A collaboration between:

# Economically Optimal Nitrogen Availability for Cotton

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Applying nutrients to obtain the maximum yield is generally not the most economical strategy. Most crops respond strongly to fertilization at low nutrient availabilities. With increasing nutrient availability, however, the yield increase per unit of additional fertilizer becomes smaller.

The economically optimal nitrogen rate (EONR) is reached when the application costs of an additional unit of fertilizer exceed the revenue from the yield increase realized. To calculate the EONR, a curve expressing yield as a function of N availability is needed, as well as information about fertilizer costs and prices for harvested products. In the following paragraphs, the EONR for Acala and Pima cotton is calculated based on studies carried out in the San Joaquin Valley.

## Price of fertilizers and cotton lint

Since the year 2000, fertilizer costs have increased considerably. The price for urea has increased from $ 0.22 per pound of N to $ 0.61 per pound of N [4] (Figure 1). The price for a 30% N solution was in the same range. The price for anhydrous ammonia was on average 25% below that of urea, while ammonium nitrate and ammonium sulfate were 25 and 60% more expensive, respectively [4]. During the same period, the price for cotton lint has increased as well (Figure 1). On average, the price for Pima lint was 50 cents/lb higher than the price for Acala lint [5].

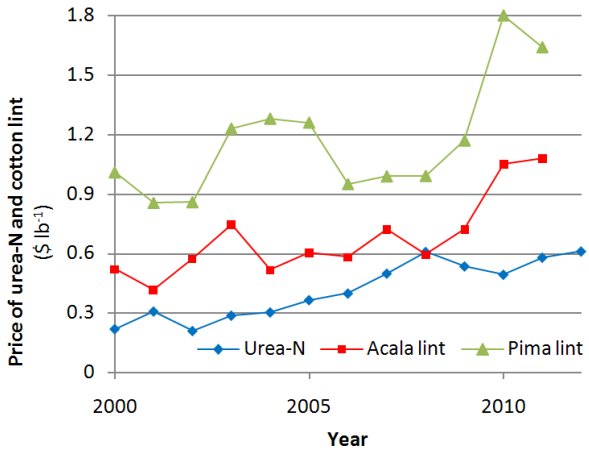


**Figure 1:** Costs for urea-N and price for cotton lint since 2000 [4, 5].

## Yield response curve

Between 1996 and 2000, Hutmacher and coworkers carried out an extensive, FREP-funded study with Acala cotton at eight locations in the San Joaquin Valley [2, 3]. For this study, they added the residual soil nitrate-N in the top two feet of the soil profile to the fertilizer N to calculate the available N. The residual soil N ranged from 35 to 220 lbs/acre. Across all sites and years, the resulting yield response curve indicated that the maximum yield of 1330 lbs lint/acre was achieved with 210 lbs available N per acre [2, 3] (Figure 2). Much less data is available for Pima cotton. Fritschi and coworkers carried out a fertilization rate trial with Pima cotton at a site in Fresno County in 1999 and 2000 [1] (Figure 2). In their study, the maximum yield of 1430 lbs lint/acre is reached with 170 lbs available N per acre [1]. As in the study with Acala cotton, the available N included the soil residual N, which ranged from 40 to 65 lbs/acre.

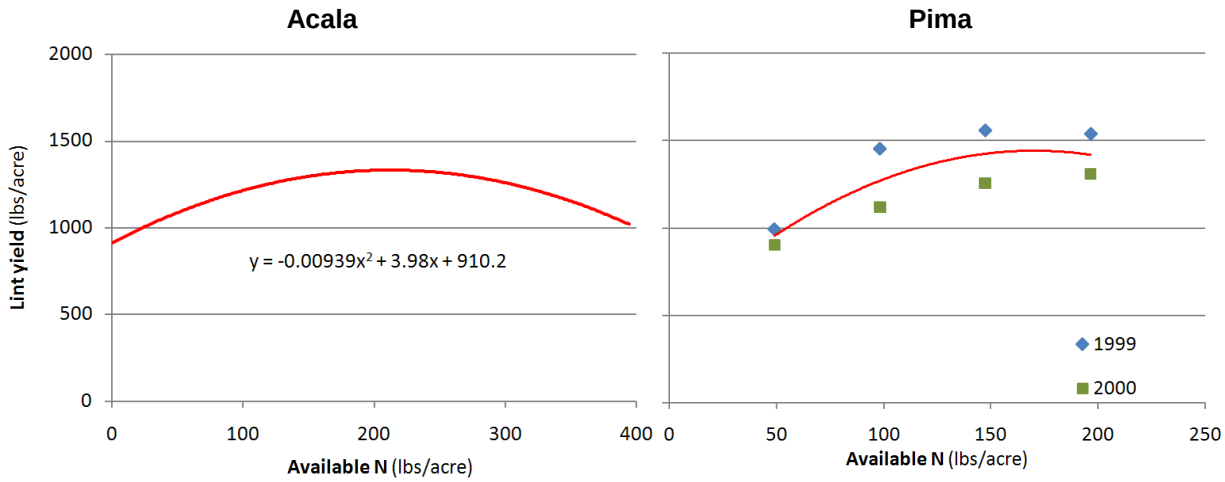


**Figure 2:** Yield response curve for Acala (left panel) and Pima cotton (right panel) grown in the San Joaquin Valley [1, 2, 3].

## Economically Optimal Nitrogen Availability

With the data presented in Figures 1 and 2, the EONR can be calculated. The analysis with different fertilizer costs (horizontal axis in Figure 3) and prices for lint (lines in Figure 3) shows that the economically optimal N availability (vertical axis in Figure 3) decreases with increasing costs of fertilizer and decreasing prices for cotton lint. These effects are much more pronounced for Acala cotton compared to Pima cotton. Two factors contribute to this difference. First, the price for Pima cotton is higher than the price for Acala cotton, while the costs for N are the same. Second, the yield response curve for Pima cotton is steeper. Because of these two factors, the optimal yield is close to the maximum yield for Pima cotton. However, as noted earlier, the dataset for Pima cotton is very small and the results presented here may not be representative for the San Joaquin Valley as a whole.

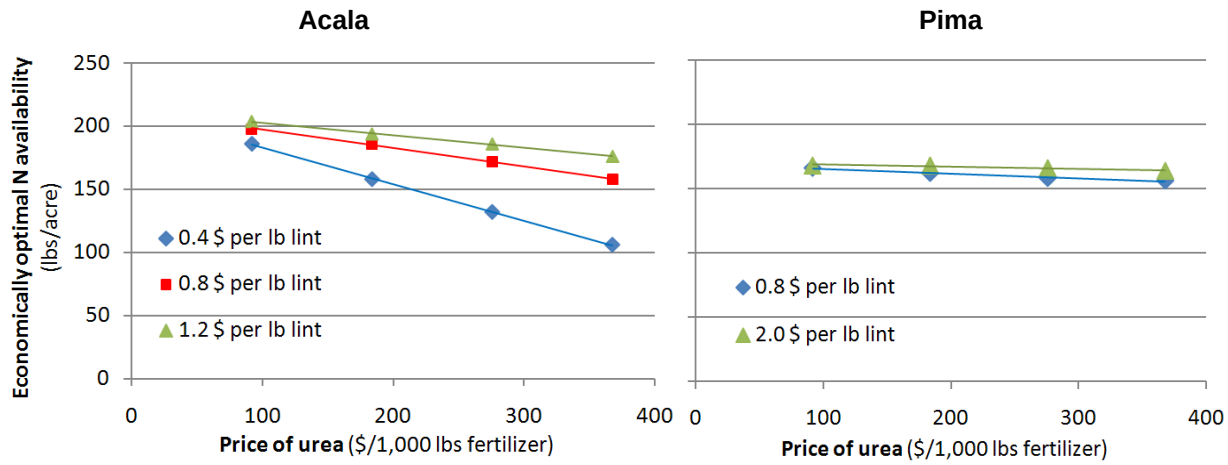


**Figure 3:** Economically optimal N availability as a function of fertilizer and lint price.

With the fertilizer costs and lint prices since 2000, the economically optimal N availability ranged between 160 and 190 lbs/acre for Acala cotton (Figure 4). This is considerably lower than the 212 lbs/acre needed to achieve the maximum yield. To determine the N application rate, the residual soil N in the top two feet of the

soil profile needs to be subtracted from the available N.

For Pima cotton, the economically optimal N availability ranged from 160 to 166 lbs/acre (Figure 4). As noted earlier, the difference to the N availability necessary for maximum yield (170 lbs/acre) is relatively small. As with Acala cotton, the residual soil N in the top two feet of the soil profile needs to be subtracted from the available N to determine the optimal N application rate. A considerable amount of nitrate-N may be present in the top two feet of the soil profile in spring. The residual N depends on many factors, such as fertilization intensity and crop grown in the previous year, as well as winter precipitation and soil type. It is therefore important to measure the soil residual N each spring and subtract it from the optimal N fertilization rate in order to prevent N over-application.

These calculations show that the optimal N rate is may be considerable lower than the N rate needed for maximum yield. The EONRs calculated here, however, are approximations, as they not only depend on fertilizer costs, lint prices and residual soil N, but also on the yield level and site-specific factors.

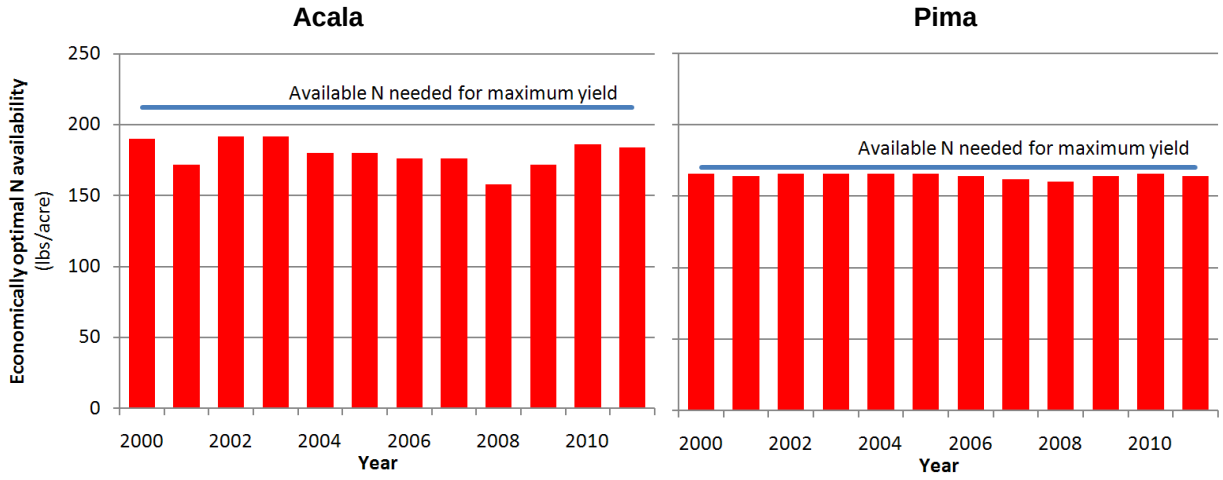


**Figure 4:** Economically optimal N availability since 2000.

## References


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