The Agriculturization of the Desert. State, Irrigation, and Agriculture in Northern Mexico (1925-1970)

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Abstract

Expanding markets, technologies with their origins in the second industrial revolution, pressing government needs, and what might be called state policy made possible the construction of large irrigation systems during the post-revolutionary period in Mexico. This led to the expansion of the agricultural frontier by millions of hectares during the 20th century. This study examines the plans that led to the construction of these irrigation systems in the north of the country, a multiregional space that comprises about 60 percent of Mexican territory, and whose main characteristic is its aridity.

Keywords: Mexico; agriculture; desert; irrigation; water supply; state participation

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Acronyms

AHA	Historical Water Archive (Archivo Histórico del Agua)
CCR	Compañía Constructora Richardson
ha	hectare
m	meter
PRI	Institutional Revolutionary Party (Partido Revolucionario Institucional)

1. EXPANSION OF THE AGRICULTURAL FRONTIER

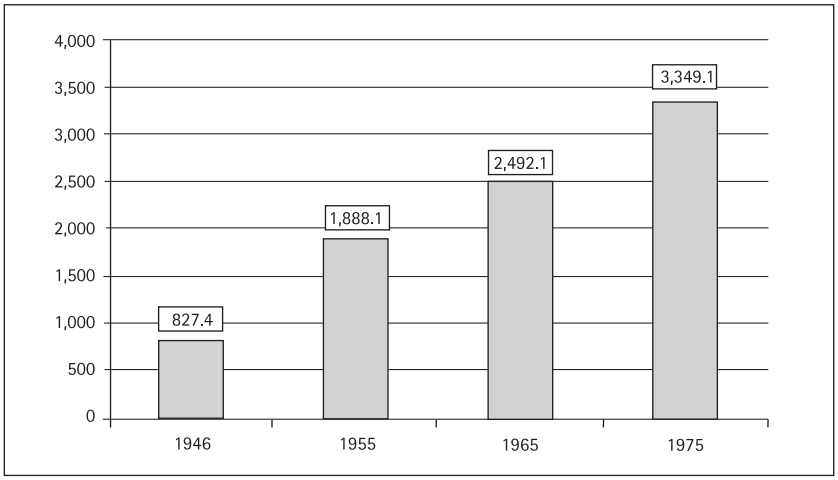
In the 1920s, Mexico underwent a difficult process of economic reconstruction and reconfiguration, led by governments which were influenced by certain political trends and which, after addressing the revolutionary proposals, succeeded in meeting the commitments made in the 1917 constitution as well as in promoting economic development. On the world front, the magnitude of the second scientific and technological revolution became apparent during this decade, as did the emergence of a constellation of groundbreaking technologies, some of which could bring about profound changes in the material infrastructure of a society.

Within this local and international combination of phenomena and transformations, two were particularly important in Mexico: (a) the socio-political and institutional reforms that, among other goals, set out to destroy big property, multiply productive capacity in the rural sphere, reconfigure social relations, and give the state a new role; and (b) the receipt, application, and intensive use of hydraulic engineering, cement, and steel: a new formula that, properly integrated, could modify the exploitation of resources such as water and contribute to implementing new modes of transport and to designing a modern urban architecture.

It was in this scenario and in the framework of what might today be called a state policy that, from the 1920s onwards, Mexico stood out for its application of the above-mentioned macro-project which, oriented above all to the construction of vast irrigation systems, would allow the agricultural frontier to be expanded and scarcely populated areas to be settled:[1] a scheme that was particularly notable and effective in the **deserts of the north**. According to various sources and authors, at least 2.5 million hectares (ha) were opened up for exploitation between 1930 and 1970. If those hectares opened for agricultural use at the end of the 1960s and which became available during the following decade are also taken into account, the sum of areas irrigated "with federal government hydraulic works"[2] by the mid-1970s, according to authors such as Esteva (1981), was close to 2.5 million ha (Figure 1).[3]

1. The institutions and agencies created from 1925 onwards were fundamental to Mexico's subsequent socioeconomic development. It is important to stress here the founding of the Banco de México and the National Irrigation Commission (Comisión Nacional de Irrigación), which encouraged the major hydraulic infrastructure works, the parallel initiative of distributing land and water to small- and medium-sized property-owners, and the simultaneous emergence of rural and urban business endeavors. (Gómez Morín 1991 [1928]; Méndez Reyes (2009); Krause (1981). A decisive complement was the progressive construction of a network of interstate highways and rural roads, which ensured the articulation of the domestic market, the multiplication of human and commercial exchanges, and the bolstering of links with the United States. For a recent summary of the role of public policy in Mexico's rural transformations starting from 1929, see Yúnez Naude (2010).
2. All quotes in this paper were translated from the original Spanish texts by Apuntes.
3. Warman (2001: 127) puts the figure at around three million hectares irrigated by "large works built and controlled by the federal government [...]."

Figure 1
Irrigated areas, 1946–1975 (in thousands of hectares)



Source: Esteva (1981: 233).

A key protagonist of this policy in the 1940s was the engineer Adolfo Orive Alba, who served under President Miguel Alemán Valdés as the Minister of Water Resources (1946-1952).[4] In 1958, Orive's aim was for there "to be 2,238,810 hectares under irrigation" by the end of that year, and, despite each president having imposed "his own model" since 1926, the irrigation project "had great continuity" (Orive Alba 1962: 147).[5] He adds that one consequence was that by 1955, Mexico already had a considerable advantage over other Latin American countries. In comparison to Mexico's 2,157,000 hectares under irrigation, Peru had 1,300,000 hectares and Chile a similar number, Argentina had a little over 1 million ha, and Brazil less than 150,000 ha.

Roger Hansen, for his part, outlines these developments as follows:

> Between 1935 and 1960 more than half of public sector investment was used for spending [...] on infrastructure in agriculture, transportation, and communications. Most of the money invested in the agricultural sector went

4. By transforming the Irrigation Commission into the Ministry for Water Resources (Secretaría de Recursos Hidráulicos), Alemán signaled the strategic importance he placed upon commercial agriculture, especially that geared toward exportation.
5. He later affirms: "The work done by governments from 1926 to 1958 has allowed the addition to Mexico's agricultural land [...] of a total irrigated area (already under exploitation) of 2,238,810 hectares, both new and improved" (Orive Alba 1962 157).

> towards the construction of vast irrigation networks. As a result, the area irrigated by way of publicly-funded hydraulic systems increased by 4.9% from 1950; it now includes more than 60% of all irrigated land in Mexico, as compared with the 13% in 1940 (Hansen 1979: 62).

But that is not all. Hansen goes on to place special emphasis on the fact that the Mexican project could be judged "one of the biggest of its kind in the world," and that it had "opened up for cultivation and irrigation more land than any other Latin American country." He adds that between 1940 and 1946 alone, "irrigated cropland tripled thanks to public funding." Arturo Warman (2001: 127), in one of his final and most thought-provoking works, insists that "the expansion of the irrigated area was one of the great public [policy] concerns and actions for development between 1940 and 1980 [...]. According to the agricultural censuses, in 1930, Mexico had an irrigated area of 1.7 million ha, almost all with works predating 1910; in 1991, the figure was 5.6 million, 2.2 times more or almost 4 million additional ha."

In her book about the modernization of Mexican agriculture with reference to the case of Sonora, Cynthia Hewitt (1999: 28) recapitulates: "The proportion of the agriculture budget assigned to large irrigation projects in post-revolutionary Mexico was ever-increasing." She accompanies this statement with figures that, while differing slightly from those cited by other authors, do confirm two clear trends: (a) that irrigated land expanded from the mid-1930s; and (b) the high percentage of irrigation districts that resulted. To illustrate the latter trend: in 1936 irrigation districts accounted for 11.35% of the total irrigated area in Mexico; this proportion rose to more than 42% in 1941, and exceeded 53% in 1964, when the total irrigated area approached 4 million hectares.

2. LARGE-SCALE IRRIGATION: WHY?

To explain the origins of this policy during the term of President Plutarco Elías Calles (1924-1928), Enrique Krauze (1981: 134-135) recalls the three aims of government-sponsored irrigation: (a) "[i]ncrease areas under cultivation to assure harvests"; (b) the "creation of small properties through the distribution of irrigated land," to help "solve the agrarian problem;" and (c) the economic liberation of "much of the peasant class" by tying peasants to the land as small property owners.".[6]

6. The former "would be achieved by irrigating land. Large expanses that could not be cultivated due to a lack of water could be made productive through the construction of irrigation works." The other objectives were grounded in the idea that "only the state could undertake the heavy spending that irrigation works required," since in addition to a utilitarian aim it "pursued a social aim." (Krauze 1981: 134-135).

Regarding the first issue, which is given the greatest attention is this study, there is widespread agreement among those who have analyzed these processes.[7] Most authors who have assessed or alluded to so-called **large-scale irrigation** in Mexico accept, in general terms, the notable economic and productive impact that it had and sustained up to at least the 1970s.[8] According to Leopoldo Solís (1971: 141-148), author of a classic work on the Mexican economy, between 1930 and 1960 agricultural production increased at a "considerable average annual rate" of 12.2% at current prices and 4.8% at constant prices.[9] This increase is explained "by the increases in the harvested area and in the yields." But "the influence of irrigation on yields" was much greater, and was not limited to "quantitative effects." After estimating that "each irrigated hectare has a yield four times greater than a rainfed hectare," he states:

> The acceleration of the increase in agricultural production in Mexico over the last 35 years is explained by, in addition to high investment in irrigation, the growing utilization of improved inputs that, used together, have stimulated this vigorous rise in (and have functioned as) complementary measures to investments in irrigation [...]. Much of these innovations and investments have been adopted as a result of public policy related to irrigation (Solís 1971: 141-148).[10]

Meanwhile, Rosario Robles points to the significance of the state's contribution to agricultural progress. Focusing on the period between World War II and 1960, she states that the major hydraulic projects "constituted the main rubric of state investment in agriculture, which allowed the irrigated area to increase considerably." Furthermore:

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7. With respect to the other points, authors diverge in their opinions according to the times and circumstances in which they wrote, their occasionally conspicuous ideological standpoints, and the objectives of their research.
8. However, it is worth noting that elements complementary to the design and construction of the big districts and to the uncertainty of irrigation accumulated over time. These included, among others, a marked regional diversity of agricultural spaces, multiple infrastructure works (roads, ports, transport systems), visible increases in productivity, the characteristics and vagaries of land distribution, different markets and crops, the research policies applied, institutional changes, the expansion of the domestic market, World War II, mechanization, and, during the glorious years of the 1950s, the Green Revolution.
9. His analysis emphasizes the decade of the "agricultural boom," (1945-1956), when growth rates of 6.9% were attained (Solís 1971: 143).
10. Solís cites some of these innovations and investments: a) the introduction of improved seeds; b) growing use of fertilizers; c) plant protection; d) increased use of insecticides and better pest control; e) improved cultivation techniques; f) the introduction of private investment; g) expanded production infrastructure; and h) sustained development of commercial agriculture (Solís 1971: 146).

> One of the fundamental aspects that characterized the agricultural modernization process of the period was genetic improvement and the dissemination of many varieties of seeds. Wheat and corn were the crops privileged by genetic research [...]. The utilization of improved wheat seeds involved the abundant use of water and complex and costly technological packages, so their employment was restricted mainly to the areas that met these conditions and which would soon become Mexico's new granaries (Robles 1988: 23-25, 31).[11]

The combination of large irrigation districts, public policy impacts, and the potential of the agricultural frontier to boost production and productivity has attracted the interest of many authors, especially those who focus on the period 1940-1970. Blanca Torres, for example, states:

> The third aspect of the policy of modernization, alongside irrigation and mechanization, was the use of improved inputs [...] it was necessary for [the] new [wheat] seeds to be accompanied by swift mechanization, the use of fertilizers and insecticides, and an adequate supply of water. This helps explain why the Green Revolution [...] occurred with particular intensity in the new lands of the northeast (Torres 2006: 75-76).[12]

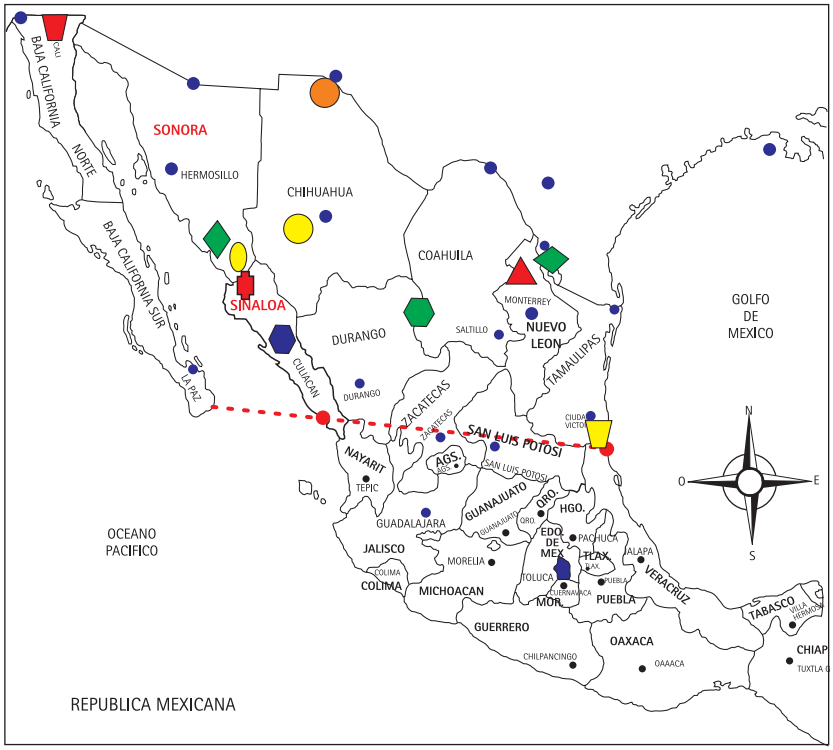
3. INTO THE DESERTS OF THE NORTH

Most of the large dams were built in the north of the country.[13] Map 1 shows the most extensive irrigation systems installed in the northern regions between 1930 and the mid-1970s. At the beginning of the 20th century, this geographical space was characterized by three fundamental aspects which, to be sure, marked the policy of the Mexican governments of the period. These included a geographical-ecological characteristic: the near-abysmal

11. He adds that in general terms, the central factors behind agricultural expansion in the 1950s include "irrigation, mechanization, genetic research, the adoption of improved seeds, and the use of insecticides and fertilizers" (Robles 1988: 23).
12. And of great importance: "To succeed in this task agricultural research was indispensable, so in 1947 the Agricultural Research Institute [Instituto de Investigaciones Agrícolas] was created. At the same time, the Office of Special Studies [Oficina de Estudios Especiales] continued to operate, [in] which the Ministry of Agriculture and the Rockefeller Foundation had collaborated since 1943" (Torres 2006: 75).
13. The area regarded here as the north is a multi-regional space occupied by ten states (Map 1), comprised of the six that border the United States (Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas) and the adjacent southern states (Baja California Sur, Sinaloa, Zacatecas and Durango), as well as parts of San Luis Potosí. This space includes around 1 million square kilometers, almost 60% of Mexico's land area.

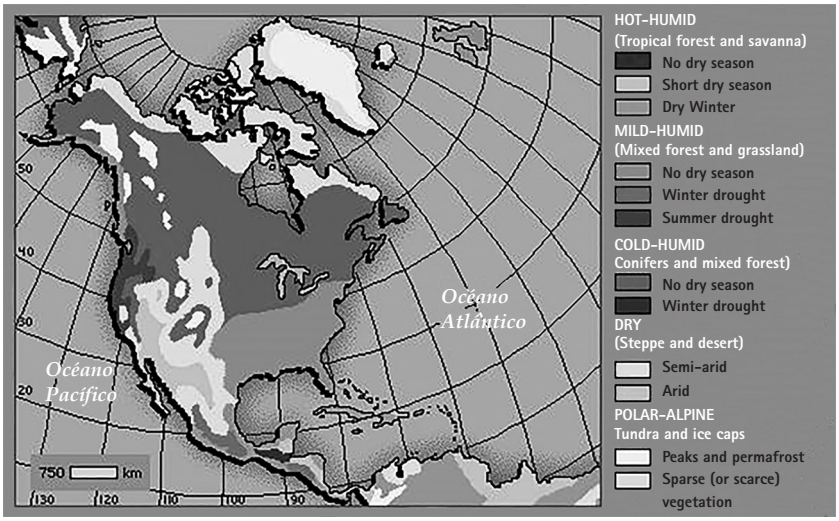
presence of the desert[14] and closely linked to this, the very sparse population; the third characteristic was the direct, overwhelming territorial adjacency to the biggest market created by the capitalist system: the United States.

Map 1
Main reservoirs or reservoir systems constructed in the north, 1930–1970



14. "Desert" in both senses: ecologically and environmentally; and as a territorial strip to be occupied effectively by the state, capital, and a population that migrated to these latitudes as the agricultural frontier expanded. Vast portions of the Mexican north are considered as the southern sector of the arid and semi-arid soils that are also found in the south and west of the United States, especially in Arizona and New Mexico. Clear examples of deserts are the Chihuahuan and Sonoran deserts, which cut across the international border almost vertically and penetrate both Mexican states. This ecological similarity between the two countries had much to do with the cotton boom on both sides of the border, and with the near-parallel construction of dams to irrigate thousands of previously-inhospitable hectares. See Samaniego López (2006); Rivas Sada (2011).

Map 2
North America: dual-nationality of deserts on the Mexican-U.S. border



Source: Small and Freeman (2003).

3.1 Large-scale hydraulics and the agriculturalization of the desert

The project implemented by the masters of the state during the 1920s, the so-called **Sonorans**,[15] attempted to articulate the **agriculturization** of the desert, the parallel exploitation and disputes involving river water shared with Mexico's northern neighbor,[16] and the settlement of irrigable areas, with an explicit strategic end: to benefit in different ways from the capitalist dynamic of the United States.[17] The government installed by the 1910 revolution urgently needed export capacity, and in response to the evident decline

15. In Mexican historiography, Sonorans are the revolutionary leaders and generals native to the border state of Sonora who came to power following the death of Venustiano Carranza, in 1920. The two most outstanding individuals - both of whom served as presidents - were Álvaro Obregón (1920-1924) and Plutarco Elías Calles (1924-1928). Obregón was a highly enterprising land owner who operated between the Mayo and Yaqui rivers in the middle of the Sonoran Desert. Calles' roots were more urban, but like his compañero he symbolized the profile of certain regional middle-classes to whom the Porfirian oligarchy tended to close its doors. Frontiersmen that were accustomed to coexisting with the epic U.S. territorial occupation, their ideas and proposals included combining new productive dynamics with "farmer" style agrarian reform (a departure from the ejidal economy), as part of which it was necessary not only to expropriate the large landowners but, above all, to expand the agricultural frontier, irrigate it, and demarcate it with small and medium-sized private properties.
16. The Colorado in the east; and Bravo, or Grande river in the center and west (see Samaniego 2006).
17. In the United States' own consumption and production markets, which would also serve as an intermediary for other markets thanks to the country's extensive rail network, port system, and gigantic commercial fleet.

of the mining sector it backed agricultural production and its **natural market** in the country to its north.

It therefore comes as no surprise that starting then, the northern region went on to become one of Mexico's foremost socio-political, economic, and entrepreneurial spaces. The institutions, visions, and notions conceived starting in 1925 were instrumental to agricultural development (above all on the business side), which was manifested in numerous territories close to Texas, New Mexico, Arizona, and California. **Callista** era policy, many aspects of which were restored after 1940, introduced truly essential measures and proposals for: (a) implementing what would be majestic works of hydraulic infrastructure; (b) opening up semi-arid areas for crop production by way of their transformation into green areas through the irrigation districts; and (c) establishing mechanisms for the distribution of land (to be fed by water that previously would have drained into the ocean) among hundreds of small and medium-sized owners, a socioeconomic scheme that would introduce or modify regional production trajectories (Cerutti 2011b; Krause 1981: 162).

Taking a different perspective, Samaniego (2006: 173) explains that by the middle of the century, **large-scale hydraulics** had "transformed the west of the United States and the north of Mexico"; as such, part of the arid territories in both countries "had been modified." What had happened? The latest advances in hydraulic engineering, including the intensive use of steel and cement, became factors that were conducive to **technologically** sustaining the gigantic projects that started to become widespread in both the United States and Mexico from the 1930s.[18] According to Samaniego:

> The construction of a new type of hydraulic works at the end of the 19th century and during the 20th century transformed the form of settlement as well as the manner of exploitation of water resources over an extensive region: northern Mexico and the western United States. [Works] of a different dimension to those built in previous years [could] transport, store, and distribute large quantities of water in completely different proportions. (Samaniego 2006: 31)

A second aspect on which both countries agreed was that such sizable investments could only be taken on by the federal government. In the case of the United States, the Franklin Roosevelt administration invested in such projects, while in Mexico, almost all the presidents who governed between 1925 and 1965 did so. These investments were accompanied by the multi-purpose usage of reservoirs, for hydroelectricity generation on the one hand, and to support the settlement of near-uninhabited areas on the other. *Agriculturalization* of

18. In the United States' own consumption and production markets, which would also serve as an intermediary for other markets thanks to the country's extensive rail network, port system, and gigantic commercial fleet.

the desert in the U.S. southwest and the Mexican north was initiated because it promised high profits from cotton production, which was transferred from wet areas in pursuit of more effective mechanisms for combating pests and improving quality (Rivas Sada 2011).

3.2 Watering the desert

Numerous authors - some with nods of approval and others striking a more discordant note - are in agreement that the distant, arid, and unpopulated north received the lion's share of resources allocated to large-scale irrigation. F. H. Beck, in a highly critical article published in 1977, provides the figures shown in Table 1 (1977: 105).[19] These are related to investments in irrigation projects from 1941 (that is, from the partial recovery of the "Sonoran version" of the Agrarian Reform) until 1970. The four top recipients are northern states. Added together, the investments made in five of these states (Sinaloa, Tamaulipas, Sonora, Baja California, and Chihuahua) total 53%. If Coahuila and Durango are also taken into account, the total amount exceeds 60%. A comparison with five states in the center and the south underlines the direction in which investment was made prior to 1970: Tabasco, Puebla, Oaxaca, Michoacán, and Guanajuato together received only 23.77% of investment.

Table 1
Investment in irrigation by state, 1941–1970 (in 1950 U.S. dollars)

State	Investment	Percentage of national total
Sinaloa	150,605.318	22.25
Tamaulipas	70,172.254	10.34
Sonora	52,331.098	7.73
Baja California	46,229.827	6.83
Tabasco	39,840.231	5.89
Chihuahua	39,513.873	5.84
Puebla	34,921.965	5.16
Oaxaca	33,437.688	4.94
Michoacán	29,283.931	4.33
Coahuila	24,133.988	3.57
Durango	23,846.936	3.52
Guanajuato	23,372.832	3.45
National total	676,710.983	100.00
Five from central-south		23.77
Five from the north		52.99

Source: Beck (1977: 105).

19. This engineering was also applied to the highway system, the expansion of ports, and the construction of airports; in numerous public works (schools, hospitals, military barracks, and for the police); and in vigorous urban expansion.

The biggest irrigation districts that were implemented, whether utilizing dams or extensive piping systems that extracted water from border rivers such as the Colorado and the Bravo, as well as inland rivers such as the Yaqui (Sonora), the Fuerte (Sinaloa), the Conchos (Chihuahua), and the San Juan (Nuevo León and Tamaulipas), generated striking results and multiple demands.[20] Table 2 shows the irrigated area in some of these districts and the main crops that historically were grown in these territories.[21]

Table 2
Main irrigation districts in the north (1930–1970)

Irrigation area	State	Hectares under irrigation	Main crops
Valle del Yaqui	Sonora	220,000	Wheat, rice, cotton
Valle del Mayo	Sonora	100,000	Chickpeas, wheat
Valle del Fuerte	Sinaloa	230,000	Sugar cane, vegetables
Valle de Culiacán	Sinaloa	95,000	Vegetables, cotton
Valle de Mexicali	Baja California	180,000 a 200,000	Cotton
Comarca Lagunera	Coahuila-Durango	100,000	Cotton, grapes, alfalfa
Bajo Río Bravo	Tamaulipas	200,000 a 350,000	Cotton, sorghum

3.3 The Yaqui Valley

This section will summarize the relationship between the construction of a vast irrigation system in the Yaqui River Valley (south of Sonora) and the events that occurred there during the 20th century. These include, among others: (a) the initial settlement of the land and the expansion of the agricultural frontier; (b) the growing preponderance of wheat production; and (c) the emergence of the Green Revolution.[22]

20. One of the first such results was the construction of regional roads that, in turn, were to be connected with the trunk roads in the center and north of the country and to the United States. Credit and financial intermediation, agroindustry, transportation, applied research, services, and heavy industry were among the most-impacted industries.
21. The Comarca Lagunera had established itself as a cotton producer during the Porfiriato, when commercial capital and powerful property owners financed the construction of large canals. The Irrigation Commission, in any case, planned the construction of a dam to regulate water in the region during the 1940s.
22. Because of space restrictions, another more significant effect already addressed in earlier works will not be considered here: the emergence of an agile regional business dynamic that, predicated upon agriculture but with parallel investment in agroindustry, services, commerce, and financial intermediation, was stimulated by the enormous irrigation infrastructure. In this regard, see: Cerutti (2011a, 2011b); Cerutti and Lorenzana (2009).

Construction of the irrigation system

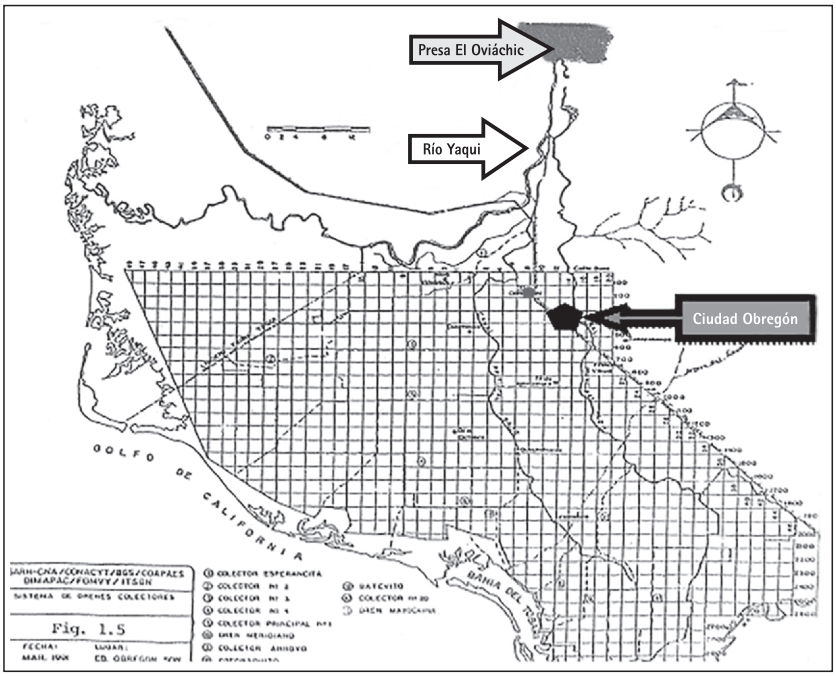
Even though the history of this system predates 1909, it is worth noting the role played starting in that year by the California-based Compañía Constructora Richardson (CCR). It was this company that succeeded in the systematic takeover of sizeable expanses of the valley, imposing a settlement mechanism — that is, colonization, which would condition the development of this warm corner of the north Pacific.

CCR's proposals entailed planned occupation of the land as immigrants progressively arrived. To this end, a functional irrigation system was required. Although it did not fulfill many of its commitments,[23] the company put in place settlement mechanisms that outlasted its own presence in the country (in 1928, its concession was withdrawn[24] and the federal government resumed what it had begun in 1909). Neither the Agrarian Reform launched in the 1930s by the government of Lázaro Cárdenas, nor the administration of Irrigadora del Yaqui,[25] nor the rural-urban transformation that would occur in this warm valley from 1940 to 1965 served to modify substantial aspects of the agricultural land settlement system.

The essential link in the system introduced by the CCR was the so-called ***manzana,*** measuring 2,000 meters (m) in length, equal to an area of 400 ha. Each was divided into forty lots of 200 m x 500 m; that is, an area of 10 ha.[26] As can be seen in Map 3, a grid system was used in the design, based on two perpendicular axes: one from north to south and another from east to west. These axes constituted the system's lines of reference, on the basis of which the arterial roads were plotted and the *manzanas* and their minor intermediate roads were defined. Land settlement, the irrigation network, and the agricultural frontier were all developed and progressed on the basis of this pattern.

23. Archivo Histórico del Agua (AHA), Fondo de Superficiales, exp. 14679.
24. In March 1928, the federal government acquired the shares of CCR and the Banco Nacional de Crédito Agrícola: "it took charge of the Assets and Liabilities of the Company" (Ortega Leite s. f.: 2).
25. Entity created in 1943 to assume control of the CCR.
26. According to the concession agreement with the federal government of August 1911, no more than 2,000 hectares (five *manzanas*) were to be transferred "to a single person or company."

Map 3
Territorial distribution of the Yaqui River Irrigation District, 1952



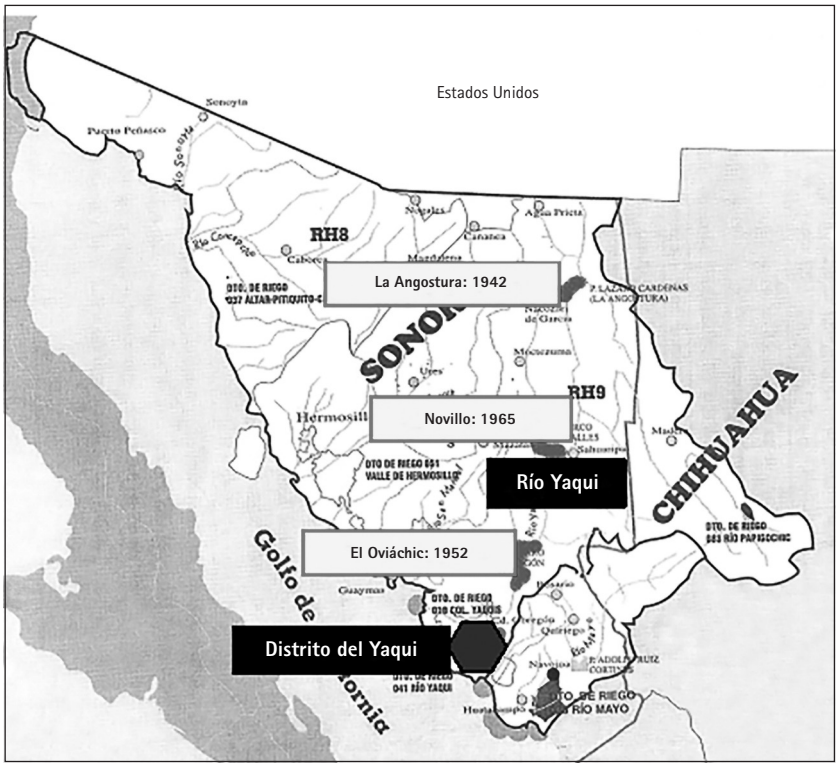
Source: AHA, multiple documents.

The expansion of irrigated and cultivated hectares would not abate. Much of this had to do with the agricultural, credit, and irrigation policies that both the federal government and the state of Sonora implemented from the end of the 1920s. Two more factors had come into play since 1925: the productive activity of ex-president Álvaro Obregón, on the one hand, and the incremental management of the afore-mentioned Banco de Crédito Agrícola, on the other. Thus, in the 1937-1938 cycle more than 52,000 ha had entered into production (Dabdoud 1964 [1955]: 331; Ortega Leite (n.d.: Table 3) and by the mid-1940s, when the La Angostura dam (Map 4) was finished, the system included more than 120,000 ha.

However, it was not until the start-up of the El Oviáchic dam (later renamed the Álvaro Obregón) in 1952 that the maximum capacity for surface irrigation was reached. According to a technical report from that year (Benassini 1952), the construction of La Angostura constituted the second stage "in the development of a large irrigation district." The new dam would make feasible "the exploitation of the total river runoff" and increase the

irrigated area to more than 220,000 ha. Although irrigation was its principal function, it would also generate almost 100 million kilowatts/hour per year in its hydroelectric plant, control dangerous river flooding and sediments, and stimulate aquatic fauna. Its basin would collect three 3 billion cubic meters of water, of which 1.5 billion were to be used for irrigation and electricity generation.

Map 4
System of dams and the Yaqui River Irrigation District (1936-1965)



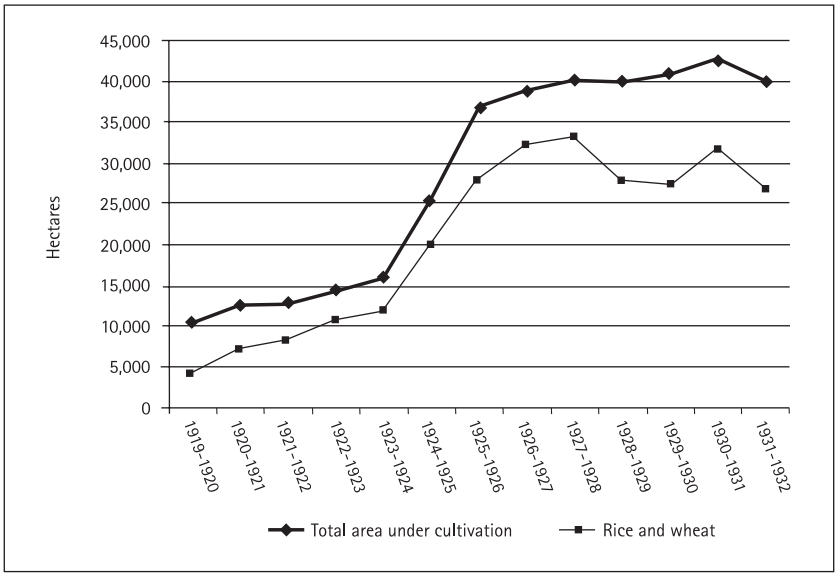
Source: AHA, several collections, multiple documents, and author's own work.

This irrigation district would go on to become one of the biggest in northern Mexico during the 1960s. It was developed in parallel to the growing involvement of both the federal government and the irrigators of Sonora, and was intended to encourage a form of agriculture capable of supplying and competing in the increasingly demanding domestic market (through the production of wheat, above all) and in the export market (through cotton production).

Green Revolution: the triumph of wheat

The expansion of production in the Yaqui Valley - under the shared domain of the state and capital - started off somewhat slowly but picked up markedly starting in the second half of the 1920s. Within this lively cycle of land occupation, which not even the Agrarian Reform of the 1930s could detain, certain crops stood out from the early years. Indeed, rice and wheat began to define not only a long-lasting rural landscape but also, at the same time, the agro-industrial character of the future Ciudad Obregón.[27] Graph 2 provides a synthesis of this period, showing how the sum of rice and wheat grown was close to the total number of hectares under crops prior to the start-up of the La Angostura dam.

Figure 2
Rice, wheat, and total planted area, 1919–1932 (in hectares)



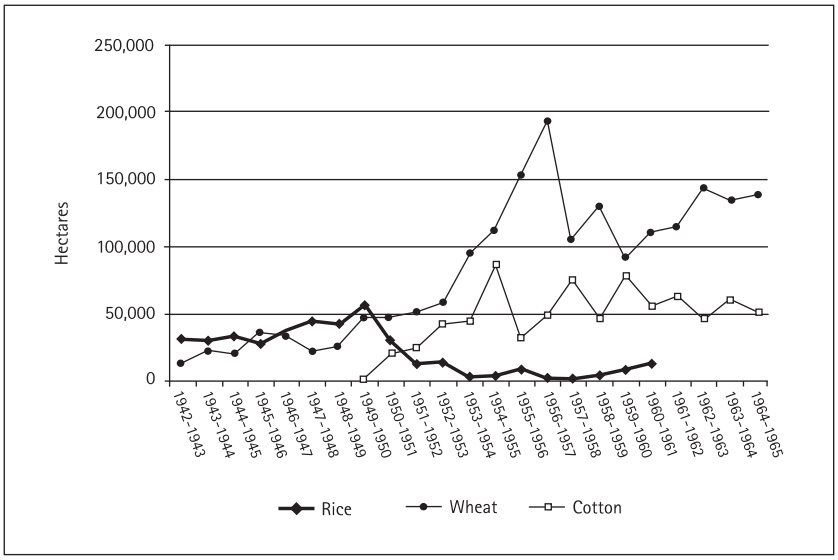
Sources: AHA, several collections, multiple documents.

The preeminence of rice and wheat continued until after World War II. Although in the long term wheat came to be regarded as the historical crop of the dry plains of the Yaqui, both rice and, subsequently, cotton experienced great boom periods. Cotton had to wait

27. On the concept of the agro-city and its application to Ciudad Obregón, see Cerutti (2006).

for the circumstances of the 1950s to enter a boom cycle that would endure into and throughout the 1960s. Graph 3 shows the abrupt emergence of cotton on Yaqui land and the near-simultaneous disappearance of rice.[28]

Figure 3
Rice, wheat, and cotton production, 1942-1965 (in hectares)



Source: AHA, several collections, multiple documents.

Certain conjunctures excepted, it is evident that wheat established itself as the predominant crop of the 20th century on these parched lands. Its agricultural and agro-industrial impact clearly marked both irrigation system usage and regional economic and business history. From the 1940s, wheat production in the south of Sonora stood out "in the national context for its considerably higher yields than the national average" (Hernández Moreno 2001: 157). This position was strengthened when the Sonoran agricultural valleys, with Yaqui at the forefront, were selected to introduce a new technological package: the **Green Revolution**, which "practically doubled the yields per hectare obtained ten years previously."

28. The cotton area harvested went from 3,600 ha in 1949-1950 to a peak of 86,800 ha in 1954-1955, which is close to the area harvested in La Laguna for certain years.

A renowned actor in this process was Norman Ernest Borlaug, an American whose great-grand parents immigrants to the United States from Norway. The son and grandson of farmers, Borlaug went on to obtain a Ph.D. in plant pathology. He arrived in Mexico in 1944 sponsored by a program jointly overseen by the Ministry of Agriculture and the Rockefeller Foundation.[29] One of his main interests was pest control, but at the same time, he planned to convert the local economy into one self-sufficient in wheat "in the least time possible time."[30] The success of the Green Revolution was based on "relevant and well-established agricultural research," which made possible an "extraordinary ability for adaptation combined with high genetic potential for yields," "notable efficiency in the use of high doses of fertilizers," and an "extensive capacity for resistance to diseases." From northern Mexico – irrigated by way of programs established and in evidence since the 1920s – not only was technology successfully transferred to Pakistan and India but, at the same time, a government policy was in place "that assured the agriculturalist of an adequate price for his grain," the "availability of the necessary inputs," (seeds, fertilizers, insecticides, herbicides, and machinery), and credit to obtain them on the market (Borlaug 1972: 6 and ff.)[31]. This was the basis of the Green Revolution in the midst of the ocher of the desert.

While Sonora consolidated itself as the "most important [wheat producer] in Mexico" (Dabdoud 1964 [1955]: 379), in Yaqui, the radical expansion of the irrigation system and the Green Revolution led to production of this cereal in excess of 100,000 hectares. In the statistical compendium, Annex 1 shows that between 1953 and 1965, wheat never accounted for less than 41% of the total harvested hectares, and there were times (such as 1955-1956) when its share was as high as 72%. An area under wheat of more than 100,000 or 120,000 hectares thus became the norm from the mid-1950s.[32]

29. A detailed description of the origins and beginnings of this project is found in Ortoll (2003).
30. Borlaug's proposal entailed "joining forces to produce varieties of wheat with greater yield potential, greater resistance to diseases, and with better agronomic characteristics [and] developing more appropriate production practices. The result [...] was the new Mexican varieties of wheat, which are now generally known, which produce astonishingly large yields, which are resistant to disease, and which facilitate intensive use of fertilizers. [Moreover] the new types can be transferred to remote parts of the world that differ in climate." (Aase Lionaes, president of the Norwegian Lagting, presentation speech for the 1970 Nobel Peace Price, retrieved from: www.nobelprize.org/nobel_prizes/peace/laureates/1970/press.html.).
31. At the conference in Oslo, after receiving the Nobel Peace Prize, Borlaug himself outlined some of his experiences in Mexico (1972: 6 and ff.).
32. In the 1980s, there were years (such as the 1987-1988 cycle) in which more than 150,000 ha of wheat were planted; later, in the 2000-2001, over 152,000 ha were planted (Hernández Hernández 2006: 39).

3.4 Cotton in its kingdom

In the large and medium-sized irrigation districts of northern Mexico, various production specializations were consolidated — some destined for the domestic market, and others (the majority) for export. Many assumed a structural character; that is, they were prolonged over decades and contributed to the definition of both the regional development profile and to a productive and business fabric that still endures in several places (Cerutti 2011a, 2011b). In historical terms, cotton would prove the most strategic objective of this state policy, as we will see below.

Territories and export capacity

Thirty years after the government of Plutarco Elías Calles, by the mid-20th century cotton production in several northern areas of Mexico had assumed the following characteristics: (a) it had expanded in a way that was consistent with a highly varied constellation of spaces; (b) it could be distinguished by its structural components, given that in certain areas it constituted the **leading crop** for agricultural development and its multipliers (La Laguna, Mexicali, Matamoros, Delicias), while in others, it flourished or diminished in response to the demands of markets through seasonal alternation with crops with a greater historical presence. This occurred in the Yaqui Valley, as has been noted, and in the El Fuerte and Culiacán valleys, where vegetable production tended to predominate; and (c) in various niches in the northern group of states, where fibers of wide-ranging quality were produced.

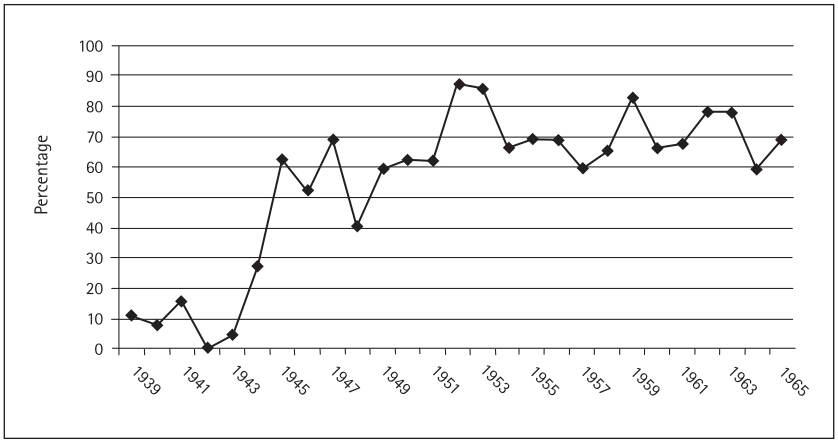
Without going into detail regarding the variations in the classification of cotton fiber internationally, the fact is that Matamoros, the Juárez Valley, and Mexicali had the capacity — in terms of quality, seasonality, and/or location — to place their product on the international market regularly and effectively, while districts like La Laguna, Culiacán, El Fuerte, Yaqui, and Costa de Hermosillo catered to both the foreign and domestic markets.

Little by little, with the firm backing of the state (and responding to its most pressing needs), cotton became a **strategic raw material** for the economic policy of the federal government. What is meant by "strategic"? That cotton as a raw material was gradually becoming a **near-decisive** or **conditioning factor** in the financing or subsidizing of many of the economic development plans of the country.[33]

33. The impacts of cotton production on regional development are beyond the scope of this study. For more on this subject, see Cerutti and Almaraz (2013).

If during the turbulent years between 1925 and 1940, cotton emerged somewhat timidly as a commercial crop sold on domestic and foreign markets (with emphasis on the former), from World War II onwards, it became a raw material that was primarily for export.[34] Indeed, there were years when more than 85% of the harvested bales were exported, and frequently, the proportion sold abroad exceeded 70%.[35] Figure 4 clearly shows this percentage increase in export capacity for the first three years of the 1940s.

Figure 4
Cotton exports, 1939-1965 (in percentages of total production)



Sources: *Algodón Mexicano* (1960: 1, 1966: 31); Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendix 12); Argüello Castañeda (1946: 212); González Santos (1967: 58).

Furthermore, Mexico, without becoming one of the planet's largest cotton producers, ranked in the 1950s as one of the biggest worldwide exporters. Table 3 shows that in the 1955-1956 and 1958-1959 cycles, it occupied second place, and in that in the 1950s it was consistently in the top three exporting countries alongside powers such as the Soviet Union, Egypt, and Pakistan.

34. "Cotton is a crop that [...] has become increasingly dependent on the export market. In 1950, 62.5% of the harvest was exported; in 1955, 69.3%, and in this decade so far [...] almost three quarters" (Unión de Productores de Algodón de la República Mexicana 1968: 15).
35. Algodón Mexicano (1960: 1; 1966: 31); Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendix 12); Argüello Castañeda (1946: 212); González Santos (1967: 58).

Table 3
Main cotton-exporting countries, 1952-1959

Ranking	1951-1952	1952-1953	1953-1954	1954-1955	1955-1956	1956-1957	1957-1958	1958-1959
1°	United States	United States	United States	United States	United States	United States	United States	United States
2°	Soviet Union	Egypt	Soviet Union	Soviet Union	**Mexico**	Soviet Union	Soviet Union	**Mexico**
3°	**Mexico**	Pakistan	Egypt	**Mexico**	Egypt	**Mexico**	**Mexico**	Soviet Union
4°	Egypt	Soviet Union	Brazil	Egypt	Soviet Union	Egypt	Egypt	Egypt
5°	Pakistan	Mexico	**Mexico**	Brazil	Brazil	Pakistan	Syria	Sudan

Source: López Hurtado (1961: Figure 1).

King Cotton

The importance of cotton during the postwar period can be measured in a number of ways, including the following: (a) the explosive growth in gross production of the fiber; (b) its rising value as compared with the other crops comprising the then highly dynamic agricultural sector; (c) its growing strategic importance compared with other export commodities, in terms of both foreign exchange revenues and fiscal impacts; and (d) its numerous multipliers in the domestic market, the supply chains, and mass employment of the workforce, and its impact on regional economic structures (agro-industry, services, finances, employment, technological change, applied research, trade, mechanization, and rural electrification). We will now review the first three of the above.

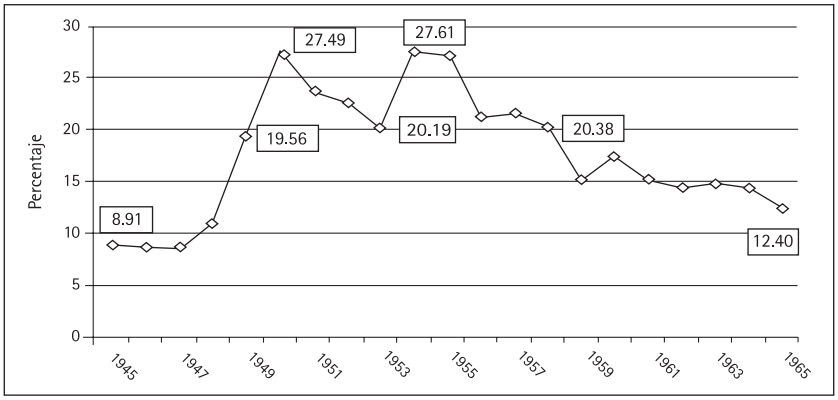
A. Annex 2 shows the explosive growth of the cotton harvest between 1940 and 1965.[36] While a little over 250,000 bales per year were harvested at the outbreak of World War II, the total exceeded 1 million by 1950, and the long-awaited target of 2 million was reached by 1955. The cycle analyzed here closes in 1965 with another record harvest: more than 2.5 million bales.[37]

36. This was based in turn on its territorial expansion. In 1945, "the total area under crops of all types rose in Mexico to 6.4 million hectares, and in 1969 it increased to 12 million [...]. The same path was followed by cotton. In 1945, this was 366,000 hectares and in 1961, 794,000. In 1955 and 1968, the area under cotton exceeded one million hectares" (Confederación de Asociaciones Algodoneras de la República Mexicana 1963: 16).

37. See: López Hurtado (1961: Table 11); *Algodón Mexicano* (1960-1975); Argüello Castañeda (1946: 65); González Santos (1967: Table 3, 46); Unión de Productores de Algodón de la República Mexicana (1968: 12-13); Quintanar (1962: 175-176); Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendices 7 and 10).

B. The years between 1940 and 1960 were among the most spectacular in the contemporary history of the Mexican agricultural sector. In the first of these decades, average growth was 7.2%, with a per capita increase of 4.5% (Guzmán Ferrer 1975: 573).[38] This rate was sustained for much of the 1950s. The dynamic was evident in the substantial expansion of the agricultural frontier under irrigation, as well as the increase in production levels which characterized the Green Revolution, with cotton as the key example.[39] In these years, specifically, the production value of cotton increased greatly within overall agricultural production value (González Santos 1967: 43). In 1950, 1954, and 1955, it even surpassed 25% of total agricultural value, undoubtedly facilitated by its export capacity.[40] Graph 5 also shows the strong impact of the relative values of cotton (as well as the beginnings of its collapse at the beginning of the 1960s).

Figure 5
Cotton values versus total agricultural production, 1945–1965 (in percentages)



Sources: see Footnote 36

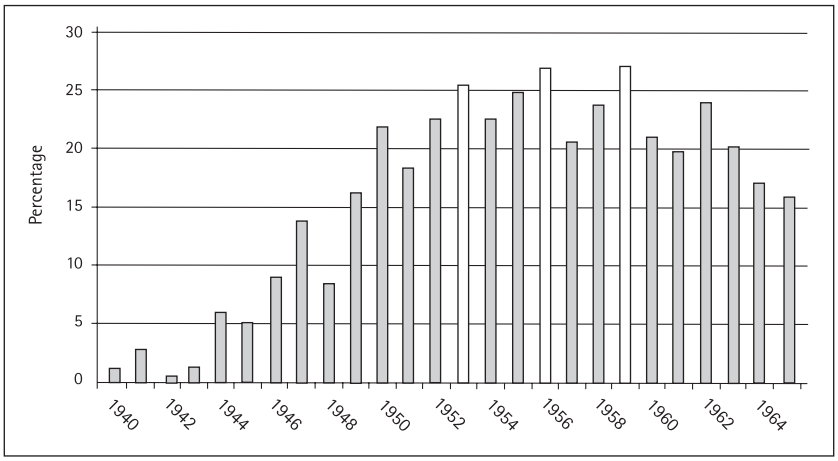
38. Víctor Urquidi (2005: 192), comparing Latin American countries after 1930, points out that until before 1965, Mexico had "the highest rate of agricultural growth: 6.4% per year." This pattern "constituted one of the leading rates in the expansion of agricultural production in the world during this period."
39. "From 1945 to 1955, Mexican agriculture had its period of highest growth: a spectacular 6% per year. This great expansion was driven by the incorporation of new lands into crop production, large irrigation works, and the introduction of modern inputs and technology" (Luiselli and Mariscal 1995: 440). These authors stress that cotton stands out among the most dynamic crops "by growing at 14.5% per year." According to Tavares Navarro, the research sponsored in Mexico by the Rockefeller Foundation and by government agencies "was focused on the development of capital-intensive technology applicable only in relatively well-endowed areas, or in those that could be created through large irrigation projects (in states such as Sonora, Sinaloa, and Tamaulipas, primarily). The new technology adapted [...] was that which, as the years went by, culminated in the Green Revolution" (Tavares 1986: 101). See also: González Hinojosa (1966: 35); Urquidi (2005: 192).
40. See: Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendix 5); Unión de Productores de Algodón de la República Mexicana (1968: 15).

C. The strategic importance of agricultural exports and especially cotton, at least until the end of the 1950s, has been stressed by various analysts of Mexican economic history. Enrique Cárdenas even goes as far as to say that "for years the agricultural sector replaced mining as the engine of economic growth." He also underlines that "cotton, the main export product, saw spectacular growth [...]. Of course, agricultural exports grew at a rate of 9.7% between 1951 and 1956" (Cárdenas 2000: 31, 36, 41, 73 and ff.). Jacques Chonchol, a Chilean expert who visited Mexico in the 1950s, stated that agricultural exports had tripled between 1945 and 1955 "thanks above all to the extraordinary increase in cotton production and exports" (1957: 1-2). A study carried out in the early 1970s shows that "the great cotton boom, above all between 1946 and 1953" was due to cotton's status as an exportable raw material (Reyes Osorio 1974: 95).[41] All of this explains and justifies the need to recall the importance of cotton exports compared with overall Mexican foreign trade. Indeed, Graph 6 shows the impressive scale and impact of cotton on foreign trade, constituting in some years of the 1950s **more than one quarter of the country's export value**.[42] Not without foundation, the Confederation of Cotton Growers' Associations (Confederación de Asociaciones Algodoneras) asserted in 1963 that the fiber "had become one of the most important sources of wealth for the nation."[43] For its part, in 1968, the influential Union of Cotton Producers of the Mexican Republic (Unión de Productores de Algodón de la República Mexicana) stated that:

> For more than 20 years, cotton had been the main export good and therefore the most important source of foreign exchange. In the period 1960-66, cotton sent to other countries made up [...] 20% of all goods exported. The foreign exchange generated by cotton in 1966, for example, [was] more than enough to finance all Mexican imports of vehicles, tractors, velocipedes, and other modes of land transport and their parts in that same year. Thus, if this source of foreign currency were to suddenly disappear, the transportation of goods and passengers, in an even shorter period, could come to a halt (Unión de Productores de Algodón de la República Mexicana 1968: 15-17).

41. See also Solis (1971: 125 and ss.).
42. See: González Santos (1967: 56); López Hurtado (1961: Tables 1, 2, 4); González Hinojosa (1966: Tables 17, 19); Unión de Productores de Algodón de la República Mexicana (1968: 17).
43. This was derived from the great expansion of the crop; in 1945 it was 366,000 ha; in 1950, 761,000 ha; and in 1955 it had exceeded one million. And while annual cotton production "in the last 20 years has almost doubled, that of Mexico has quadrupled" (Confederación de Asociaciones Algodoneras de la República Mexicana 1963: 3-4).

Figure 6
Cotton export values versus total foreign trade, 1940–1964 (in percentages)



Sources: González Santos (1967: 56); López Hurtado (1961: tables 1, 2, 4); González Hinojosa (1966: tables 17, 19); *Algodón Mexicano* (1966: 32); Unión de Productores de Algodón de la República Mexicana (1968: 17).

Cotton provided the state with a substantial proportion of its foreign exchange. This was a fact frequently stressed by the Confederation of Cotton Growers' Associations: between 1958 and 1962 "almost one billion dollars from the export of cotton lint" had been accrued (Confederación de Asociaciones Algodoneras de la República Mexicana 1963: 19-20).[44]

With respect to taxation, the discussions and disputes regarding the numerous taxes were never-ending. There were federal taxes, as well as those set by states and municipalities. These different layers of public administration sought to extract some or a great deal of the farmers' prosperity, which was as uncertain as it was voluminous. "Our public treasury has found a significant source of revenues in the multiple taxes levied upon cotton-growing activities," complained the producers' associations in 1964. These taxes were "not only federal, since there are also state and municipal ones." While the federal government imposed a duty of 106.75 pesos for each cotton bale exported, municipalities and states collected "considerable [taxes] on the production, ginning, trade, and industrialization of cotton products" (Confederación de Asociaciones Algodoneras de la República Mexicana

44. In relation to the other significant generators of foreign exchange - coffee, the second largest; and lead - the absolute and relative distances were staggering. According to certain sources (which are not always in agreement), in 1956 cotton accounted for 32.59% of the total export value, as compared to 13.02% for coffee. In 1958 the figures were 26.83% and 11.1%, respectively.

1963: 25).[45] Annex 3 illustrates cotton's contribution to taxation as a percentage of the total collected by the federal government in export duties. The figures leave no doubt about the federal government's obvious dependence on this product (and on agriculture in general).[46] In 1962 and 1965, cotton comprised 55% and 62%, respectively, of the total collected. It was on this basis that the funding of development and, in part, social welfare policies was made possible. For this among other reasons, cotton was regarded as **a strategic raw material** during the period analyzed.

3.5. Cotton in the north of Mexico

The great Mexican north, from Matamoros to Mexicali and La Laguna to Yaqui Valley, played a fundamental role in this process. Irrigation policy — launched in 1925, consolidated in the mid-1930s, and put into effect through large works between 1940 and 1970 — was decisive for the gigantic agricultural front utilized for cotton, whether structurally or according to the conjuncture.[47] The figures, though they differ depending on the source, institution of origin, or authors, were striking to say the least. A review and comparison of the different sources shows that cotton not only reigned under the northern sun; it can also be inferred that from its irrigated deserts flowed a sizable portion of the revenues that fed the ever-voracious public finances. The relevant figures and proportions are provided by the following overview:

A. Annex 4 shows cotton production percentages in 1950 and 1960 in certain districts, details the most outstanding areas in the northern space, and compares these areas with other niches located in the center and south. In 1950, 97.3% of cotton production was harvested in the north, while in 1960, when some southern areas had begun to flourish,[48] the proportion was 94.7%. Figure 7 provides a cogent illustration of this phenomenon in 1950.

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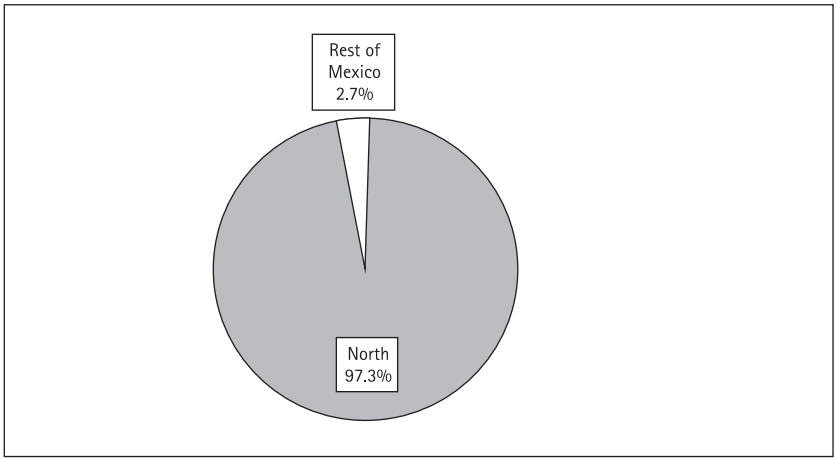
45. González Santos stated in 1967 that cotton "as a product is subject to different taxes as per the policy followed by the municipalities, states, and the Federal Government itself." Subject to "municipal, state, and federal taxes," this rendered critical the situation of indebted farmers, who were prevented from investing in and achieving increases "in production and in yield" (González Santos 1967: 83).
46. According to González Hinojosa (1966: 63, Table 18), among the most evident advantages of agricultural exports were "the increase in foreign exchange inflows necessary for the purchase of productive assets" and their constituting an "important source of income for the Public Sector." Coffee and tomatoes, for their part, comprised 23% of total revenue from export duties in 1958; 20.7% in 1964; and 21.45% in 1965.
47. "Almost three-quarters of the Mexican government's total investment in the large irrigation works undertaken between 1926 and 1958" went to "the north and northwest, and only 26% to the other areas of the country" (González Jameson 1966: 31, 32). See also Tavares Navarro (1986: 120) and the assessment of Aboites Aguilar (1987).
48. Especially Apatzingán, in Michoacán.

Figure 7
Cotton production, north vs the rest of Mexico, 1950 (in percentages)



Source: Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendix 9).

B. Tables 4 and 5 indicate a similar phenomenon, taking into consideration the planted area and production of cotton during the period 1940–1965 (Algodón Mexicano 1966: 31). The sources incorporate the percentages of production and the gradual geographical shift of the crop, both within the north and towards central-southern Mexico.

Table 4
Crop geography, area, 1940–1965

Area (%)	1940	1950	1960	1965
Mexico	100.0	100.0	100.0	100.0
North	96.6	91.3	95.1	89.4
Rest of the country	3.4	8.7	4.9	10.6

Source: *Algodón Mexicano* (1966: 31).

Table 5
Crop geography, production, 1940–1965

Area (%)	1940	1950	1960	1965
Mexico	100.0	100.0	100.0	100.0
North	97.1	91.7	95.5	89.6
Rest of the country	2.9	8.3	4.5	10.4

Source: *Algodón Mexicano* (1966: 31).

C. Tables 6 and 7 refer to three specific harvests (1955-1956, 1960-1961 and 1965-1966 [García Ortiz 1976: annexes 13-15]). With respect to the planted area, the north went from 95% to more than 99%, and, in the case of production (bales), from almost 100% to a little over 90%.

Table 6
Planted area, north vs. the rest of the country, 1955–1966

Harvest	Bales	North	Percentage	Rest of the country	Percentage
1955-1956	1,058,990	1,054,304	99.58	4,686	0.42
1960-1961	872,663	832,658	95.41	40,005	4.59
1965-1966	792,251	762,360	96.23	29,891	3.77

Source: García Ortiz (1976: annexes 13-15).

Table 7
Production, north vs. the rest of the country, 1955–1966

Harvest	Bales	North	Percentage	Rest of the country	Percentage
1955-1956	2,210,752	2,206,066	99.79	4,686	0.21
1960-1961	2,065,528	1,958,028	94.79	107,500	5.21
1965-1966	2,578,545	2,323,676	90.11	254,869	9.89

Source: García Ortiz (1976: annexes 13-15).

D. Tables 8 and 9 (*Algodón Mexicano* 1960-1970) show that changes in the proportions began to become apparent in the 1960s, both in terms of planted hectares and bales harvested. In the same period, the central-southern areas (in Michoacán and Chiapas) made relative progress in cotton production, though the north - albeit to a less striking extent - continued to predominate. Within the northern space, on the other hand, the northeastern coastal strip stands out, especially Sonora. Meanwhile, Mexicali in Baja California experienced sporadic prominence; the north of Tamaulipas was depleted;[49] the south of this same state took on new importance; and the small niche of Baja California Sur started to feature in the statistics.

49. For the crop's slow shift towards Altamira, Apatzingán, Tapachula, and La Paz, see González Santos (1967: 48-50).

Table 8
Planted area in hectares, north vs. the rest of the country, 1959-1969

Harvest	Hectares	North	Percentage	Rest of the country	Percentage
1959-1960	891,812	867,812	97.31	24,000	2.69
1961-1962	815,577	755,777	92.67	59,800	7.33
1962-1963	834,286	767,886	92.04	66,400	7.96
1965-1966	792,851	721,851	91.04	71,000	8.96
1966-1967	701,289	632,289	90.16	69,000	9.84
1967-1968	691,000	611,000	88.42	80,000	11.58
1968-1969	700,790	611,075	87.20	89,715	12.80

Source: *Algodón Mexicano* (1960-1970).

Table 9
Bales harvested, north vs. the rest of the country, 1959-1969

Harvest	Bales	North	Percentage	Rest of the country	Percentage
1959-1960	1,907,637	1,848,637	96.91	59,000	3.09
1961-1962	1,946,329	1,792,529	92.10	153,800	7.90
1962-1963	2,401,470	2,165,270	90.16	236,200	9.84
1965-1966	2,578,545	2,323,765	90.12	254,780	9.88
1966-1967	2,208,621	1,987,677	90.00	220,944	10.00
1967-1968	2,200,000	1,950,000	88.64	250,000	11.36
1968-1969	2,401,141	2,136,991	89.00	264,150	11.00

Source: *Algodón Mexicano* (1960-1970).

In short, almost the entire **modern history of cotton** in Mexico unfolded in the vast northern space which borders in the United States. The project to create an effective agricultural north became - thanks in no small part to cotton, as was envisaged from the 1920s - one of the shrewder strategies for stabilizing the trade balance, fueling the ever-pressed public finances, boosting regional development policies, and, gradually but increasingly, promoting industrialization. The crop's golden period started during World War II, when the ambitious irrigation plans began to come to fruition. Thus, the **cotton dynamic** – the backbone of Mexican agriculture's boom period – meant that the prosperous 1950s and 1960s were driven by the north[50].

50. Two indispensable works about the modern history of cotton in Mexico, approached from the perspective of the north and this area's relationship to U.S. spaces, are Walsh (2010) and Aboites Aguilar (2013).

4. FINAL COMMENTS

4.1 If we define a **state policy** as a long-term project that is applied more or less systematically regardless of changes of government and heads of state, we can assert that something akin to this occurred in Mexico during the 20th century.

4.2 It is highly likely that the following were factors contributing to this long-lasting policy: (a) though individual governments changed, the one-party system remained;[51] (b) a post-revolutionary state with an urgent initial need for resources and lacking the revenues that mining had generated during the period 1885-1910; (c) the geographical and territorial proximity of the biggest capitalist market: the United States; (d) the pressing need to mollify the effervescent Mexican rural scene; (e) the formidable need to prevent such a powerful neighbor as the U.S. from appropriating the border rivers; and (f) the obviously Keynesian criteria (albeit predating Keynes) regarding the use of the state as a decisive and/or functional instrument in economic matters.

4.3 The large irrigation works helped to consolidate the sociopolitical project of agrarian reform, leading to a broader and more effective distribution of land and water and turning certain regions into specialized production areas for both foreign markets (cotton, vegetables) and domestic consumption (wheat, sorghum, cotton, vegetables).

4.4 It is also worth noting the following visible consequences: (a) the considerable expansion of irrigated areas through a policy unprecedented in its scale in Latin America; (b) the resulting structural importance of agriculture, especially that controlled by the private sector; (c) the corresponding increases in productivity in an increasingly capitalized rural world; (d) the rise of regional business hubs in keeping with the proposal devised by the Sonorans; and (e) the financing, through hard currencies and export duties, of the most extensive development proposals and efforts aimed at attenuating social inequity.

51. Founded by Elías Calles after the assassination of Obregón in 1928, it is now called the Institutional Revolutionary Party (Partido Revolucionario Institucional, PRI).

4.5 In the specific case of the north, this policy achieved objectives such as: (a) irrigating and **agriculturalizing** vast tracts of desert; (b) converting it into an agricultural area with entrepreneurial characteristics and an evident capacity, in some cases, to compete on foreign markets[52]; (c) rendering arid or semi-arid regions productive in a process comparable or in parallel to that employed in Texas, Arizona, or New Mexico; (d) sponsoring regional development mechanisms built on agricultural foundations; (e) constituting the principal setting for large-scale hydraulics, that is, for transferring and applying cutting-edge technologies to the construction of dams and canals; (f) populating the desert through the transfer of thousands of workers to irrigation districts, a phenomenon that accompanied urban growth; and (g) ensuring the emergence, in areas where these were previously non-existent or very weak, of multiple business activities linked to agriculture (agro-industry, banking, and financial intermediation, services, specialized commerce, transport).

52. Recent research has borne this out extensively (Cerutti 2011b). What happened in these northern areas produced the opposite results to those corresponding to urban industrial activity which, with few exceptions, grew under the excessive protection of its extremely limited domestic market.

STATISTICAL SUPPLEMENT

Annex 1
Wheat in Yaqui, 1952–1965 (in hectares)

Harvest	Wheat harvest (a)	Total harvest (b)	Ratio (a) / (b)
1952-1953	56,755	126,027	45.03
1953-1954	94,283	154,427	61.05
1954-1955	113,267	209,493	54.07
1955-1956	154,039	213,746	72.07
1956-1957	143,110	221,848	64.51
1957-1958	105,126	212,594	49.45
1958-1959	130,500	226,492	57.62
1959-1960	90,799	22,311	41.03
1960-1961	110,685	258,916	42.75
1961-1962	114,546	255,626	44.81
1962-1963	143,504	234,853	61.10
1963-1964	134,016	256,079	53.33
1964-1965	138,392	263,913	52.44

Source: Silos-Alvarado (1968: Table 3, adaptation)

Annex 2
Cotton production, 1940–1965 (in thousands of bales)

Year	Bales	Year	Bales
1940	284.8	1953	1,190.0
1941	253.1	1954	1,699.7
1942	447.6	1955	2,210.7
1943	503.8	1956	1,851.1
1944	461.4	1957	2,078.3
1945	424.3	1958	2,287.8
1946	396.2	1959	1,678.5
1947	417.1	1960	2,065.5
1948	520.3	1961	1,967.3
1949	903.0	1962	2,372.1
1950	1.130.6	1963	2,057.2
1951	1.250.5	1964	2,361.7
1952	1.150.2	1965	2,578.5

Sources: López Hurtado (1961: Table 11); *Algodón Mexicano* (1960-1975); Argüello Castañeda (1946: 65); González Santos (1967: Table 3, 46); Unión de Productores de Algodón de la República Mexicana (1968: 12-13); Quintanar (1962: 175-176); Confederación de Asociaciones Algodoneras de la República Mexicana (1963: appendices 7 and 10).

Annex 3
Total and cotton export duties, 1955–1965 (in millions of pesos)

Year	Impuestos recaudados		
	Total (a)	Cotton (b)	Ratio (b) / (a)
1955	1,464.1	356.0	24.31
1956	1,265.4	426.1	33.68
1957	1,186.5	286.7	24.16
1958	1,087.0	344.4	31.68
1959	976.7	409.5	41.93
1960	950.6	319.4	33.60
1961	807.0	308.2	38.19
1962	761.0	423.7	55.68
1964	880.7	323.2	36.70
1965	666.1	413.1	62.02

Source: González Hinojosa (1966: Table 18).

Annex 4
Cotton production by agricultural district: 1950 and 1960 (in percentages)

Cotton-producing area	1950 (%)	1960 (%)
Norte	**97.3**	**94.7**
La Laguna	21.6	15.0
Mexicali Valley	19.6	18.0
Matamoros	30.7	18.2
Delicias	5.3	8.7
Juárez Valley	4.6	3.2
Don Martín	3.6	1.0
Sinaloa and Sonora	11.9	306
Rest of the country	2.7	5.3
México	**100.0**	**100.0**

Sources: Confederación de Asociaciones Algodoneras de la República Mexicana (1963: Appendix 9).

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