AGRICULTURE, DROUGHT, AND CHUMASH CONGREGATION IN THE CALIFORNIA MISSIONS (1782-1834)

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In examining European-Native American interaction in the centuries following 1492, scholars have studied missions as an interface of cultural, religious, and social change. One question that has received attention is why native peoples abandoned their traditional way of life in favor of the missions, which, as recent studies have shown, could become unhealthy and in some instances very exploitative.[1] In particular, the question of the motives of native peoples for accepting life in the missions has gained recent scholarly attention in the case of the California missions operated by the Spanish government and staffed by the Franciscans between 1769 and 1834.

In a study of the decline and collapse of tribal life in the San Francisco Bay region, Randall Milliken suggested a number of motives for native peoples to enter the missions. Initially, some Indians were attracted by a desire to take part in something new, and perhaps obtain new material goods brought by the Spaniards. However, as disease and mission livestock spread, the missions became the only option available. The Indians lost faith in their traditional way of life that could not cope with the changed circumstances. Moreover, the political and social system, trade, and festival networks collapsed. Newly introduced livestock destroyed food resources. Finally, disease and migration reduced the size of villages, leaving them vulnerable to attacks by interior groups.[2]

[1] Robert H. Jackson, *Indian Population Decline: The Missions of Northwestern New Spain, 1687-1840* (Albuquerque, 1994); Robert H. Jackson and Edward Castillo, *Indians, Franciscans and Spanish Colonization: The Impact of the Mission System on California Indians* (Albuquerque 1995); Erick Langer and Robert H. Jackson (eds.), *The New Latin American Mission History* (Lincoln 1995).

[2] Randall Milliken, *A Time of Little Choice The Disintegration of Tribal Culture in the San Francisco Bay Area, 1769-1810* (Menlo Park, 1995).

Another recent study that built on earlier lines of interpretation interjected environmental factors and the risk minimalization theory to explain why the Chumash entered the missions, and did so quite rapidly; 85% of the Chumash entered the missions between 1786 and 1804, and more than 1 200 moved to the missions in the year 1803 alone. Based on an analysis of climatic variability and shifts in sea surface temperatures caused by El Niño effects, this interpretation maintained that Chumash consciously elected to move to the missions to minimize the risk of variable food supplies caused by unpredictable weather and disruption of Santa Barbara Channel fisheries. The collapse of traditional trade and political alliances coupled with the impact of epidemics and subsistence insecurity made the missions an attractive alternative to a dying traditional way of life.[3]

Dendroclimatic, sea surface temperature data, and archaeological and ethnohistorical evidence seems to support the contention that climatic variability, both dry and excessively wet years, was increasing during the pre-mission (1670-1750) and mission (1780-1830) periods. Tree rings show dry years/drought in 1794-1795, 1805-1813, and 1821-1825. There was also a strong El Niño effect in 1815-1816 that disrupted the Santa Bárbara Channel fishery, and caused a famine among the Santa Rosa Chumash, a group that depended heavily on the fishery.[4] Skeletal remains from pre-mission and mission periods show evidence of nutritional stress, such as Harris lines.[5]

Studies of Chumash congregation have pointed to a relationship between food supply and the decision to relocate to the emerging mission communities, but in doing so have largely ignored other broader and complex social, economic, and political factors that may have contributed to the decision to move to the missions. The ecological thesis provides a compelling explanation for the Chumash groups wholly dependent on fish and other marine animals as sources for food, and who probably saw the missions as a more reliable source of food during a period of decline in the local fisheries. However, the discussion of rainfall variability as a source of subsistence insecurity needs further

[3] Daniel Larson, John Johnson and Joel Michaelson, "Missionization Among the Coastal Chumash of Central California: A Study in Risk Minimalization Strategies," *American Anthropologist* 96:2 (1994), p. 263-299. In an earlier study titled "The Conversión of the Chumash. An Ecological Perspective", *Human Biology* 5 (1977), p. 309-328, Gary Combs and Fred Ploogh argued that a statistical analysis of baptisms and agricultural production at Santa Barbara mission through the year 1804 showed a strong relationship, but that after 1804 the relationship was much weaker.

[4] *Ibid*., p. 272-274, 281-282.

[5] *Ibid*., p 286-287.

refinement, particularly as regards the mainland groups that relied more heavily on plant foods and hunting, supplemented by trade with coastal groups. Tree ring analysis provides an idea of the range of wet, normal, and dry years, but does not provide specific evidence for the affect of variable rainfall on the plant foods the Chumash depended on. Did low or excessive rainfall substantially reduce the supply of acorns, grass seeds, and other plant foods? Moreover, if the insecurity of traditional food sources caused by climatic variability was a factor that pushed the Chumash into the missions, what affect did the same climatic variability have on the agricultural based mission economies? Furthermore, was the mission food supply a strong pull factor for the Chumash to enter the missions? An alternative interpretation might be that the influx of population and labor enabled an expansion of grain production to satisfy the needs of the growing mission populations, and of the Spanish military stationed in the province and supplied by mission surpluses.

As argued elsewhere, tree ring analysis provides the general range of rainfall levels, but equally important was when rainfall occurred.[6] In the case of agriculture, low rainfall during the farming cycle will not necessarily lead to crop loss. A drought following the planting of a crop could lead to losses, but lower but fairly constant rainfall throughout the maturation of a crop might lead to smaller harvests, but not crop failure. The same might apply to the wild plant foods the Chumash relied on. For example, prolonged drought might significantly reduce the acorn crop, but low rainfall levels over a longer period might not? Drought also affects individual fields differently. For example, plants in the center of a field may receive less water and would wither, whereas the plants on the edges would not. The impact of drought was anything but uniform.

This essay re-examines the relationship between mission agricultural production and the decision made by Chumash to abandon their traditional way of life in favor of a radically new life in the missions, but within a comparative context that relies on data for other California missions. It tests population and grain supply, and the performance of different cultigens during the years identified by tree ring analysis as having been characterized by extremely variable but generally dry weather. It draws on data on grain production for four missions established among the Chumash: San Luis Obispo (1772), San Buenaventura (1782), Santa Bárbara (1786), and La Purísima (1788). Within a larger

[6] Robert H. Jackson, "The Changing Economic Structure of the Alta California Missions-A Reinterpretation," *Pacific Historical Quarterly* 61:3 (1992), p. 387-415.

context this study examines the reliability of tree ring analysis for measuring potential agricultural production levels, using an extensive data set of figures for actual agricultural production abstracted from detailed annual reports prepared by the missionaries stationed at each establishment. It also explores in a broader sense the factors that led California natives to enter the missions, and the ways in which the introduction of European agrarian economies modified or changed the way of life of non-European populations brought under colonial control.

Grain supply offers a stronger basis for discussing the amount of food available to the Indians congregated on the missions, although there are also limitations to its use. The missionaries directed the raising of large herds and flocks of cattle, sheep and goats, and horses, but most of the animals were not used to supplement the diet of the Indians. The missionaries had cattle slaughtered to produce hides and tallow, and sheep produced wool and hence were generally not slaughtered for meat. After 1800, the Franciscans also exported hides and tallow. The Franciscans also supplied the military garrisons in California with food, and had to set grain aside for future planting.[7] However, grain did constitute the largest part of the diet of the Indians in the missions.

Congregation and Food Supply

We have tested twenty year samples of data on the population of selected California missions and total grain production, using two statistical tests: regression and correlation; that establish the level of statistical significance between two or more variables.[8] The first tested the relationship between population and total grain production at five missions: San Diego (established 1769); San Gabriel (established 1771); San Antonio (established 1771); San Carlos (established 1770); and Santa Clara (established 1777). The sample years chosen are 1785-1804 and 1812-1831. The results reproduced in Table 1 suggest a weak statistical relationship existed between the two variables.

We ran the same tests for the four missions established among the Chumash, with somewhat different results (see Table 2). The adjusted

[7] *Ibid*.; Robert H. Jackson, "Population and the Economic Dimension of Colonization in Alta California: Four Mission Communities," *Journal of the Southwest* 33:3 (1991), p.387-439.

[8] For a similar although not as extensive analysis see Robert H. Jackson, "Grain Supply, Congregation, and Demographic Patterns in the Missions of Northwestern New Spain: Cases from Baja and Alta California," *Journal of the West* 34:1 (1997), p. 19-25.

r2, the t-statistic, and the correlation coefficient were high for both samples from San Buenaventura and Santa Barbara, somewhat lower for La Purísima, and lower still for San Luis Obispo. Clearly, patterns for three of the missions established among the Chumash were different than for the other missions in the region. The question remains as to the significance of this finding. Does it establish a conclusive relationship between food supply and population, or labor and production?

A second set of data suggests that the relationship between food supply and congregation was weak, although the nature of the evidence is such that it only supports the suggestion of a hypothesis. It consists of total grain production and the number of baptisms of converts only recently settled on the missions, which is a more accurate indication of a possible cause and effect relationship between population levels and the food supply as measured by grain production. We have taken twenty year samples for San Luis Obispo (1785-1804) and Santa Inés (1804-1823) missions, and again tested the data using regression and correlation. For San Luis Obispo the statistical tests show a weak relationship, but a somewhat stronger relationship for Santa Inés (see Table 3). In other words, grain production had only a weak to moderate relationship to the number of converts entering the missions.

The Performance of Mission Agriculture

The dendroclimatic criteria used by Larson *et al.,* as the basis for the analysis of the risk minimalization hypothesis suggests that mission crops might also have been deficient during the years the tree rings identified as having been dry. Any analysis of mission agriculture must first begin with a description of the crops being grown. Wheat was the single most important crop cultivated, and, as indicated above, was grown during the winter when coastal California receives most of its rainfall. Corn and barley were secondary crops, and the relative importance of the two varied from mission to mission. The Franciscans directed the planting of corn in the spring, and barley in the spring or summer. At San Luis Obispo corn was far more important than barley, and barley was not even planted most years. Corn and barley were of about equal importance at San Buenaventura and Santa Barbara, while corn was more important at La Purísima (see Appendix).

The data on agricultural production analyzed includes the reported amount of grain sown and harvested reported as fanegas and almudes. It is used to calculate the ratio of grain harvested to grain sown, and indices of grain sown and harvested. These data are presented as five year means, and show the variations in harvests and productivity. Variations in production levels and productivity could be caused by a variety of factors, including too little or too much rain at key points in the agricultural cycle, the destruction of crops by insects such as grasshoppers and other vermin, and in the case of production levels decisions about the amount of grain to be sown from year to year and labor shortages.

Table 4 summarizes five year mean ratios of grain harvested: sown for the two larger sample periods. An average return for wheat would be about a ratio of 10, and for corn from 50-100. The ratio shows considerable variation over time, and in particular the decade between 1822 and 1831 showed diminished returns for wheat and corn at all four missions, and barley at the three missions where it was an important crop. A number of factors may explain the poor returns. Climatic variation certainly was an important factor, but other variables must also be considered. In the late 1820s (1827-1831), the Franciscans directed the planting of less wheat at all four missions, and less corn at two (see Table 5). The decision to plant less most likely was related to rapid declines in the Indian populations at the missions, and thus the availability of less labor to harvest the crops. The annual reports from San Luis Obispo and other missions mention the scarcity of labor, and the chronically ill Indian adults who could not work as hard as the missionaries might have wanted them to. However, the worst wheat harvests at the four missions during the decade did not coincide with the dry years (1821-1825) identified by Larson *et al.,* but rather at the end of the decade. The same was the case for corn production at two of the missions (see Table 6).

How did mission agriculture perform during the dry years 1805-1813 and 1821-1825? During these years there were only a handful of poor crops at the four missions, as measured by the size of the crop when compared to the crops in other years. At San Luis Obispo the corn crop in 1807, 1812, and 1813 was deficient, and the wheat crop in 1812. San Buenaventura had perhaps the largest number of poor crops; corn from 1809-1812 and 1822; and wheat in 1805, 1807, and 1824. At Santa Bárbara it was 1823-1824 for wheat, and 1807 and 1809 for corn. For La Purísima the wheat crop was low in 1807 and 1809, and corn in 1812 (see appendix). However, there was no region-wide drought that destroyed or reduced crops at all four missions. The central Chumash missions Santa Bárbara and La Purísima both had poor wheat crops in 1807, and 1812 was a poor year for both wheat and corn at three missions. But none of the dry years produced true famine conditions.

Crop totals varied during the dry years, but still averaged large returns for most years. Table 7 records the average wheat and corn crops for the four missions in the dry years 1805-1813 and 1821-1825. The wheat crops were still large, and averaged between 2 000 and 3 000 at all establishments, although the crops in the early 1820s were a bit lower than during the earlier sample period. The ratio of seed harvested/sown also shows evidence of only a few very bad crops (see Table 9). At San Luis Obispo the wheat crop in 1809 and 1824 was poor, as was the 1807 corn crop. For San Buenaventura the wheat crops in 1805, 1807, and 1824 were low, and corn in 1822. For Santa Bárbara the wheat crops in 1823 and 1824 were low, but there were no low corn crops. Finally, the only poor crops at La Purísima were wheat in 1806 and 1824.

The analysis of agricultural production shows that dry conditions as recorded in tree rings did not necessarily translate into poor crops. Some but not all mission crops were irrigated, but dry conditions and inadequate rainfall would also potentially reduce the level of streams and springs that provided water for irrigation. This, in turn, suggests that the connection between tree rings and the destruction of plants traditionally used by the Chumash for food may not have been strong. Only a more detailed analysis of the water requirements and seasonality of different edible plants could shed further insights on the impact of low rainfall as indicated in tree ring analysis.

Regional Crop Failure

Was there a problem with crop failure across the Alta California mission frontier? An analysis of very poor harvests of wheat (a ratio of harvest/sown of 5 or less) and corn (a ratio of harvest/sown of 20 or less) shows that there were few instances of conditions leading to very poor crops in at least one crop across southern and central coastal California. We have divided the 26 missions into six groups based on general geographic match. Group one consists of San Diego, San Luis Rey, and San Juan Capistrano, all located in coastal valleys; group two San Gabriel and San Fernando in the Los Angeles Basin; group three the five missions established among the Chumash, including San Luis Obispo, San Buenaventura, Santa Barbara, La Purísima, and Santa Inés; group four the missions located in the Salinas and San Benito Valleys, including San Miguel, San Antonio, Soledad, and San Juan Bautista; group five being San Carlos and Santa Cruz on Monterey Bay; and group six the five missions in the San Francisco Bay region, which are San Francisco, Santa Clara, San José, San Rafael, and San Francisco Solano. In order to filter out instances of very poor harvests at a single mission, we have recorded only instances of very poor harvests at the majority of establishments. This means that for the missions of group two and group five the very poor harvest had to have occurred at both missions.

Table 9 summarizes the results of this analysis. Not surprisingly, the group with the largest number of very poor crops was one, the establishments located in the driest part of Alta California. Group three, the Chumash missions, had the second highest number. There were several instances of regionally centered poor harvests: the control imposed for the two groups with only two missions each means that the establishments in the Los Angeles Basin are not counted, although the drier climate in the Los Angeles Basin may have produced an equally large number of very poor harvests at one of the two missions that would not be included in the data analyzed here. In southern Alta California there were poor crops in 1807, and in 1809 in some parts of southern Alta California and the Salinas-San Benito Valleys. Both coincided with one of the dry periods identified in the dendroclimatic data. The only years with very poor harvests across all or most of Alta California were 1827 and 1829, which did not coincide with the dry periods, but occurred at the time of a serious measles epidemic that probably incapacitated many Indian workers (see Table 9).

Conclusions: A Larger Context

This examination of the performance of mission agriculture has shown that climatic variability and periods of below normal rainfall did not in every instance limit grain production at the missions established among the Chumash. There were only a few very poor crops at the missions. What does this mean for a discussion of the use of climate and the variability of rainfall to explain the congregation of the Chumash? It is my contention that the analysis of dendroclimatic data does not provide direct evidence of food shortages among the Chumash resulting from insufficient plant foods. Moreover, there is a need to go beyond the tree ring evidence to document the specific impact of low and poor rainfall levels on the different wild plant foods collected by the Chumash. On the other hand, the data on mission agriculture also shows that during most dry years the missions did produce grain that would have been available had the wild plant foods sources been limited. The only conditions leading to very poor harvests across all of Alta California did not coincide with the dry periods identified in the dendroclimatic data used in support of the ecological thesis as used to explain Chumash congregation on the missions.

The statistical relationship between total grain production and population or the baptism of converts also suggests a rethinking of one of the basic premises of the ecological model: does the high statistical relationship between total grain production and population mean that increases in the grain supply lead to population growth, or something else such as increases in labor supply resulting in higher levels of grain production? Our view is that both factors were at play, but the weaker correlation between total grain and baptisms of converts suggests that tbe labor/grain production relationship was probably stronger. An examination of non-ecologgical factors, such as the social, political, and economic (trade) factors outlined in the study by Randall Milliken for the northern California missions, leading to the decision to enter the missions would be equally revealing.

What factors did convince the Chumash to enter the missions? It is our intention here to suggest possible lines of future investigation. The missionaries frequently targeted traditional political leaders for conversion in the belief that the conversion of leaders would result in the rapid conversion of commoners. Did internal divisions and conflicts between the different Chumash tribes result in some leaders seeking alliances with the Spanish, alliances facilitated by baptism? Did the less socially prestigious members of Chumash society see alliances with the Spanish as beneficial? The missionaries in other parts of California also targeted children, and used control over children as leverage over the parents. Did this occur in the Chumash missions?

Once the exodus to the missions began, did existing social, political, and economic networks began to disintegrate as posited by Milliken for the northern missions? Put into broader terms, the Chumash suffered the fate of other tribal peoples brought under European colonial control: social disruption and disintegration. Increased mortality both in and outside the missions, undermined belief in traditional Chumash religious beliefs and world view that could not explain the existence of new and terrifying maladies.[9] Did the missions become an acceptable solution viewed as the lesser evil to remaining outside of the missions in an increasingly unfriendly and isolated world.

[9] On the demographic decline of the Chumash see Philip Walker and John Johnson, "The Decline of the Chumash Indian Population," in *In The Wake of Contact: Biological Responses to Conquest* (New York, 1994), p. 109-120; Robert H. Jackson, "The Population of the Santa Bárbara Channel Missions (Alta California), 1813-1832," *Journal of California and Great Basin Anthropology*, p. 268-274; Robert H. Jackson, "La colonizacion de la Alta California: Un análisis del desarrollo de dos comunidades misionales," *Historia Mexicana* 41 (1991), p. 83-110; Robert H. Jackson, "Patterns of Demographic Change in the Alta California Missions: The Case of Santa Inés," *California History* 71:3 (1992), p. 362-369, 451.

One other factor related to the possibly increasingly unreliability of the supply of wild plant foods may have contributed to the decision to move to the missions. Variable rainfall probably did not cause sufficient shortages of wild plant foods to force the Chumash into the missions, but the introduction of European livestock, particularly cattle and sheep, may have modified the environment and reduced the supply of wild plant foods. A recent study analyzed and compared the affect of the introduction of sheep to central Mexico in the sixteenth century and Australia in the nineteenth century, and possible parallels can be drawn with the experience of the Chumash.[10]

The livestock, particularly sheep, destroyed many of the native plants. In Australia the sheep and cattle destroyed plants used as foods by the Aborigines. Moreover, the English settlers stopped the Aborigines from using fire to control and promote the growth of plants that provided food, leading to the expansion of scrub into grasslands and the impoverishment of wild food supplies. Grazing also destroyed ground cover, particularly in semi-arid areas, leaving baked and eroded soils.[11]

As Milliken has suggested for the San Francisco Bay region, a similar scenario played itself out in the Chumash territory. The Franciscans introduced cattle, sheep, horses, and other animals, and the size of the herds grew quite rapidly. As shown in Table 10, thousands of cattle and sheep ranged across Chumash territory, and the numbers of livestock rapidly increased after 1800. In 1800, four missions counted a total of 16 572 head of cattle and 20 215 sheep (see Table 10). A decade later, in 1810, the numbers had risen to 41 425 cattle and 37 786 sheep. The common practice was to place livestock at sites close to large centers of indigenous populations, which meant that the growing number of livestock destroyed plants that were traditional sources of food in the immediate environs of Chumash villages.

Burning was also a common means used to control plants and to promote the growth of the plants used for food, a practice eliminated by the Franciscans for similar reasons. If shortages of wild plants motivated Chumash to enter the missions, the shortages would have resulted more from the destruction wrought by the livestock brought by the Spaniards that proliferated rapidly.

A complex set of social, economic, and demographic push and pull factors contributed to the decisions made by Chumash to abandon their traditional way of life and enter the missions. Poor rainfall may have

[10] Elinor G. K Melville, *A Plague of Sheep: Environmental consequences of the conquest of Mexico* (Cambridge 1994).

[11] *Ibid.*, chapter 3.

damaged or destroyed traditional sources of food, but the tree ring data does not provide conclusive evidence. If destruction of traditional plant foods indeed was a factor in compelling Chumash to enter the missions, the proliferation of destructive herds of livestock may very well have played a far more important role than did insufficient rainfall. The reports that record the yearly numbers of livestock generally do not mention insufficient pasture. On the contrary, the numbers of livestock grew rapidly in the decades following the establishment of the missions. Pasture apparently was not a problem, except for the Chumash when the mission livestock consumed the plants they traditionally had used for food.

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Table 1: STATISTICAL TESTS OF THE RELATIONSHIP BETWEEN TOTAL GRAIN PRODUCTION AND POPULATION FOR SELECTED ALTA CALIFORNIA MISSIONS

Regression *Mission*	*Years*	*Adj R2*	*t*	*Correlation*
San Diego	1785-1804	.0456	-.414	-.0971
	1812-1831	.0441	-.444	-.1042
San Gabriel	1785-1804	.0242	1.213	.2749
	1812-1831	-.0526	1.433	.3201
San Antonio	1785-1804	-.0553	-.065	-.0153
	1812-1831	.1681	2.200	.4603
San Carlos	1785-1804	-.0229	-.758	-.1758
	1812-1831	.0958	1.736	.3787
Santa Clara	1787-1804	.0835	1.597	.3707
	1812-1831	.0418	-.527	-.1268

Source: Robert H. Jackson and Edward Castillo, *Indians, Franciscans and Spanish Colonization: The impact of the Mission System on California Indians* (Albuquerque, 1995); Robert H. Jackson, *Indian Population Decline: The Missions of Northwestern New Spain 1687-1840* (Albuquerque, 1994).

Table 2: STATISTICAL TESTS OF THE RELATIONSHIP BETWEEN TOTAL GRAIN PRODUCTION AND POPULATION FOR FOUR CALIFORNIA MISSIONS ESTABLISHED AMONG THE CHUMASH

Regression *Mission*	*Years*	*Adj R2*	*t*	*Correlation*
San Luis Obispo	1785-1804	.1734	2.233	.4657
	1812-1831	.1025	1.781	.3870
San Buenaventura	1785-1804	.4814	4.317	.7133
	1812-1831	.7323	7.278	.8639
Santa Bárbara	1787-1804	.5394	4.573	.7527
	1812-1831	.3486	3.342	.6188
La Purísima	1789-1804	.1307	1.804	.4343
	1812-1831	.3895	3.622	.6493

Source: Appendix, in Robert H. Jackson, *Indian Population Decline: The Missions of northwestern New Spain 1687-1840* (Albuquerque 1994).

Table 3: STATISTICAL TEST OF THE RELATIONSHIP BETWEEN TOTAL GRAIN AND THE BAPTISMS OF CONVERTS AT TWO ALTA CALIFORNIA MISSIONS

Regression *Mission*	*Years*	*Adj R2*	*t*	*Correlation*
San Luis Obispo	1785-1804	.0412	.498	1167
Santa Inés	1804-1823	.1511	-2.093	.4425

Source: Appendix in Robert H. Jackson and Edward Castillo, *Indians, Franciscans and Spanish Colonization: The Impact of the Mission System on California Indians* (Albuquerque, 1995); Robert H.. Jackson, "Patterns of Demographic Change in the Alta California Missions: The Case of Santa Inés," *California History* 71:3 (1992), p. 362-269.

Table 4: Five Year Mean Ratio of Harvest: Sown at Four Alta California Missions Established Among the Chumash, 1785-1804 & 1812-1831

Mission	*Years*	*Wheat*	*Corn*	*Barley*
San Luis Obispo	1785-1789	18.4	149.9	No Data
	1790-1794	15.3	126.6	No Data
	1795-1799	10.5	160.9	No Data
	1800-1804	11.4	174	No Data
	1812-1816	13.7	36.8	4**
	1817-1821	19.3	38.1	7.7**
	1822-1826	12.3	8.3***	No Data
	1827-1831	4.2	28.7	2.8@
San Buenaventura	1785-1789	11	125.8	32.6
	1790-1794	9.4*	173.5	28.4*
	1795-1799	54	52.9	38.2
	1800-1804	31.7	71.9	35.3
	1812-1816	19.5	139.5	20.6
	1817-1821	19.2	95.4	19.6
	1822-1826	9.1	58.9	8.9
	1827-1831	8	70.6	17.1
Santa Bárbara	1787-1789	10	80	16.7**
	1790-1794	12.8	50.8	25.96
	1795-1799*	17.9	125.9***	No Data
	1800-1804	22.98	34.4	18.6*
	1812-1816	21.9	139.3	43.8
	1817-1821	13.9	86.2	16.4
	1822-1826	11.1	32.2	8.5
	1827-1831	6.9	41.6	7.8
La Purísima	1790-1794	16	173.5	32**
	1795-1799	18.8	53.2	70**
	1800-1804	10.7	100.3	40.7
	1812-1816	15.5	147	23.3***
	1817-1821	14.9	70.3	17.7
	1822-1826	13.2	53.7	10**
	1827-1831	9.96	85.7	5

* Four years only; *** three years only; @ two years only; ** one year only.
Source: Appendix.

Table 5: FIVE YEAR MEAN INDEX OF GRAIN SOWN (1810=100) AT FOUR MISSIONS ESTABLISHED AMONG THE CHUMASH, 1785-1804& 1812-1831

Mission	*Years*	*Wheat*	*Corn*	*Barley*
San Luis Obispo	1785-1789	50	127	No Data
	1790-1794	103	135	No Data
	1795-1799	155	134	No Data
	1800-1804	171	265	No Data
	1812-1816	94	110	No Data
	1817-1821	144	138*	No Data
	1822-1826	144	433***	No Data
	1827-1831	75	108	No Data
San Buenaventura	1785-1789	6	99	5
	1790-1794	15*	142	19*
	1795-1799	22	119	30
	1800-1804	63	112	62
	1812-1816	125	77	106
	1817-1821	131	80	109
	1822-1826	114	121	59
	1827-1831	61	137	67
Santa Bárbara	1786-1789	18	55***	53***
	1790-1794	46	81	24*
	1795-1799	54	64***	No Data
	1800-1804	77	124	39*
	1812-1816	101	257	81
	1817-1821	145	193	187
	1822-1826	126	201	181
	1827-1831	74	217	217
La Purísima	1790-1794	29	95	Incomplete Data
	1795-1799	42	43	Incomplete Data
	1800-1804	72	80	Incomplete Data
	1812-1816	70	140	Incomplete Data
	1817-1821	104	130	Incomplete Data
	1822-1826	65	120	Incomplete Data
	1827-1831	43	115	97

* Four years only; *** three years only; @ two years only; ** one year only
Source: Appendix.

Table 6: Five Year Mean Index of Grain Harvested (1810=100) at Four Missions Established Among the Chumash, 1785-1804 & 1812-1831

Mission	*Years*	*Wheat*	*Corn*	*Barley*
San Luis Obispo	1785-1789	63	254	No Data
	1790-1794	106	178	No Data
	1795-1799	108	207	No Data
	1800-1804	182	338	No Data
	1812-1816	82	39	Few Harvests
	1817-1821	183	74*	Few Harvests
	1822-1826	123	25*	Few Harvests
	1827-1831	18	29	Few Harvests
San Buenaventura	1785-1789	4	96	6
	1790-1794	7*	224	23*
	1795-1799	86	49	41
	1800-1804	134	58	75
	1812-1816	91	104	86
	1817-1821	176	73	85
	1822-1826	74	71	24
	1827-1831	31	97	46
Santa Bárbara	1787-1789	14***	60	123@
	1790-1794	41	66	91*
	1795-1799	73	93***	No Data
	1800-1804	134	54	101*
	1812-1816	153	428	285
	1817-1821	144	166	280
	1822-1826	94	169	180
	1827-1831	33	91	176
La Purísima	1790-1794	29	111	Incomplete Data
	1795-1799	51	23	Incomplete Data
	1800-1804	49	28	Incomplete Data
	1812-1816	75	176	Incomplete Data
	1817-1821	101	99	Incomplete Data
	1822-1826	55	60	Incomplete Data
	1827-1831	30	71	17

* Four years only; *** three years only; @ two years only; ** one year only
Source: Appendix.

Table 7: AVERAGE WHEAT AND CORN CROPS AT FOUR MISSIONS ESTABLISHED AMONG THE CHUMASH IN FANEGAS, 1805-1813 & 1821-1825

	1805-1813		*1821-1825*	
Mission	*Wheat*	*Corn*	*Wheat*	*Corn*
San Luis Obispo	2 033	191	2 352	No Data
San Buenaventura	3 410	871	2 580	544
Santa Bárbara	3 320	436	2 951	171
La Purísima	2 400	528	2 037	364

Source: Appendix.

Table 8: RATIO OF GRAIN HARVESTED/SOWN AT FOUR MISSIONS ESTABLISHED AMONG THE CHUMASH, 1805-1813 & 1821-1825

	San Luis Obispo		*San Buena-ventura*		*Santa Bárbara*		*La Purísima*	
Year	*Wheat*	*Corn*	*Wheat*	*Corn*	*Wheat*	*Corn*	*Wheat*	*Corn*
1805	12.8	10	4.4	42.9	35.6	83.3	21.4	50
1806	11.7	75	19.4	55.6	17.1	42.9	4	50
1807	12	3.7	3.6	135.7	10.7	45	2.5	133.3
1808	11.3	100	13.4	140	21.1	166.7	12	90
1809	8.6	100	20.1	42.9	15	31	10.3	100
1810	15	100	15	62.5	13.4	84.1	15	126.5
1811	30	250	22.5	62.5	17.5	185.2	16.7	112.5
1812	11.7	24	16.8	200	23	133.3	20	50
1813	28.6	40	26	100	15.5	218	24	285.7
1821	30	N/A	18	73.2	16.3	100	16.7	66.7
1822	21.3	25	14.8	10.8	17.1	27.5	10.6	128.6
1823	18.8	0	10	66.7	0.8	34	10	50
1824	6.6	0	8	81.8	5.3	41.2	9.8	30
1825	10	0	10	112.5	24.7	33.3	22.2	40

Source: Appendix.

Table 9: POOR HARVESTS BY YEAR IN AT LEAST ONE CROP (WHEAT, CORN) IN THE MAJORITY OF ALTA CALIFORNIA MISSIONS, BY GROUP

Group 1	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
1800	None	1803	1809	1792	1827
1807		1807	1829	1796	1829
1809		1827			
1813		1829			
1823					
1826					
1827					
1829					
1832					
1833					

Source: *Annual Reports*, Archivo General de la Nación, México; Santa Bárbara Mission Archive-Library, Santa Bárbara, California; "Mission Statistics," The Bancroft Library University of California, Berkeley.

Table 10: NUMBERS OF CATTLE AND SHEEP REPORTED AT FIVE MISSIONS ESTABLISHED AMONG THE CHUMASH IN SELECTED YEARS

	1790		*1800*		*1810*		*1820*	
Mission	*Cattle*	*Sheep*	*Cattle*	*Sheep*	*Cattle*	*Sheep*	*Cattle*	*Sheep*
S. Luis	3 457	3 387	5 150	6 000	6 000	9 000	7 600	6 501
S. Buen.	771	965	8 022	4 600	17 945	8 486	15 280	12 600
S. Bar.	208	286	1 800	5 615	4 280	8 000	3 500	8 000
La Pur.	169	464	1 600	4 000	10 000	10 000	9 000	12 000
Sta. Inés	3 200	2 300	7 000	5 000				

Source: Finbar Kenneally, O.F.M., trans. and ed., *Writings of Fermín Francisco de Lasuén*, 2 v., (Washington, D.C., 1965), v. 2, p. 402-403; p. 422-423; Annual Reports, Santa Bárbara Mission Archive-Library, Santa Bárbara, California.

APPENDIX: Grain Sown and Harvested at Four Alta California Missions Established Among the Chumash, in Fanegas

San Luis Obispo Mission 1781-1834

	Wheat		*Corn*		*Barley*	
Year	*Sown*	*Harvested*	*Sown*	*Harvested*	*Sown*	*Harvested*
1781	70	1343	3	782	0	0
1782	100	1478	3	521	0	0
1783	100	1300	3	650	0	0
1784	50	800	2	300	0	0
1785	30	500	2/3	150	0	0
1786	40	700	3	400	0	0
1787	70	1500	2	300	0	0
1788	60	1158	4	745	0	0
1789	50	863	2	110	0	0
1790	100	1200	2	280	0	0
1791	86	1078	2½	123	0	0
1792	83	1548	3	735	0	0
1793	107	1800	3½	500	0	0
1794	141	2300	2½	140	0	0
1793	107	1800	3½	500	0	0
1794	141	2300	2½	140	0	0
1795	150	1047	3½	332	0	0
1796	120	1400	2 1/3	340	0	0
1797	160	2100	2½	400	0	0
1798	165	2180	2 ¾	500	0	0
1799	180	1400	2¼	500	0	0
1800	110	1525	3	800	0	0
1801	122	2200	4½	1100	0	0
1802	161	4000	4	950	0	0
1803	160	2300	3	31	0	0
1804	300	3600	4½	500	10	100
1805	239	3062	10	100	4	250
1806	213	2500	4	300	10	12
1807	165	2001	3	11	30	300
1808	179	2030	3	300	10	42
1809	175	1500	2	200	40	25
1810	100	1500	2	200	40	200
1811	100	3000	2	500	0	0
1812	60	700	1	24	4	16
1813	70	2000	2	80	0	0
1814	100	1000	4	100	0	0
1815	109	1400	2	90	0	0
1816	130	1060	2	100	0	0
1817	130	702	4	243	3	23
1818	190	4000	2	74	0	0
1819	200	4037	2	19	0	0
1820	100	2000	3	250	0	0

Year	Wheat Sown	Wheat Harvested	Corn Sown	Corn Harvested	Barley Sown	Barley Harvested
1821	100	3000	0	0	0	0
1822	150	3200	2	50	0	0
1823	160	3000	16*	0	0	0
1824	160	1060	8*	0	0	0
1825	150	1500	0	0	0	0
1826	100	500	0	0	0	0
1827	80	200	3/4	25	15	0
1828	80	230	3	66	0	0
1829	100	89	2	30	15	½
1830	68	500	3	130	15	67
1831	47	350	2	60	0	0
1832	40	350	2	60	0	0
1833	40	207	2	50	4	12
1834	40	400	2	100	0	0

Source: *San Luis Obispo Annual Reports*; Archivo General de la Nación, México; Santa Bárbara Mission Archive-Library, Santa Barbara, California; "Mission Statistics," The Library, University of California, Berkeley.

San Buenaventura Mission, 1782-1834

Year	Wheat Sown	Wheat Harvested	Corn Sown	Corn Harvested	Barley Sown	Barley Harvested
1782	2	13	2	345	1	9
1783	1	11	1 ½	387	½	6
1784	6	22	8	412	¾	26
1785	3	31	2 1/6	511	1 ½	5 1/3
1786	3	41	5 ½	806	1 ½	92 ½
1787	5	54	8	415	3	104
1788	15	105	8	830	3	89
1789	19½	256	11	1000	7	183
1790	22	155	9	1000	18	719
1791	44	259	9¼	1600	0	0
1792	0	0	9½	2350	11	370
1793	11	230	11	1800	10	200
1794	14	50	11	1900	10	200
1795	16	100	11	900	10	200
1796	10	600	12	600	7	400
1797	20	1600	11	50	7	300
1798	65	4000	6	50	30	1000
1799	63	4000	1 2/3	200	40	1500
1800	102	4620	10	400	45	1270
1801	99	4000	5	300	50	900
1802	96	3500	1 1/3	200	8	500
1803	95	1000	8	450	45	1140

Year	*Wheat*		*Corn*		*Barley*	
	Sown	*Harvested*	*Sown*	*Harvested*	*Sown*	*Harvested*
1804	111	2900	15	800	50	2360
1805	180	800	21	900	50	200
1806	211	4095	18	1000	50	318
1807	14	50	14	1900	10	200
1808	160	2136	10	1400	50	1028
1809	159	3200	7	300	50	601
1810	160	2400	7	740	64	1641
1811	200	4500	4	250	70	1845
1812	200	3361	4	350	76	2023
1813	200	5200	5	1000	32	645
1814	200	3500	5	500	70	1264
1815	200	3600	5	800	70	868
1816	200	3800	8	1200	90	2300
1817	200	4800	6	900	70	1500
1818	200	5000	6	500	100	2400
1819	200	3000	5	520	50	800
1820	200	3800	6	400	68	681
1821	250	4500	5	366	60	1600
1822	250	3700	5	54	50	681
1823	250	2500	7 ½	500	50	150
1824	100	800	11	900	35	500
1825	140	1400	8	900	50	500
1826	169	500	11	250	35	130
1827	124	148	9	500	40	112
1828	76	1000	12	1800	36	1000
1829	99	1200	3	100	70	1400
1830	100	900	10	1000	50	1000
1831	90	400	14	200	20	300
1832	100	200	10	600	28	500
1833	90	400	14	200	20	300
1834	140	1500	11	400	0	0

Source: *San Buenaventura Mission Annual Reports*, Archivo General de la Nación, México; Santa Bárbara Mission Archive-Library, Santa Barbara, California; "Mission Statistics", The Bancroft Library, University of California, Berkeley.

Santa Bárbara Mission, 1786-1834

Year	*Wheat*		*Corn*		*Barley*	
	Sown	*Harvested*	*Sown*	*Harvested*	*Sown*	*Harvested*
1786	7½	0	0	0	0	0
1787	7½	120	3/4	30	10	0
1788	432/3	178	2½	250	12	200
1789	56	644	1	70	10	230
1790	60	725	1 ½	50	6	100
1791	65	1500	2½	262	8	340

	Wheat		Corn		Barley	
Year	*Sown*	*Harvested*	*Sown*	*Harvested*	*Sown*	*Harvested*
1792	80	1000	2	120	7	100
1793	78	936	1	50	3	100
1794	98	400	2½	15	0	0
1795	73	100	0	0	0	0
1796	75	1400	0	0	0	0
1797	89	3500	8/10	110	0	0
1798	92	1700	2	160	0	0
1799	123	1420	1 2/3	276	0	0
1800	106 1/3	1971	1 5/6	80	0	0
1801	129 1/6	2327	3 ¾	70	1/3	6
1802	113½	2876	9/10	40	2	40
1803	149½	1856	3	12½	33/4	42
1804	142 ½	5796	6	330	24½	620
1805	138	4912	6	500	15	1008
1806	210	3595	7	300	25	920
1807	200	2142	2	90	18	800
1808	208	4380	1 ½	250	22	1014
1809	219	3294	2	62	23	779
1810	166	2217	2 1/3	196	20	176
1811	154	2689	5	926	25	308
1812	124	2853	3	400	11	126
1813	246	3800	5 ½	1200	15	860
1814	150	2573	4 ½	900	6	484
1815	144	2641	8	1150	9	500
1816	144	5098	9	540	40	534
1817	193	4155	12	1000	100	1522
1818	162	3200	½	80	24	677
1819	205	1468	4	250	14	20
1820	286	1340	4	100	19	41
1821	355	5800	2	200	30	1046
1822	195	3336	4	110	39	160
1823	315	250	10	340	30	60
1824	163	870	2½	103	17	200
1825	182	4500	3	100	45	560
1826	190	1400	4	100	50	600
1827	160	700	3	300	60	600
1828	100	800	3 3/4	80	90	300
1829	39	410	3	120	17	67
1830	150	1050	9½	300	25	248
1831	165	730	6	90	25	336
1832	115	900	4	150	15	35
1833	148	1008	5	420	25	89
1834	150	1300	8	420	30	700

Source: *Santa Barbara Mission Annual Reports*: Archivo General de la Nación, Mexico; Santa Bárbara Mission Archive-Library, Santa Bárbara, California; Ms. "Mission Statistics," The Bancroft Library, University of California, Berkeley.

La Purísima Mission, 1789-1832

	Wheat		Corn		Barley	
Year	Sown	Harvested	Sown	Harvested	Sown	Harvested
1789	15	331	2	357	0	0
1790	25	530	3	521	½	16
1791	76	880	4	653	0	0
1792	61	602	4	891	0	0
1793	55	1102	6	200	0	0
1794	68	1254	2	549	0	0
1795	96	308	3	502	0	0
1796	75	1250	2	15	0	0
1797	65	1700	2	0	0	0
1798	92	1900	½	38	0	0
1799	92	2500	1	15	1	70
1800	69	1200	1	160	0	0
1801	165	1600	10	130	1/6	8
1802	96	1000	1	160	1/6	5
1803	161	500	1	125	0	0
1804	230	3000	3	130	0	0
1805	140	3000	2	100	0	0
1806	300	1200	3	200	10	50
1807	400	1000	3	400	10	50
1808	177	2000	5	450	3	10
1809	175	1800	6	600	6	60
1810	200	3000	4	506	13	360
1811	180	3000	4	450	25	800
1812	150	3000	1	50	0	0
1813	150	3600	7	2000	100	2000
1814	100	200	6	2000	0	0
1815	180	2000	6	400	3	50
1816	123	2500	8	10	18	600
1817	157	2800	8	1000	39	500
1818	250	3000	2	200	12	200
1819	180	2900	6	900	6	200
1820	208	2435	4	0	0	0
1821	240	4000	6	400	13	334
1822	150	1587	7	900	0	0
1823	150	1500	4	200	0	0
1824	112	1100	4	120	0	0
1825	90	2000	5	200	3	30
1826	150	2000	4	80	0	0
1827	120	2000	4	800	12	60
1828	102	1000	7	200	15	58
1829	90	300	4	400	10	80
1830	50	500	4	300	12	50
1831	70	700	4	100	14	56
1832	60	500	4	100	11	45

Source: Robert H. Jackson, "La colonizacion de la Alta California: Un análisis del desarrollo de dos comunidades misionales," *Historia Mexicana* 41:1 (1991), p. 83-110.

Artículo recibido el 24 de abril de 1999 y aprobado el 19 de mayo de 1999.