BREAKING THE ALFALFA YIELD BARRIER

Dr. J. Paul Mueller
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Historical Background for U.S. Production

During the past one-hundred or so years, alfalfa production has spread and flourished in the United States. It has contributed to progress in many phases of the livestock industry.

The value of alfalfa, or lucerne as it is called in Europe, as a forage crop was recognized early in U.S. history. Colonists attempted frequently to introduce alfalfa to the Atlantic states prior to the Revolutionary War (alfalfa was recorded in Georgia in 1736 and North Carolina in 1739). In general, these attempts failed for reasons not stated.

Between 1854 and 1873 alfalfa was brought from Chile to California where a sizable and successful production area was established in the San Joaquin Valley. From this "foot hold" in California, alfalfa production spread eastward. At the same time, Wendelin Grimm's "everlasting clover" contributed greatly to alfalfa expansion in the colder regions of the U.S. where a hardy type was needed. By the early part of this century, alfalfa was considered one of the best known forage plants.

In preparation for this paper, I reviewed some of our Experiment Station documents to learn something about when interest in alfalfa developed among North Carolina researchers. In the process, I found a bulletin from 1894 which reported evaluations made in 1891. I believe that the following quote from that bulletin typifies the early recognition by researchers of alfalfa's potential as a forage plant. "Lucerne grows best upon a deep, loose, dry limestone soil, but when lime or marl can be artificially supplied does excellently on sandy loam. Our plates were upon a stiff red-clay soil and upon a lowland plat rather too moist. The roots could not penetrate deeply, and upon such soil (lowland) the growth was necessarily slow and the plant was unable to withstand the intrusion of crab and bermuda grasses and weeds. Where it succeeds lucerne is the best of all meadow plants".

Many factors are responsible for making alfalfa one of the most widely grown forage crops in the U.S. Some of these factors include:

a. high yields and nutritive value of alfalfa relative to other forages.

Some factors contributing to the increase in alfalfa yields over the years include:

- perennial nature of the crop (stand persistence).
- deep root system and drought tolerance, but also good
- adaptation to irrigated conditions.
- development of regionally adapted cultivars.
- development of intensive cultural management.
- availability of sound research data that positively influenced production.
- development of a stable and active seed industry.

Table 1. Average Yield Estimates for Alfalfa Grown in North Carolina 1919 - 1981

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Individual Year Avg.</th>
<th>Decade Average</th>
<th>Change</th>
<th>Tons/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>1.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1919-1929</td>
<td>1.73</td>
<td></td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>1.60</td>
<td>1.85</td>
<td>0.25</td>
<td>+6.9</td>
</tr>
<tr>
<td>1935-1939</td>
<td>2.00</td>
<td>2.07</td>
<td>0.07</td>
<td>+3.5</td>
</tr>
<tr>
<td>1940</td>
<td>2.15</td>
<td>1.98</td>
<td>-0.17</td>
<td>-4.3</td>
</tr>
<tr>
<td>1950-1959</td>
<td>2.0</td>
<td>2.08</td>
<td>0.08</td>
<td>+4.0</td>
</tr>
<tr>
<td>1960</td>
<td>2.40</td>
<td>2.54</td>
<td>0.14</td>
<td>+5.6</td>
</tr>
<tr>
<td>1970-1979</td>
<td>2.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>2.40</td>
<td></td>
<td></td>
<td>+33.3</td>
</tr>
<tr>
<td>1981</td>
<td>-</td>
<td></td>
<td></td>
<td>+46.8</td>
</tr>
<tr>
<td>1981 vs. 1919</td>
<td>-</td>
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d. development of regionally adapted cultivars and development of intensive cultural management.

e. availability of sound research data that positively influenced production.

f. development of a stable and active seed industry.

Alfalfa Yield Potential and Progress

If one examines the annual estimates of alfalfa yields in the United States over a period of several decades, the apparent increase in average yields over the years is dismally low. The average alfalfa yield was 2.5 tons per acre; in 1950, the average estimated yield was 3.18, a 0.68 ton/A increase in 40 years.

I would like to use some data from North Carolina as a specific case in point. Average alfalfa yields are presented in Table 1 for the period of 1919-1981 with average yields for the six decades as well as the individual years of 1919, 1929, 1939, 1949, 1959, 1969, 1979, 1981.

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The North Carolina data are similar to national averages in that the actual increases in yield varied from 0.60 tons/A for the decade 1919-1929 to 2.64 tons/A for the decade 1981 vs. 1919.
individual year comparisons 1919 vs. 1981, to 0.81 tons/A for the decades comparison 1919-1929 vs. 1970-1979. These changes represent an increase of 33-47% in 60-70 years in North Carolina versus a 27% increase in 60 years for the national average yields. When comparing alfalfa yield increases to increases of other crops such as corn or grain sorghum where over 100% increases have been achieved in a decade, alfalfa average yield increases appear to have been minimal.

Nevertheless, relying on average yields as an indication of production trends can be deceiving. It is well documented that top farmers have been able to consistently produce 100-150% more than state average yields. Also, in some areas of the U.S. where state yield averages have not shown a consistent trend toward increasing, individual growers have regularly recorded yield increases far superior to the state averages.

**Breaking Yield Barriers**

We have been breaking yield barriers for 60 years. Each new advance in cultural management or in breeding has tended to act in a barely perceptible, but additive way so that slowly but steadily, yield advances have been made. What is particularly disturbing is that during the past 50 or so years these increases have not been used to advantage by a sizable percentage of the growers. This is reflected to a large degree in the poor to mediocre increases in average yields mentioned previously.

It is believed by some that the progress in yield improvement made during the decade of the 70's was the greatest ever seen in the U.S. Notably, in the past five years numerous reports from many states have shown high yield responses. This is encouraging, but there is plenty of need for further improvement particularly in view of the tremendous acceleration in production costs.

**High Yield Recipe**

Reports of non-irrigated yields of 7 to 10 tons of hay equivalent per acre have been frequent during the past several years. Irrigated yields of 11-14 tons have also been reported. Numerous steps, keys, formulas, factors, etc. have been offered as recipes for attainment of high yields. Not surprisingly, most of the high yield programs have recommendations with such in common. Below is an attempt to collate some of these ideas that research and extension workers from many states feel are important to the high yield approach.

1. **SOIL SELECTION** - Choose a deep, well-drained, fertile soil.
2. **LIME SOIL** to pH 6.5 - 7.0.

3. **SOIL FERTILITY** - Establish stand to soil test.
   - Annual topdressing with P, K, B essential (some times S is needed)
   - K requirement usually 2-3 times that of P
   - P fertilizer to yield-goal level
   - Split annual topdressing
   - Frequent soil testing

4. **PLANT AN ADAPTED VARIETY WITH HIGH YIELD POTENTIAL.**

5. **GET AN EXCELLENT STAND**
   - Prepare a good seedbed
   - sow enough seeds (8-25 lbs/A)
   - Always inoculate seed with proper strain of Rhizobia (use sticker)
   - Use herbicide to control weeds in seedling stands.

6. **HARVEST PROPERLY**
   - 1st cut - late bud stage
   - 2nd and later cuts - 100 to 25% bloom or about 30 to 35 day intervals.
   - Manage for as many cuts as possible in your area, 3, 4, 5, 6, etc.

7. **CONTROL PESTS**
   - Insects - alfalfa weevil, leaf hoppers, aphids, armyworms, etc.
   - Weeds - use recommended amounts of labeled herbicides
   - Disease - cultivar selection

8. **FALL MANAGEMENT**
   - Do not harvest within about 30 days of the average frost date. Allow 12-18" regrowth prior to frost.
   - Harvest surplus growth after killing frost of about 24°F.
   - Leave 3-5 inches of stubble for snow cover.

**Maximum Economic Yields**

To the farmer, high yield without regard to profitability is absurd. Profit is not only influenced by the yield per acre, but also by the costs associated with producing such yields. Clearly, simply maximizing yield per se is no guarantee of maximizing profit.

To the scientist, investigating the scientific principles relating to plant yield is very important. His treatments or his specific approach to a problem may not be economically feasible by present day standards. Nevertheless, he must continue to determine the hows and the whys, for it is this approach that will assure future success.

Just imagine what the skeptics were saying about Thomas Edison while he was spending years and innumerable tests on some "fool thing" called the electric light!
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Growers should find out the yield potential of their soils and climates and strive to reach this potential as economically as possible. As break-even yield levels continue to increase during the 80’s, maximum economic yields will become essential to profitable alfalfa production.

CHALLENGES FOR THE 80’s, 90’s AND THE 21st CENTURY

Growers Challenge

In the years ahead, the successful grower will be the one who is able to put numerous production components together in the proper fashion. Much like fitting pieces of a puzzle together, he must be able to select the important information from a variety of sources and form a smooth running production system. Flexibility will be very important. The ability to feed, store, sell or further process the alfalfa crop will be a great advantage to the grower. Alfalfa, in the final analysis, is marketed through animals. It is unlikely that this will change again in the humid areas of the U.S. because of the leaf angle being more upright allowing light penetration into the leaf. The competitive spirit of growers must be maintained to reach this potential as economically as possible. As breakeven yield levels continue to increase during the 80’s, maximum economic yields will become essential to profitable alfalfa production.

Researchers Challenge

Much progress is still to be made with existing technology. We must strive to find the right combinations. Intensified soil fertility is as much a part of the high yield approach as cultivar improvement or any one thing. There is still much to be learned about nutrient interactions. Irrigation must be studied again in the humid areas of the U.S. because of the recent development of high yielding disease resistant cultivars. Establishment, harvest and utilization techniques that increase the odds of success and profits are continually needed. Cultivars be developed that regrow quickly producing enough leaf area so that plants may be cut more frequently without depleting carbohydrate reserves or lowering yield per cutting? Should leaf angle be more upright allowing light penetration into the leaf?
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Seedsman Challenge

Seedsmen must continue to increase seed yields per acre in order to maintain a reasonable margin of profit and to assure the grower the lowest possible price to growers. Cultural techniques that influence seed yield should be studied completely. Concentrated work in the area of pollination and seed set could help to increase seed yields. Moreover, finding ways to produce PI hybrids effectively and efficiently could advance forage yield significantly. Many times experimental lines with excellent yield potential are discarded because conventional seed production practices produce unacceptable amounts of seed. New seed production practices must be explored and made practical so these high potential experimental lines can be offered to the grower at a reasonable price.

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