A collaboration between:

Almond Production in California

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Background

Almonds were planted in California as early as 1853 [12]. The varieties used were of European origin. In many locations they seem to be poorly adapted to the climatic conditions and were irregular bearers [12]. Many almond trees, especially those planted in the south, were thus either grafted over into prunes or plums or were made into firewood. The varieties, however, were not alone to blame. The lack of knowledge about the need for cross-pollination also contributed to the unsatisfactory results. In the 1880s, local varieties, more adapted to the climatic conditions, became available and allowed for profitable production of high quality almonds [12]. In 1886 A.T. Hatch of Suisun presented a number of varieties at the Citrus Fair in Sacramento, including Nonpareil and Ne Plus Ultra [12]. These two varieties are still planted today, with Nonpareil still being the dominant variety [1]. Furthermore, the need for cross-pollination with compatible cultivars was established in the early 1900s. This greatly improved production [7].

Initially, almonds were mainly planted on higher lands in coastal valleys, free from fog and protected from direct wind, as well as in the interior valleys and foothills. Almonds were recommended to be planted on light soil. They were expected to produce good crops on soils that are too sandy and dry to grow peaches or nectarines. Most often, almonds were produced without irrigation [12]. With adapted varieties available, almond production increased steadily. While the statewide production was about 250 tons in 1888, it averaged 2250 tons between 1910 and 1914 and 4600 tons between 1915 and 1919 [10, 13]. Even though it was recognized early that irrigated almond trees produce larger crops, growers did not start to apply irrigation water until the 1930s [14]. The almond acreage continued to increase slightly, reaching 100,000 acres of bearing almond trees in 1964. During this period harvest practices shifted from hand to mechanical harvest [6].

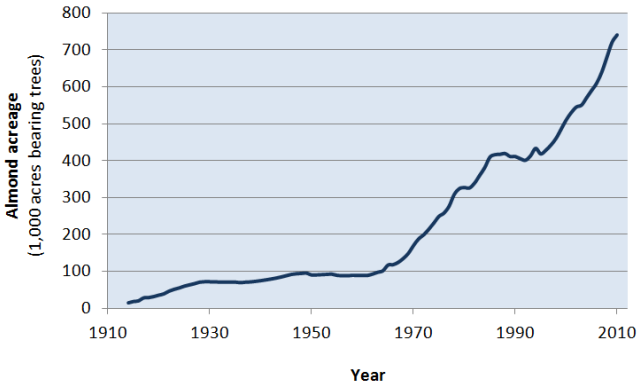

Figure 1: Area of bearing almond trees in California since 1914 [10, 14].

A major expansion of almond production took place between 1964 and 1985 when the area increased to more than 400,000 acres. Product development and marketing contributed significantly to this increase in acreage, with innovative new products leading to expanded markets of almond products [4]. A second factor was the increase in the irrigated area in the San Joaquin Valley, where soils and climatic conditions are ideal for almond production [4].

While the acreage remained relatively stable between 1985 and 1995, it increased again reaching a new high in 2011 with 760,000 acres of bearing orchards producing 2.02 billion pounds of almonds, which accounted for 84% of the global production [1].

Production area

In the 1930s, almonds were grown from Shasta county in the north to Riverside and San Diego counties in the south, with the main production areas being the Sacramento Valley, San Luis Obispo county and the northern San Joaquin Valley [14]. In 1950, 50% of California's almonds were still produced in the Sacramento Valley, while the San Joaquin Valley and the coastal counties contributed 25% each [5]. However, by 1970, the major areas of almond production had moved to the San Joaquin Valley, and most of the expansion since then has taken place there [4]. Today, Kern, Fresno, Stanislaus, Merced and Madera counties together produce two thirds of California's almonds (Figure 3) [11]. The shift in production was due California Water Project, which increased the availability of irrigation water in the San Joaquin Valley [4]. Better soils and a more favorable climate with less rainfall and warmer temperatures at bloom have also contributed to the popularity of almonds in the San Joaquin Valley [4].

Figure 3: Location of the five leading almond producing counties in California [11].

Yield

The early almond plantings were seen as unreliable and did not seem to be adapted to California's conditions [2]. The development of local varieties and the recognition, that almond are self sterile, were two important steps towards stable yields and profitable almond production. The yield of almonds has increased tremendously over the years. From 1915 to 1935 the average yields in California's almond orchards remained relatively stable at approximately 210 lbs/acre shelled almonds [10]. By 1960, the yield had more than tripled. The increased use of irrigation contributed significantly to the higher yields during this period. Since the 1960s, the yield has increased even faster, reaching an average of 2100 lbs/acre in the period from 2006 to 2010 [10]. The relatively large yield fluctuations are mainly due to the effects of varying late winter and spring weather conditions, with rain and cool temperatures during bloom resulting in lower yields [7].

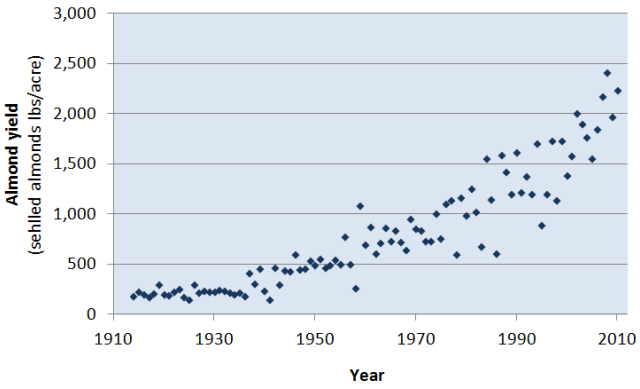

Figure 2: Almond yield since 1914 in California [10, 14].

Several factors have contributed to the astonishing yield increase, including practices to maximize cross-pollination, selection of adapted rootstocks, as well as improved fertilization, irrigation and pest management [4, 2]. Compared to many other crops, the genetic improvement of varieties is likely of lesser importance. The major variety "Nonpareil", which accounts for 39% of the almonds produced in 2011/12 [1], was already introduced in 1886 [12].

Fertilization

Different surveys about almond fertilization have been carried out since the late 1990s. Based on a survey conducted by the USDA in 1999, California almond growers applied some 134 lbs N/acre. In the same year, the potassium (K_2O) and phosphate (P_2O_5) applications reached 127 and 85 lbs/acre [9]. Nitrogen was applied by more than 90% of the growers, while potassium and phosphorus were applied by one out of four growers [9].

In a FREP-funded survey conducted in the San Joaquin Valley in 1999, King found that all growers interviewed applied N fertilizer to almonds between March and September. The application rate ranged from 50 to 350 lbs/acre, averaging 150 lbs/acre [3]. The most widely used fertilizer was UN32, followed by CAN 17. More than half of the growers applied N via a pressurized irrigation system, while a third used broadcast application. Shanking the N in or applying it with flood irrigation were other practices reported. About a third of the growers reported applying N during the winter months with an average application rate of 70 lbs/acre [3]. Similar results in terms of preferred N fertilizers and application time were obtained in a survey carried out in 2007 by a research team led by Patrick Brown among California Almond growers [8]. In addition, the survey revealed that potassium sulfate was the preferred K fertilizer, followed by potassium thiosulfate and potassium chloride. The proportion of growers using fertigation had grown to two thirds and 80 to 90% of growers reported applying foliar N, P and K at least once a year [8].

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