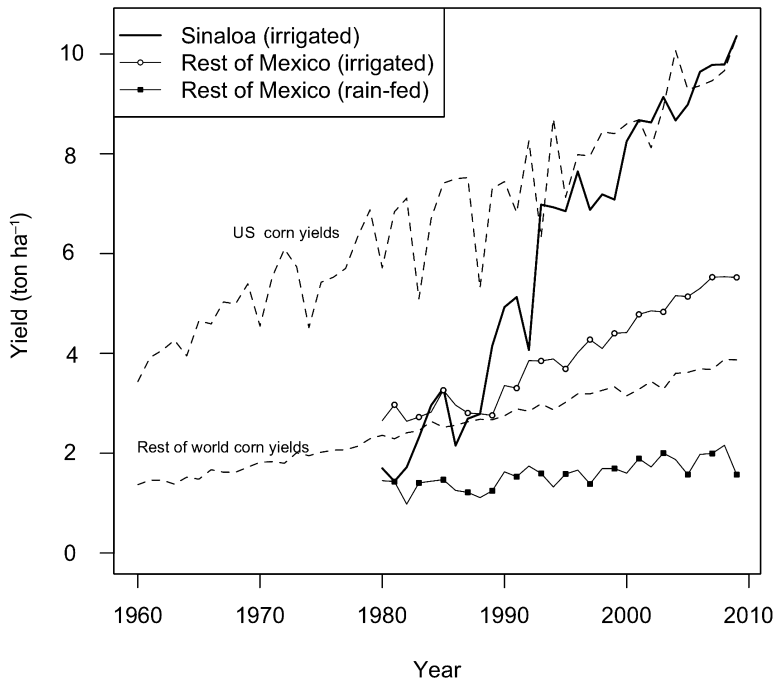
Figure 2 The average area planted in maize, sorghum, soy, and wheat from 2005 to 2009, by mode of production. Solid lines indicate autumn planting and dashed lines indicate spring planting. Grey shading indicates autumn vegetable plantings (the area planted in spring vegetables is negligible)



Source: Authors' calculations based on data from SIAP (2010).

Maize, in contrast, was relatively unknown as a commercial crop in Sinaloa, and was also not widely produced for subsistence in the irrigated coastal plain. In the late 1980s, maize was primarily farmed in rain-fed areas in the southern and eastern portions of the state, and yields averaged just barely 2 tons per hectare (ha). Between 1990 and 1992, the area planted in white maize nearly doubled, and continued to rise throughout the 1990s (Figure 2; SIAP 2010). Yields rose even more sharply, reaching 10 tons ha^{-1} in 2009 (Figure 3). These trends accompanied a shift in maize farming from regions of poor soils, steep slopes and rain-fed conditions to the prime irrigated fields in the centre of the state. Where wheat and soy were once a common crop rotation in Sinaloa irrigated fields, now an autumn–winter maize crop is typically the sole crop, covering 54 per cent of the state's area planted in the autumn–winter season of 2009–10. Eighty-seven per cent of Sinaloa's white maize production is on irrigated land (Gobierno del Estado de Sinaloa 2010). The state is the dominant player in the autumn–winter season, providing over 70 per cent of the seasonal output and nearly a quarter of Mexico's annual production of white maize (Table 1).

Figure 3 Sinaloa irrigated white maize yields relative to average (largely rain-fed) yields of yellow maize in the USA, the rest of the world and the rest of Mexico (rain-fed and irrigated)



Source: Authors' calculations based on data from FAS (2011) and SIAP (2010).
Note: The price deflator in this figure was calculated based on the farm-gate price per unit volume of the five major grains grown in Mexico: rice, maize, soy, wheat and sorghum. Starting with the nominal price per unit volume, p'_{jt}, we created an index relative to year 2000 prices for each crop, $p'_{jt}/p'_{jt=2000}$. The deflator for maize prices is defined as the yearly average of that relative price measure over the five grains.

Table 1. Maize cultivation in Sinaloa

Characteristic	*1990 Agricultural year*	*2009 Agricultural year*
Average irrigated maize yield (tons ha^{-1})	5.04[a]	10.36[a]
Total production of irrigated maize (tons)	317,517[a]	5,236,720[a]
Per cent of national maize production	2.16%[a]	26%[a]
Irrigated area planted in maize (ha)	57,627[a]	502,802[a]
Irrigated area planted in wheat (ha)	199,236[a]	30,720[a]
Irrigated area planted in soy (ha)	212,225[a]	0.0[a,b]
Ejido land in agricultural production (ha)	1,018,589 (1991)[d]	1,082,803[c]
Private land in agricultural production (ha)	263,606 (1991)[d]	405,244[c]

Sources: [a] SIAP (2010); [b] Gobierno del Estado de Sinaloa (2010); [c] Gobierno del Estado de Sinaloa (2009); [d] INEGI (1994).

Table 2. A summary of the interviews

Type of organization	*Number of organizations interviewed*
Private sector	
Industry (seed suppliers, agribusinesses)	2
Private organizations (farmer associations)	5
Irrigation modules (farmers, farm leaders, water modules)	5
Public sector	
Federal (rural financing institutions, agricultural research institutions, water managers)	5
State (water managers, Secretary of Agriculture)	2
Universities	1
Total	20

METHODS

The research presented here is based on semi-structured interviews with officials from twenty public and private organizations in Sinaloa (Table 2). Our aim was to understand the shift into maize and its implications from the perspective of diverse actors in the region. We focused on gaining perspectives from public officials directly involved in developing or implementing federal and state programmes associated with maize farmers; public and private input providers (finance, water, seed and fertilizer); farmer representatives (leadership of agricultural associations) and irrigation water administrators (irrigation district module leadership). We also interviewed academics, private and public extension agents and agronomists, and a few individual farmers. In the majority of cases, the invitation for the interview was delivered to the individual in charge of the associated organization (i.e. the director, manager etc.), who then either volunteered to be interviewed or appointed an individual to meet with us. The individual farmers interviewed were typically those who were also serving as leaders in an organization with which we were consulting, or were invited to participate in the interviews by managers in the irrigation districts. Most of the interviews were digitally recorded; at the request of some respondents, some interviews were not recorded. We transcribed the digital interviews, and coded the transcriptions and/or the interview notes using the NVivo 7 software (QSR International 2007) according to emergent themes and our initial hypotheses associated with the drivers and outcomes of maize expansion (Table 3). Where possible, we used government statistics, published literature and other documents (media reports) to triangulate and validate the narratives conveyed in the interviews.

DRIVERS OF SINALOA'S MAIZE EXPANSION

The dominant narrative explaining Sinaloa's rapid embrace of white maize was one of necessity, opportunity and ingenuity. The interviewees narrated a fairly consistent story: prior to 1990, few commercial farmers planted maize. Farmers in the northern states historically focused on animal feed crops such as sorghum, grains such as wheat, and export-oriented crops such as vegetables, and left the production of staple foods to southern and central Mexico, where the demand for tortillas and other maize-based foods is concentrated.

Table 3. Codes for Sinaloa interviews

Drivers	*Codes*
Climate and environment	Growing conditions; water scarcity; pests; decline of other crops
National policy and programmes	Compras Anticipadas; credit; differentiated policies; NAFTA; price supports; Procampo
Price and profitability	Maize demand; relative prices; input costs
Culture and national identity	Farmer education and management
Infrastructure and technology	Irrigation infrastructure; hybrid seed varieties
Outcomes	Codes
Environmental	Monoculture, pests, soil contamination, water contamination, water availability
Economic	Credit availability, farmer debt, income diversification, land consolidation, change in maize area, change in maize yields, market saturation, renting land, selling land, using land for other purpose
Social	Farmers organizing, impacts on small-scale growers, impacts on large-scale growers

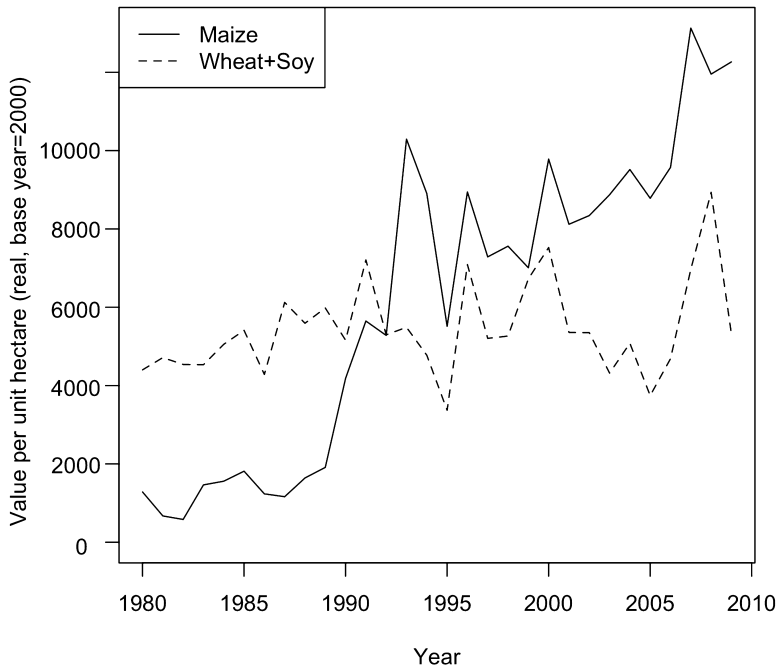
Relative Prices

The turning point in Sinaloa was 1989, when the federal government abolished price guarantees for all crops but maize and beans, and lifted import restrictions for sorghum, soybeans and other oilseeds (de Ita Rubio 2003). Sinaloa's major crops at the time – soybeans, wheat, safflower and rice – were already declining in profitability. Droughts in the 1980s had contributed to a perception of water shortage, which discouraged the cultivation of water-intensive crops such as rice and sugar. Pests and disease – white fly (*mosca blanca*) in cotton and soybeans and a fungus (*carbón parcial*) in wheat – were affecting profits. White fly infestations were also hurting the vegetable export industry. The loss of price guarantees for all crops but maize and beans and the lifting of import restrictions for all crops was the final blow. Producers of soy, wheat, rice and cotton were no longer able to compete with imports from international markets. Farmers immediately started to transition out of the wheat/soy double-cropping system, and into irrigated winter maize. Data from the state and federal government on cropping patterns and price confirm this story: winter-season maize rapidly replaced the wheat/soy cropping system in the early 1990s (Figure 2), paralleling a significant change in relative prices. In 1989, the real value per hectare planted in wheat and soy dropped precipitously to match the value of maize, and after 1995 the real value per hectare planted in maize had risen to eight to ten times that of wheat and soy (Figure 4), inflated in part by a premium price assigned to maize by the Ministry of Agriculture (Appendini 2001, 2012).

Public Support

Respondents from the public sector explained that maize and beans remained protected commodities as NAFTA was signed, and for some farmers, this protection provided significant security relative to other crops. The bean market was relatively inelastic and unable to absorb additional supply. The national white maize supply, however, was perceived to be insufficient to meet demand. In light of their protected status until 1993, maize and beans represented the most profitable and attractive option for farmers. As one respondent stated: 'Maize was considered something for people from the south. However in the 1990s maize was given substantial

Figure 4 The value (in Mexican Pesos) per unit hectare for maize and wheat + soy in Sinaloa, 1980–2010



Source: Authors' calculations based on data from SIAP (2010).
Note: Prices are deflated using an agricultural price index created by the authors.

support. The price guarantee was really good. And suddenly people [in Sinaloa] realized they were planting very little maize' (authors' translation). While the initial move to plant maize was consistently presented as motivated by exogenous factors of national policy and international markets, two interviewees – one who had been in a position of influence in the early 1990s – independently suggested that the federal government intentionally designed programmes with Sinaloan farmers in mind, and thus fuelled the intensification of maize production and the dramatic yield increases of the 1990s. They explained that although price supports were removed for most crops, the federal agricultural policy of the 1990s entailed a suite of additional financial supports, such as ASERCA, that were specifically aimed to facilitate larger-scale, commercial marketing of maize grain. The marketing supports and programmes have led to concentration of federal resources in Sinaloa and, within the state, to larger-scale commercial producers (Fox and Haight 2010; Appendini 2012). One interviewee argued that the federal Secretary of Agriculture and Hydrological Resources specifically targeted these programmes at Sinaloan farmers to demonstrate the capacity of agricultural modernization to Mexico's President Salinas, who was championing the modernization programme. CONASUPO, the grain marketing board charged with purchasing surplus grain, was hardly present in Sinaloa in 1989, but by 1993 had increased its maize purchases in Sinaloa by 177 per cent (Appendini 2012). In the crucial years of the early 1990s, maize was made both attractive for the commercial growers in terms of price, as well as 'safe,' as one interviewee from a grower's association described it. Unlike alternative commercial crops, the availability of these

institutional supports meant that if something went wrong with their maize crop, such as a pest outbreak or a decline in prices, growers did not lose all they had invested that season.

Private–Public Collaboration

While interviewees generally acknowledged the role of the state in circumscribing the choice of maize adoption, they also celebrated endogenous attributes of Sinaloa's farm community and geography as determinants of success in maize production. Sinaloan farmers were described in many interviews as rapid learners who quickly adapted to the new crop. Prior to 1990, commercial farmers did not have extensive experience in producing maize. In the words of one respondent, in the short span of two or three growing seasons, commercial farmers 'quickly walked the learning curve', experimenting with planting dates, fertilizers and plant density to achieve maximum yields. An interviewee from an irrigation district said:

> The growers themselves had to search for the best alternatives to make the crop yield, looking at fertilizers, irrigation, when is the best moment to irrigate and fertilize, pests, and a lot has to do with genetics . . . you can really change the management of a crop. This is the most important thing in the region . . . [Today] the producers have already experimented with different planting dates, types of fertilizers, and they know which ones are best. (Authors' translation)

By the early 1990s, Sinaloa white maize yields exceeded the national average, and by the mid-1990s they were on par with US yellow maize yields[3] (Figure 3).

It was not only individuals who learned and experimented; it was clear from the interviews that the process was collaborative as well as competitive, and featured a strong state presence and private-sector participation. The state government and farmer organizations made active efforts to spread knowledge about maize cultivation in Sinaloa, as well as to improve it, and the success of the early maize growers attracted more growers to plant maize. In the early 1990s, a prominent farmer and politician in the state recounted how the Fundación Produce (Production Foundation) was established as a liaison between government and growers, and as a means of ensuring that state policy favoured the interests of farmers. Fundación Produce not only proved to be an effective mechanism for research and education for commercial growers, but also became an influential organization in state and federal policy development. Fundación Produce now has branches throughout Mexico.

Many of the interviewees, including one from Fundación Produce, also commented on the importance of the annual 'Agro-Expos' – a form of agricultural fair – that were initially organized in the early 1990s to promote commercial farming in the state by the Confederación de Asociaciones Agrícolas del Estado de Sinaloa (CAADES, Confederation of Agricultural Associations of the State of Sinaloa), a prominent network of farmers associations in the state. The expos are modelled on county fairs and agribusiness expositions in the USA, and feature agribusiness services offered through the private sector (equipment, machinery and input suppliers). These 'Agro-Expos' have now become important annual events in Sinaloa, filling hotels and becoming permanent features on farmers' calendars (Beltrán 2010).

[3] While the benchmark of yields is the primary indicator of competitiveness from the perspective of farmers, it was repeatedly observed by public officials that US yellow corn has the advantage of being produced in rain-fed conditions with heavy subsidies. Sinaloan white corn, by contrast, is considered by regional experts to be more costly to produce under irrigation. For a detailed comparison of maize production in Iowa and Sinaloa, see Aguilar Soto and López González (2009).

Representatives of commercial seed suppliers, government officials and farmers all highlighted the importance of technological innovation in Sinaloa's short maize history. Commercial seed suppliers recalled that prior to the 1990s, there were no high-yielding maize varieties adapted for Sinaloa's growing conditions. Most of the available seed stock was adapted for the highland rain-fed conditions of Jalisco. The interviewed representatives of international seed companies operating in Sinaloa characterized their participation in the maize boom as primarily reactive: in the early 1990s, they noticed the expansion of area planted in maize and responded quickly by developing new hybrids for the region. As yields increased with the new seed varieties, so did the appeal of maize to farmers. As more and more farmers began planting maize, the seed companies developed increasingly productive seed varieties in response to their clients' demands. One interviewee contrasted Sinaloan farmers' constant demand for improved seed varieties with most other Mexican farmers, who were depicted as more conservative: they become accustomed to the performance of a single seed variety and are reluctant to switch. In the 1980s, Monsanto and Pioneer developed new commercial seed varieties every 4 or 5 years. Interviewees from these same companies expressed that now they feel pressured by farmers to issue new seed varieties almost annually, to meet farmers' expectations of increased yields. It was clear, however, that the companies are aggressively competing for farmers' attention and are actively disseminating their technology. Pioneer (owned by Dupont) and Monsanto (marketing Dekalb and Asgrow seeds) are now the principal players in the maize seed industry in Sinaloa, and while there are dozens of seed varieties planted in the state, they are almost all produced by the two companies. Prior to planting each year, Fundación Produce collaborates with the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP, National Institute of Forestry, Agriculture and Livestock Research) to conduct seed trials that determine which of the available commercial seed varieties is the highest yielding.

Many respondents commented that the success of maize in Sinaloa is also a function of the state's growing conditions. Sinaloa has fertile soils, flat land for mechanization and impressive irrigation infrastructure that channels surface water from eleven rivers. Interviewees emphasized that Sinaloa's mild winters are ideal for maize production, allowing Sinaloan producers to supply maize at a time when few other states have active production cycles. In the words of one interviewee: 'the climate in Sinaloa is good for many crops, but for maize it is special' (authors' translation).

EMERGING CONCERNS, OPPORTUNITIES AND SINALOA'S MAIZE FUTURE

As described in the previous section, the explanation for Sinaloa's aggressive engagement in the maize market was relatively consistent across the interviews: highly capable farmers in ideal production conditions responded to market forces, supported by technological innovation and public investment. Nevertheless, perspectives on the implications of the maize 'boom' for the farm sector, for Sinaloa and for national maize markets were more nuanced and complex. In this section, we describe respondents' nascent concerns over the ultimate sustainability of the growth trajectory, and how these concerns were counterbalanced by a discourse of pride and defensiveness of Sinaloa's new dominant role in national maize supply.

One concern that emerged from the interviews was the expanding maize monoculture and associated ecological impacts of maize expansion. A few interviewees commented on an emergent problem of pests: new pests that had previously not been seen in the region, and an increase in the frequency of pesticide applications on some farms, and thus the possibility of pesticide resistance. Nevertheless, no data independent of the interviews was available to confirm these observations (Bausch 2011). Excessive application of synthetic nitrogen on maize

Table 4. Estimated costs per hectare of irrigated conventional white maize in Sinaloa, 2009

Expense type	*Cost per hectare (pesos)*	*Percentage of cost per hectare*
Land rental	8,000[a]	27
Purchased inputs	12,370[b]	41
• Fertilizer, irrigation water, irrigation labour, canal maintenance, pesticides/herbicides, seeds		
Land preparation	3,050[b]	10
• Tillage, furrowing, plot formation, field bordering, canal preparation, pre-plant irrigation (includes labour)		
Insurance and Fees	2,904[b]	10
• Crop loss and investment insurance, planting permit, market insurance		
Planting	710[b]	2
• Sowing and soil management		
Weeding	750[b]	3
Harvesting	2,150[b]	7
• Threshing, transport, field levelling		
Total	29,934	100
Producer price per ton 2009 (winter): 2693 pesos[c]		

Sources: [a] Centro de Estadística Agropecuaria (2009); [b] Financiera Rural (2009); [c] SIAP (2010).
Note: The total does not include finance-related expenses such as interest or bank fees, administrative expenses or taxes. These expenses may be several thousand pesos. The total also does not include farm-level income from government transfers and subsidies, which offset some of these expenses (e.g. diesel, transport and insurance).

was also an issue of growing concern, given the expense of fertilizers and other inputs for farmers (almost 40 per cent of input costs; see Table 4) and some local analyses that had illustrated that farmers were using far more nitrogen than necessary to achieve their desired yields. One informant tied the observation of excessive input use to farmers' preoccupation with yield: inputs are applied with the attitude that 'more is better' rather than managing input use according to the soil, climate and topographic conditions of specific fields.

The most critical concern voiced by farmers, agricultural-sector officials in the state government and farm organization leadership was the phenomenon of 'overproduction'. Sinaloa's productive success was threatening to cripple farmers in the state. Because Sinaloa's comparative advantage is the winter season, farmers have only a short period – from June to September – to distribute their harvests in national markets before the harvests of the summer season (produced in the centre and south of the country) enter the market. According to various interviewees, the market typically can absorb 3 to 4 million tons of Sinaloa's maize between June and September. However, in recent years, Sinaloa's harvest has exceeded 5 million tons. In addition, in 2008 support for commercialization through the Compras Anticipadas programme was capped at 3.85 million tons (Juarez et al. 2009), leaving over a million tons without coverage under this programme. Without the federal government's backing, suppliers did not enter into future contracts on their own. Thus at the time of harvest in 2009, there was a prevailing perception of an 'excess' harvest, one that went beyond the limits of the federal commercialization subsidy programme. While some farmers explained that they had sold their

harvests at the lower price of yellow maize for the livestock feed industry, many others refused, staging protests and blocking highways to demand that the government resolve their situation (Cabrera 2009).

The issue was not only one of the availability of federal support, but also the transport bottlenecks created by the large volume of grain leaving the state. Informants claimed that rail was the most efficient and cost-effective way of moving Sinaloa's harvest to the centre and south of the country, where the demand is greatest. Nevertheless, capacity is limited. According to some informants, only 600,000 tons per month can leave Sinaloa by rail. Additional volumes are transported south by sea, from Sinaloa's coast through the Panama Canal, and north to the port of Veracruz, where it is offloaded for consumption in central Mexico. By October, the harvests from the summer season in central Mexico begin to be available. There is little incentive for large-volume processors of maize to purchase grain from Sinaloa and transport it to distant processing facilities when they could purchase the summer maize crop from other regions with lower transport costs.[4] The resistance of farmers to the idea of selling their harvests at prices other than what some had been able to achieve via the Compras Anticipadas programme suggested that few farmers were willing or able to fully engage with competition in the domestic market and offer their harvests at prices that would be competitive in the centre and south.

Underlying the expressed frustration with the challenge to effectively and profitably market their harvests was farmers' acknowledgement that maize was their preferred crop and one that they were not inclined to abandon. As farmers have expanded their landholdings and invested in equipment, the cost of switching to a non-grain crop (such as high-value vegetables) has also increased. And it is not just machinery that impedes a shift in course: several interviewees described how over the past 20 years they have established strong social relationships with commercial input suppliers, and with harvesting, transport and storage providers. Harvest outcomes depend not only on the farmer, but also on the honesty of the individuals contracted to harvest and transport the grain to local silos, and the honesty of the silo management. While no interviewee suggested that these relationships would be an impediment to change, it was clear that these social ties helped to further embed Sinaloa in its current path as a national maize supplier, and to cement the ties of the state to its producers.

The security offered by the continued substantial federal support to Sinaloan maize farmers was perhaps the element that most wedded farmers to maize. According to estimates made by the government farm credit agency Financiera Rural (Rural Finance), purchased inputs including fertilizer, irrigation and seeds make up over 35 per cent of the costs of production (Financiera Rural 2009). Land rental prices have increased dramatically over the past 5 years, now averaging $8,000 pesos per hectare, or as much as 24 per cent of production expenses[5] (Table 4; Centro de Estadística Agropecuaria 2009). Sinaloa farmers appear to be increasingly on the agricultural treadmill (Cochrane 1959; Levins and Cochrane 1996), facing narrow

[4] Keleman et al. (2009) describe the maize–tortilla production chain in five stages: (1) maize producer, (2) commercial maize companies and small markets, (3) masa (dough) preparation, (4) retailers and tortillerías, and (5) consumers. They emphasize how five large companies have come to dominate maize purchasing since the 1990s, especially the corn flour companies GIMSA and Minsa-Arancia Corn Products International, who produce the brands Maseca and Minsa, respectively. Both companies have a corn flour plant in Sinaloa, but GIMSA has eighteen other processing plants throughout Mexico (GRUMA n.d.), and Minsa has five other plants throughout the country (Minsa Mexico n.d.).

[5] Several interviewees commented that the escalation in land rental is associated with drug-related money-laundering activities. Following the rise in global commodity prices in 2007–8, it became relatively easy for drug money to be invested in maize farming. Farmers reported being offered significantly higher prices for land rental than they had been accustomed to receive in the past – as much as double ($8,000–10,000 pesos per hectare). The land would then be farmed in maize. Although commodity prices have since declined, land prices remain high.

profit margins that they feel can only be improved by expanding the area under production through land rental, and pursuing the highest possible yield per hectare. In this context, federal supports play essential roles. The federal finance agency, Fideicomisos Instituidos en Relación con la Agricultura (FIRA, Trust Funds for Rural Development), indicated that as much as 27 per cent of the cost of maize production was supported by direct farm subsidies in Sinaloa (e.g. PROCAMPO and associated ASERCA programmes paid to individual farmers) (FIRA 2006). Without the substantial public support offered to Sinaloa producers, FIRA's analysis indicates that farms of most scales would not be profitable (FIRA 2006). Indeed, few informants could suggest an alternative crop that would provide the same level of security for farmers, although it was clear that the security acquired in maize was largely from the level of government support, not stability in international maize prices. As an interviewee from a growers' association put it: 'We are willing to plant any other crop as long as it is regulated by the government and has guaranteed commercialization' (authors' translation). Although the state government has made an effort to encourage farmers to plant yellow maize (a grain that Mexico currently imports from the USA, largely for livestock feed and industrial markets), farmers have been reluctant; prices are generally lower in domestic markets, and yields tend to be lower than white maize yields. An interviewee from a growers' association said: 'Here, what pays is [white] maize, and that is what [farmers] plant' (authors' translation).

Nevertheless, instead of viewing Sinaloa's monoculture and market gluts as problems, the interviewees often framed Sinaloa's dedication to white maize in nationalist terms, suggesting that their productivity should be recognized for its importance to Mexico's food sovereignty. Ignoring the fact that Mexico's maize imports are largely in the form of yellow maize, a representative from a growers' association said: 'At the level of the Mexican Republic, we import maize. It is not possible that we can overproduce when we are importing maize' (authors' translation).

Officials in the state government were also defensive, arguing that Sinaloa makes a critical contribution to national food security, effectively enabling Mexico to be self-sufficient in white maize. Several interviewees claimed that if Sinaloa did not produce white maize, Mexico would have a shortage in one of its most important food staples. Interviewees from both the private sector and the public sector remarked on how different Sinaloa's mechanized, modern mode of production is from the rest of Mexico, and how their yields are comparable to US production. Interviewees repeatedly held Sinaloa maize up as a standard of high quality, 'perfect' for tortilla manufacture.

The nationalist discourse was in part a response to the fact that at the time of the interviews, scholars and the media were highlighting the fact that Sinaloa had received a disproportionate allocation of federal agricultural support, and were using this fact as evidence of biases and inequities in federal programmes (i.e. Trujillo Félix and López Cervantes 2007; Pérez U. 2008, 2009; Hernández and Alvarado 2009; Fox 2010). Information offered by one informant from FIRA confirmed that 16 per cent of its national agricultural finances were taken up by Sinaloa's farmers, but justified this allocation by the high productivity, high input use and thus lower risk of maize production in Sinaloa.

By framing Sinaloa's maize production in nationalistic terms, the responsibility for addressing any emerging sector inefficiencies was implicitly or explicitly placed with the federal government. Rather than reducing supply by reducing the area dedicated to maize production, farmers have used their associations to lobby the state and federal government to provide more guarantees, demanding that all their harvests are purchased at a price that they deem viable (e.g. Perez U. 2007; see also Trujillo Félix and López Cervantes 2007).

The state officials interviewed did not contradict the farmers' position. One official argued the federal government should actively support those farmers who produce, distinguishing such farmers from rural households in the centre and south of the country whose production activities also often entail subsistence goals. Rather than critique the dependence on subsidies in Sinaloa, one prominent public official argued that Sinaloan farmers were entitled to it, portraying farmers as the principal generators of national production, state income and thus federal taxes. From the perspective of this respondent, federal resources should be spent where productivity is highest:

> You can't go around mixing things, supports for poverty and supports for production; if you confuse this, you fall into demagoguery and populism, and you are denying the reality that, as a result of having 5 million tons [of white maize] stored here, when the Bajio dried up from drought . . . fortunately we had [maize] stored here, calmly available, as a food security reserve . . . But no one will acknowledge this. Fortunately – if we did not have this food reserve, the chaos we would have had! People would be eating tortillas made from forage grain, from transgenics . . . (Authors' translation)

While Sinaloa's contribution to national food security and national public welfare was a theme across most of the interviews, in a few instances concerns were raised about the changes in resource distribution that had accompanied the growth in maize. For example, an interviewee from a growers' association pointed out the contradiction of simultaneously offering price supports for maize and implementing neoliberal reforms: 'It has never been a free market, really. It's a hybrid that has ended up being a Frankenstein. I'm not leftist or anti-free market, but when you mix things you get neither *chicha* [fermented maize beverage] nor lemonade. This is what has happened' (authors' translation).

Several individuals interviewed raised the issue of the distribution of productive resources within the state as an emergent issue, if not necessarily a concern. Land, still nominally in the hands of *ejidatarios*, was now reported to be concentrated in fewer hands. This concentration was not occurring as a result of land sales but rather *rentismo*, the phenomenon of an increase in land rental. One interviewee estimated that as much as 60 per cent of land area in some irrigation modules was rented out to third parties – in some cases, entire *ejidos* were reportedly rented out; official census data (INEGI 2011) indicates that in the municipalities in the centre of the state, where maize production has been strongest, between 15 and 30 per cent of the planted area is rented. Interviewees, as well as the local academic literature (e.g. Aguilar Soto and López González 2009), described a process in which small landholders – primarily *ejidatarios* – unable to qualify and negotiate accessible credit in the early 1990s, and who were aging, began renting out their land to larger growers who were looking to expand their operations. As an interviewee from a seed company explained, those who continue in maize are the most profitable of all the growers; those who could not survive the challenges of the neoliberal reforms have already abandoned agriculture.

Most Sinaloa growers are producing what is considered a profitable yield: an analysis by FIRA (2006) suggests that to break even, Sinaloa growers must obtain a yield of 9.37 T ha^{-1}. In 2010, the average yield in Sinaloa was 10.65 t ha^{-1} (SAGARPA 2010). However, profitability is also a question of landholding size. Two interviewees, one from a federal-financing institution and the other from a water district, pointed out that 10 hectares is not much to live on, especially in an increasingly consumerist culture. While the latest Agricultural Census figures have the average farm size in Sinaloa as 19 ha (INEGI 2011), a respondent from the federal finance institution suggested that 100 ha would be a viable farm size in Sinaloa, commenting that smaller farms would face significant problems: 'A producer of that size has no negotiating

power, not even to buy inputs or sell his harvest. They have to organize in growers associations, *ejido* unions, or *parafinancieras* [financial intermediaries operating from input supply stores] to have any buying or selling power' (authors' translation). In contrast, renting provides a steady income with minimal risk, so there is little incentive to sell. Landowners receive payment in full for their land at the start of each planting season and thus have a guaranteed income that is independent of harvest outcomes. While most of those interviewed did not perceive the phenomenon of renting to be a problem, one respondent associated with the largest association of *ejidal* farmers, the Liga de Comunidades Agrarias (CNC, League of Agrarian Communities), claimed that living standards had not improved for landowners who rent, and because alternative employment opportunities are scarce, and alcoholism and other forms of delinquency (particularly involvement with drug cartels) are on the rise.

DISCUSSION

The process of neoliberal policy implementation is now widely understood to be place-specific, heterogeneous and complex in its manifestation in particular contexts. As Martin (2005, 205) states, 'neoliberalization is not driven by an inescapable logic but, rather, is underpinned by specific actors, institutions and discourses'. The account of the process of maize adoption and expansion in Sinaloa offered by actors in Sinaloa adds further credence to Martin's argument. The prominent narrative put forth by Sinaloan agricultural officials, farmers and agricultural leadership was one of capable farmers responding to opportunity: the interviewees presented themselves and their peers as entrepreneurial, profit-oriented and unsentimental about their production practices and crop choices. In appropriating the opportunities presented by national-sector reform, Sinaloan actors were participating in shaping and legitimizing neoliberal governance. Farmers and state officials rationalized the current focus on maize to the exclusion of other crops as a 'natural' phenomenon: a logical response to the opportunities of the market and to the 'ideal' suitability of their natural resource base. Despite the fact that prior to 1990 maize was never a dominant crop in the region, respondents from public and private agencies present maize as the 'perfect' crop for Sinaloa in term of soils, topography, infrastructure, water and climate conditions.

Not only was Sinaloa's adoption of maize a 'natural' response, but it was also characterized as a necessary contribution to public need and national demand. Respondents characterized their production strategies as critical to national food security. Sinaloa's contribution to the national supply was presented in nationalistic terms, as meeting a social and economic need that was under-appreciated at the federal level. In this light, the suggestion that addressing Sinaloa's 'excessive' production might require farmers to adjust in crop choice and land use was resisted – particularly on the part of farmers interviewed. Reluctant to directly confront the vagaries of the international market, these actors expressed an entitlement to fair prices and guaranteed markets on the basis of their perceived contribution to the public welfare: meeting Mexico's demand for white maize. Armed with this discourse of national food security, the state officials we interviewed legitimized the allocation of substantial federal support to Sinaloan white maize farmers and thus, implicitly, the 'neoliberalization' and the elite capture of the maize sector.

Nevertheless, coupled with secondary data and the analyses of other scholars, the interviews also indicate that Sinaloa's embrace of maize was not a fortuitous accident or national responsibility but, rather, was at least partially engineered through state and federal policy, shaped by key local actors. The interviews add further credence to Aguilar Soto's (2000, 2004) assessment that the farm associations and associated agricultural leadership in Sinaloa had sufficient political capital and social organization to capitalize on and appropriate President

Salinas' emphasis on agricultural modernization and concurrent concern over national maize supply. The interviewees portrayed Sinaloa's farm associations as highly professional and organized (see also Perez U. 2007). Individuals who have served in leadership positions in CAADES are likely to also move into leadership positions in Fundación Produce and in public office. This process has increased the likelihood of ensuring consistent access to federal resources. As Aguilar Soto argues, 'facing the open market, [farmer organizations] have been able to commercially integrate with glocal [*sic*] weight' (authors' translation, Aguilar Soto 2010, 96; see also Aguilar Soto 2004).

National data illustrate that federal policy was at least accompanying Sinaloa's expansion into maize, if not intentionally paving the way for it (see Appendini 2012). According to an analysis by Reyes Pruneda (1993), the portion of CONASUPO's total maize purchases that came from Sinaloa increased from 1.5 per cent to 25 per cent in just 5 years (1989–93), accompanying and almost anticipating Sinaloa's expansion in production. While PROCAMPO was promoted in Mexico as a programme designed in part to facilitate the transition of smallholder farmers of basic grains into higher-value crops, in practice it has become a steady source of cash income for farmers of all scales. A recent analysis by Scott (2010) demonstrates that Sinaloa and four other northern states have received the largest rural per capita shares of public investment in agriculture over the 1990s, in part as a result of larger land extensions and thus larger benefits via PROCAMPO, but also due to the number of support programmes that target capital-intensive, mechanized agriculture; the kind of agriculture that is typical in Sinaloa. For example, Sinaloa receives over 12 per cent of public agriculture expenditures, with a 4 per cent share of the population employed in the farm sector and almost 8 per cent of state gross domestic product (GDP) in agriculture. In contrast, for example, the state of Mexico in the centre of the country receives approximately 3 per cent of public expenditures with a 5 per cent share of total agricultural employment and almost 4 per cent of state GDP. Per capita expenditure of federal supports in Sinaloa is second only to the state of Tamaulipas, and far exceeds the average allocated to other states (see Scott 2010, figs 14 and 15). From 2000 to 2006, Sinaloa received 68 per cent of the budget allocated to the Ingreso Objetivo programme (although contributing at that time only 16 per cent of national maize output), and Sinaloa received *all* of the Cobertura de Precios subsidy in 2008 and 2009 (see Appendini 2012). In addition, irrigated producers have enjoyed a relatively large investment of federal resources for subsidies of diesel fuel, electricity and irrigation equipment (Scott 2010). Much of the federal resources allocated to Sinaloa's farmers also entails substantial subsidies for commercial agribusiness. The programme Compras Anticipadas, which underwrites the transaction costs of participation in futures markets, has been a substantial benefit for commercial entities such as Cargill, Maseca and Minsa, who have received the funds to subsidize their contracts with Sinaloa growers (Aguilar Soto 2007; Appendini 2012). In sum, despite their relatively small numbers (less than 4 per cent of all farms in Mexico are in Sinaloa, and of these, a still smaller fraction represent the commercial farms actively benefitting from public programmes), and even in consideration of the important contribution of Sinaloa to national agricultural income (~7 per cent of national agricultural GDP in 2010), Sinaloa has received a hefty share of public agricultural investment.

Technological innovation, reported by many interviewees as a critical component in Sinaloa's success story, is also a product of the federal government's retreat from the business of agricultural research and development, resulting in a production environment in which yield is everything. The private sector has aggressively filled the void: while there are a large variety of seeds available for Sinaloa farmers to choose from, nearly all are produced by Pioneer or Monsanto, who have consolidated their influence over Mexico's seed industry and maize

farmers' production choices over the past decade. The federal research institute INIFAP no longer generates its own seed. Instead, it collaborates with the quasi-public producer organization Fundación Produce to conduct public annual seed trials to see which seed variety produces the highest yield. By not factoring soil management, irrigation management and nutrient management into the production equation, the seed trials promote an obsession with achieving high yields through seed selection and chemical inputs, irrespective of cost and the natural capacity of the resource base.

Our interviews have shown that by most measures, Sinaloan maize farmers have benefited in the neoliberal era, in part because they have been active participants in maintaining and cultivating the public sector as a critical buffer and intermediary in their engagement with the markets. While state agricultural officials defended this investment on the basis of Sinaloa's now impressive contribution to national white maize supply and food provisioning, not all are comfortable with the extent of federal intervention and support of the maize sector in Sinaloa. As one respondent commented: 'The government has thought about putting aside these subsidies, but it is impossible. They simply can't. As a result, we are losing competitiveness . . .' (authors' translation). A few interviewees suggested that the degree of federal support has led to unhealthy and increasingly expensive path-dependence. One interview respondent suggested that it was dangerous to do away with the subsidies that Sinaloa growers have come to expect and depend on; the social and political consequences would be too great. Newspaper reports confirmed that the farmers do not hesitate to make their expectations clear using the political means that farmers in Mexico have always relied on: public demonstrations and protests (e.g. Perez U. 2007; Cabrera 2009). Gaxiola Carrasco and Trujillo Félix (2010, 64) suggest that maize production in Sinaloa has become problematic for the federal government, which 'has not had the capacity to alter [Sinaloa's] pattern of specialization' (authors' translation).

The case of Sinaloa further supports Gledhill's (1995) claim that the Mexican federal government's approach to liberalism was and is essentially 'soft': responding to the demands and needs of increasingly entrenched private capital in maize rather than pursuing a clear vision of the public sector's mandate in providing longer-term national maize security. By all accounts, Sinaloa's 'boom' has been engineered through federal policy paving the way for dynamic private-sector activity, but also through significant federal investment that raises questions about the long-term autonomous viability of maize production in Sinaloa. López and Galinato (2007) argue that subsidies for commercialization and marketing, irrigation improvements and commodity-specific expenditures – the type of supports that Sinaloan farmers have enjoyed – are essentially subsidies for private goods, and as such 'crowd out' the capacity for governments to support the maintenance of public goods in rural areas through investment in research, extension, education and environmental protection. They argue that the result is not only a bias against smallholder farmers who play a role in public good provisioning, but also that such subsidies can result in ecological and other negative externalities that impede economic growth. Sinaloa's maize expansion is not the only example of this in Mexico's history. From the 1960s and through the 1980s, many farmers throughout Mexico, including in Sinaloa, switched to sorghum in response to federal subsidies and infrastructure investment, abandoning the production of wheat and maize. The reallocation of federal resources supported the development of the livestock feed processing industry and domestic meat suppliers, but ultimately did little to address Mexico's malnutrition problem (Barkin and DeWalt 1988). By the early 2000s, sorghum monoculture in the northern state of Tamaulipas had resulted in soil degradation, climatic sensitivities and increased pest problems (Eakin and Bojórquez-Tapia 2008).

The ecological implications of Sinaloa's maize expansion are not yet evident[6] (Bausch 2011). Nevertheless, the incentives as currently structured do not appear to induce efficient use of water, nitrogen and soil, despite the high real costs of production. Until 2011, water supply had not been a constraining factor in Sinaloa's maize production. Sinaloa is sensitive to periodic droughts, and variability of precipitation is associated with the El Niño Southern Oscillation (Arriaga-Ramírez and Cavazos 2010). Indeed, while one interviewee characterized Sinaloa as insurance against the impact of droughts in rain-fed regions, a devastating black frost that occurred in early February 2011 (Branson et al. 2011), and the current drought (Juarez and Hansen 2012) demonstrate that Sinaloa's harvest is not immune to shocks. Nearly all of Sinaloa's winter maize harvest was destroyed in the 2011 frost, and the federal government responded with a rescue package that one interviewee estimated eventually exceeded 3 billion Mexican pesos in direct payments to farmers, with additional funds allocated to help farmers acquire machinery and find markets for replanted crops. Media reports confirmed that substantial federal resources were allocated to Sinaloa's farm recovery (Cabrera Martínez 2011; Cardoso 2011). Sinaloa is currently plagued with drought, with reservoir levels at 46.8 per cent of capacity as of late 2011. As a result of the water shortage, the area planted in white maize for the 2011–12 autumn–winter crop cycle dropped to 320,000 ha (Juarez and Gonzalez 2011), a 33 per cent decline compared to the maize area planted in Sinaloa during the autumn–winter season of 2009–10. Given the national dependence on Sinaloa's harvests, climatic impacts in Sinaloa now represent threats to the national food supply. In the future, increasing aridity is a concern for rain-fed production in central Mexico (Feng et al. 2010) and climate experts involved in national climate policy scenarios anticipate that pressure on northern irrigated districts will probably increase in the short to medium term (V. Magaña pers. comm., January 2010). The longer-term impacts of global warming on Sinaloa's water resources and agricultural conditions have not been researched.

The social outcomes of maize expansion in Sinaloa are also poorly understood. One agronomist we interviewed feared rising and unsustainable levels of farmer debt, although none of the bank representatives interviewed were concerned about this. As in other parts of Mexico, lack of access to finance has driven some smaller-scale producers (largely *ejidatarios*) from commercial production. Yet, whereas in central Mexico farmers might continue to farm for subsistence purposes, in Sinaloa renting out productive land is the preferred option. While more research is required on the social and economic outcomes of *rentismo*, it is clear that land concentration is occurring at a broad scale (see Aguilar Soto and Solorza Luna 2009; Gaxiola Carrasco and Trujillo Félix 2010).

CONCLUSION

While our data do not dispute the conclusions that the sector reforms of the 1990s had substantial impacts for smallholder maize farmers across Mexico, we show that some actors had the political organization and influence to secure substantial gains in the process of policy reform. While actors in the region narrate the impressive response of growers in terms of opportunity, ingenuity and entrepreneurship, combined with 'perfect' infrastructural and biophysical conditions, the interviewees also provided evidence that the resulting 'neoliberal

[6] Scientists based in Sinaloa, such as Dr Federico Páez-Osuna (e.g. Páez-Osuna et al. 2007) Dr Carlos Green-Ruiz (e.g. Green-Ruiz and Páez-Osuna 2003) and Dr Miguel Betancourt Lozano (CIAD 2010), are studying ecological impacts of agricultural activities in Sinaloa, but there is little data specific to maize.

landscape' has been more engineered by public-sector intervention than by free market forces. While the Sinaloan producers would conceivably have been in a perfect position to invest in the high-value export crops touted as the future for Mexican agriculture, their movement into maize – a crop imbued with strong political, economic and social significance – not only provided a secure livelihood but also a means to legitimize the continued strong support of the public sector.

The immediate outcome is indeed impressive. Mexico is now, as many in Sinaloa like to argue, relatively self-sufficient in white maize, albeit maize in the form of processed commercial corn-flour tortillas and high-input, commercially processed maize food products. Sinaloan maize now penetrates grain and tortilla markets across Mexico. Yet this mode of self-sufficiency has come at a cost: Mexico is now dependent on Sinaloa for nearly a quarter of its annual maize supply, raising the prospects of geographical vulnerabilities that are yet unexplored. The development path that Sinaloa has chosen with maize appears increasingly inflexible, weighted with growing farmer entitlements and significant inertia. The shift in public support, while generating impressive results in terms of yield and volume, has trade-offs at various scales. Ecological and social consequences may be of less concern than the analogous story of maize expansion in the USA might suggest, yet as of now, there appears to be little effort dedicated to monitoring and evaluating those potential negative externalities. If, as anticipated by some, Mexico's irrigated sectors become increasingly important for national food supplies with warming temperatures and less reliable rainfall, the sustainability of Sinaloa's maize expansion will be increasingly critical.

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