INTRODUCTION

Dry edible bean production is a major agricultural industry in North Dakota and Minnesota. In 1987 North Dakota ranked second nationally in production of all dry edible beans and first in production of pinto beans. Minnesota ranked seventh in production of dry edible beans and sixth in the production of pinto beans. Significant production has occurred since 1972 when approximately 55,000 acres were grown. By 1987 acreage had increased more than 800 percent in the two-state area.

During this period technology has advanced, but there has never been a comprehensive survey to determine growers' actual practices or problems. Similar surveys of growers have been done in Michigan (1). Baseline data need to be established so that research can be better directed and industry support better planned. The results of this survey together with results of successive surveys will allow assessment of the impact of new products, new varieties and other changes in technology on bean production.

A single page survey form requesting information on 18 topics related to bean production was developed by Lamey and Peterson. This form was similar to one successfully used by A.G. Dexter, Extension Sugarbeet Specialist, to evaluate sugarbeet problems in North Dakota and Minnesota.

Questionnaires were mailed to nearly 3,600 growers identified through the Northarvest Bean Growers Association. This grower association administers checkoff funds taken from the sale of beans in North Dakota and Minnesota and has the most accurate and current listing of growers.

Survey forms were mailed in November after harvest was completed. The survey was anonymous and purposefully did not request information on yield to preclude any misconception that the survey was for marketing information purpose. The nature of the survey was reviewed at the Northarvest Bean Growers Association annual meeting in January to encourage maximum grower participation.

RESULTS AND DISCUSSION

A total of 862 forms were returned. Of these, 69 respondents indicated they no longer grew beans and 19 forms were so incomplete that they were unusable, which left 774 information-bearing forms. Of the 774, 610 growers were from North Dakota and 159 were from Minnesota. Three growers from South Dakota planting a total of 208 acres responded to the survey.

The total acreage represented by the respondents was 169,039 with 144,679 acres from North Dakota and 23,892 from Minnesota. This represents 38 percent of the total bean acreage in the two states. North Dakota survey acreage was 39 percent of the state's total (370,000 acres) and Minnesota survey acreage was 32 percent of the state's total (75,000 acres) based on USDA Crop Report estimates (2,3).

These results properly represent only one year's production, which may not reflect long-term problems or practices. The data do form a basis for making current estimates. Several years' data will indicate trends and allow analysis of the impact of changing technologies on production.

As the results were compiled, structural problems were noted. Some important questions were unclear or overlooked. For example, a blank for state identification was omitted and growers in counties with the same name from different states could not be distinguished. In these cases the information was attributed to the county which historically produced the most beans. The exception was when the growers indicated the state in some way. This problem introduced a small error into the results which should be rectified in future surveys.

The compilers attempted to do as little editing as possible. Most responses were considered "as is." When grower's responses were unclear or apparently in error (for example, herbicides or micronutrients listed as fungicides) judgements were made and responses modified as well as possible. When there was no basis for judgement, the response in doubt was discarded. Partial data were kept as much as possible. Missing portions of associated data were coded to allow counting but were converted in the tabulate program to equal 0 if any cumulative figures were calculated. As a result, final computations provided sums that did not necessarily cross check.

In this report, all of the tabular data are based on the survey. To extrapolate these data to the entire production for a state, the North Dakota data should be multiplied by 2.56, the Minnesota data by 3.125, and the total data (both states) would be times 2.63.
When asked to designate their biggest production problem in the 1987 crop, growers clearly ranked disease and weeds as the top two (Table 1). The major varieties grown in the two states are given in Table 2. On these varieties, white mold caused by *Sclerotinia sclerotiorum* was the most serious disease (Table 3). Other significant diseases were rust (*Uromyces appendiculatus* var. *appendiculatus*), bacterial blight (includes halo blight caused by *Pseudomonas syringae* pv. *phaseolicola*), bacterial brown spot caused by *Pseudomonas syringae* pv. *phaseoli*, and common blight caused by *Xanthomonas campestris* pv. *phaseoli*) and Alternaria leafspot (*Alternaria* spp.).

Bagged and tagged (includes certified and affidavit) seed was planted on 127,217 (88 percent) of the North Dakota surveyed acres and on 23,081 (97 percent) of the Minnesota acres. The remaining acreage was planted with undesigned seed. Blight ranking was compared to seed source (Table 4). It is notable that 78 percent of the tagged seed was grown without noted blight problems while 71 percent of the bin run seed had no significant blight disease.

In North Dakota, 3 percent (3,852 acres) of the bean acreage was grown under irrigation while in Minnesota 27 percent (6,351 acres) of the bean acreage was irrigated. The severity of disease was compared to irrigation or dryland production (Table 5). In most cases percentage of acreage in which disease was a problem was similar between irrigated

### Table 1. Percentage of growers and acres affected by various production problems in North Dakota and Minnesota in 1987.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Problem</th>
<th>ND growers</th>
<th>ND acres</th>
<th>MN growers</th>
<th>MN acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Disease</td>
<td>44.6</td>
<td>72,614</td>
<td>18.2</td>
<td>9,382</td>
</tr>
<tr>
<td>2</td>
<td>Weeds</td>
<td>23.4</td>
<td>33,615</td>
<td>41.5</td>
<td>7,672</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
<td>8.5</td>
<td>8,108</td>
<td>13.2</td>
<td>2,069</td>
</tr>
<tr>
<td>4</td>
<td>Emergence</td>
<td>6.2</td>
<td>7,022</td>
<td>8.8</td>
<td>1,940</td>
</tr>
<tr>
<td>5</td>
<td>Water</td>
<td>7.9</td>
<td>10,799</td>
<td>1.9</td>
<td>183</td>
</tr>
<tr>
<td>6</td>
<td>Drought</td>
<td>2.0</td>
<td>2,331</td>
<td>3.8</td>
<td>531</td>
</tr>
</tbody>
</table>

### Table 2. Frequently grown cultivars of beans, acreage and numbers of growers in North Dakota and Minnesota in 1987.

<table>
<thead>
<tr>
<th>Variety</th>
<th>North Dakota</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>Growers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Upland</td>
<td>28,427</td>
<td>227</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Topaz</td>
<td>23,302</td>
<td>217</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Nodak</td>
<td>15,142</td>
<td>159</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Fiesta</td>
<td>11,863</td>
<td>136</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Olathe</td>
<td>11,015</td>
<td>125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Pindak</td>
<td>4,858</td>
<td>53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Fleetwood</td>
<td>3,907</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Snobunting</td>
<td>2,954</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. C2O</td>
<td>2,474</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Hyden</td>
<td>1,062</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. Worst disease (ranked as #1, 2, or 3) on North Dakota or Minnesota beans in 1987.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Disease</th>
<th>North Dakota</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acres</td>
<td>Growers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>White Mold</td>
<td>101,709</td>
<td>378</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>5,606</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>5,687</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>1,411</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td>White Mold</td>
<td>8,679</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>28,742</td>
<td>109</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>17,525</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>3,494</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>White Mold</td>
<td>10,733</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>13,806</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>11,924</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>4,944</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Disease</th>
<th>Minnesota</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acres</td>
<td>Growers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>White Mold</td>
<td>12,972</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>178</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>85</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>39</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td>White Mold</td>
<td>1,070</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>2,282</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>768</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>White Mold</td>
<td>2,604</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rust</td>
<td>210</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bact Blight</td>
<td>2,232</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternaria</td>
<td>200</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bact. Blight = bacterial blights including halo blight, common blight or brown spot.
and dryland production. The exception was white mold in which there was 12 percent less acreage classified as having a problem in irrigated compared to dryland production.

The relationship between hailed acres and disease severity is given in Table 6. Compared to nonhailed acres, rust was rated as a significant problem on 9 percent more of the hailed acres. Similarly, bacterial blight was considered a problem on 9 percent more of the hailed acres and root rot on 8 percent more.

Fungicides applied to the bean crop are listed in Table 7. Topsin (14,401 A.), Maneb + Zinc F4 (9,532 A.), Maneb 80 (7,930 A.), and MF-4 (5,434 A.) were the most widely used fungicides. When white mold was considered the most serious disease, Topsin was applied to 12,186 acres, Benlate to 2,950 acres and Mertect to 200 acres (Table 8). While not traditionally recommended for white mold, sulfur was sprayed on 1,400 acres by one grower. When white mold was listed as the second most important disease, Benlate was applied to 130 acres and Topsin was applied to

### Table 4. Relationship between seed source and ranking of bacterial disease problem.

<table>
<thead>
<tr>
<th>Rank of Blight Problem</th>
<th>Seed Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bagged &amp; Tagged</td>
</tr>
<tr>
<td>1**</td>
<td>4%**</td>
</tr>
<tr>
<td>2</td>
<td>11%</td>
</tr>
<tr>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>0</td>
<td>78%</td>
</tr>
</tbody>
</table>

* Generally certified or its equivalent.
** 1 = Most serious of disease problems, 2-3 = successively less serious, 0 = none.
*** Numbers are % of surveyed acreage with ranked blight problem.

### Table 5. Relationship between irrigation and disease problems.

<table>
<thead>
<tr>
<th>Rank of disease problem</th>
<th>WM</th>
<th>Rust</th>
<th>Bacteria</th>
<th>Alt.</th>
<th>Root Rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(25,542 A)</td>
<td>1</td>
<td>56</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
<td>16</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Dryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(158,117 A)</td>
<td>1</td>
<td>68</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
<td>19</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

* Numbers are percent of acres in that category. WM = White mold, ALT = Alternaria leafspot.

### Table 6. Percentage of diseased acres on fields that had received hail* compared to fields without hail.

<table>
<thead>
<tr>
<th>Rank of disease problem</th>
<th>WM</th>
<th>Rust</th>
<th>Bacteria</th>
<th>Alt.</th>
<th>Root Rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hailed Acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>69</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>16</td>
<td>8</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Nonhailed Acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>68</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>17</td>
<td>8</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total Acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>68</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>17</td>
<td>8</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

* 19.6% of the acreage received hail. There was no indicator for hail severity, frequency or timing. WM = White mold, Bacteria = Bacterial blight, Alt. = Alternaria leafspot. Root rot includes those caused by Rhizoctonia, Pythium or Fusarium species.

### Table 7. Fungicides used on the 1987 bean crop in North Dakota and Minnesota.

<table>
<thead>
<tr>
<th></th>
<th>North Dakota</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Variety</td>
<td>Acres</td>
</tr>
<tr>
<td>Bravo</td>
<td>Maneb 80</td>
<td>83</td>
</tr>
<tr>
<td>Champion</td>
<td>Maneb</td>
<td>100</td>
</tr>
<tr>
<td>Kocide</td>
<td>MF-4</td>
<td>.83</td>
</tr>
<tr>
<td>Maneb 80</td>
<td>Maneb + Zinc</td>
<td>540</td>
</tr>
<tr>
<td>AgSCO MN</td>
<td>Benlate</td>
<td>160</td>
</tr>
<tr>
<td>Maneb</td>
<td>Benlate</td>
<td>500</td>
</tr>
<tr>
<td>MF4</td>
<td>Benlate</td>
<td>3,623</td>
</tr>
<tr>
<td>Maneb + Zinc</td>
<td>Broadcast</td>
<td>625</td>
</tr>
<tr>
<td>F4</td>
<td>Dithane M22</td>
<td>315</td>
</tr>
<tr>
<td>Benlate</td>
<td>Broadcast</td>
<td></td>
</tr>
<tr>
<td>Banded</td>
<td>Special</td>
<td></td>
</tr>
<tr>
<td>Toppin</td>
<td>Banded</td>
<td></td>
</tr>
</tbody>
</table>
700 acres. White mold as a third most important disease was treated with Topsin (1,515 acres). A total of 17,681 surveyed acres were treated with a fungicide recommended for white mold control.

Fungicides for rust control are given in Table 9. Maneb compounds were most commonly used (15,565 acres or 9.2 percent of the surveyed acres). Most growers sprayed a single time (average = 1.25 sprays) against rust. Copper compounds were used on only 120 acres and chlorothalonil (Bravo) on 200 acres.

Only 215 acres were sprayed with a copper compound (Kocide) for bacterial blight control.

There was no apparent relationship between method of land preparation and disease (Table 10). In North Dakota, 57 percent of the growers used chisel plow and 42 percent prepared land with mold-board plow. Few (9 percent) used conservation tillage. In Minnesota 46 percent of the growers used chisel plow, 51 percent used mold-board plowing and 9 percent used conservation tillage.

Of the many potential diseases of dry edible beans, growers in North Dakota and Minnesota seem particularly concerned with only five (white mold, rust, bacterial blight, Alternaria, and root rot). Numbers of diseases are kept small through several mechanisms. Breeding programs have provided cultivars resistant to anthracnose and the major virus diseases. Losses due to bean rust have been minimized by planting cultivars resistant to most of the prevalent races in the states. Nematodes are not yet a serious problem in the region although the soybean cyst nematode can affect dry edible bean production.

The use of high quality seed is very important in suppressing seedborne diseases. Of the acreage planted to bagged and tagged seed, 78 percent was judged to have no blight problem. Growers are advised to have bin-run seed tested for amount of bacterial contamination and to plant only the highest quality seed. In North Dakota, results of the dome test (4) are used as the basis of the advisory. Of acreage planted with bin-run seed, 71 percent had no apparent problem from bacterial disease. Almost all bagged and tagged seed has been treated with a fungicide (frequently captan), an insecticide (such as lindane), and streptomycin sulfate which reduces surface contamination by bacterial pathogens. Seed treatment and vigorous seeds reduce the impact of damping off and early season root rots.

The 1987 growing season (May to August) was characterized by wet warm conditions. The moist season was especially conducive for the development of white mold. The moisture also favored high statewide yields (1,400 pounds

### Table 8. Fungicide use compared to estimated white mold ranking.

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Treatment</th>
<th>Acres</th>
<th>Sprays</th>
<th>Growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Benlate Broad</td>
<td>2,100</td>
<td>20.5</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Benlate Band</td>
<td>850</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tospin Broad</td>
<td>10,053</td>
<td>58</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Tospin Band</td>
<td>2,133</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Mertect Broad</td>
<td>200</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sulfur</td>
<td>1,400</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>#2</td>
<td>Benlate Band</td>
<td>130</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Tospin Broad</td>
<td>325</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Tospin Band</td>
<td>375</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>#3</td>
<td>Tospin Broadcast</td>
<td>810</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Tospin Band</td>
<td>705</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

1 Worst problem = #1.
2 Broad = broadcast application. Band = Band application on row.

### Table 9. Fungicides applied to beans when bean rust was designated a serious consideration.

<table>
<thead>
<tr>
<th>Rust severity</th>
<th>Fungicide</th>
<th>Acreage</th>
<th>Number of sprays</th>
<th>Number of growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Champion</td>
<td>80</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Kocide</td>
<td>40</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Maneb 80</td>
<td>455</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Maneb + Zinc F4</td>
<td>1,560</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>M22 Special</td>
<td>240</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>#2 Bravo</td>
<td>200</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Maneb 80</td>
<td>3,247</td>
<td>15</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Agsco MN</td>
<td>520</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Manex</td>
<td>275</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>MF-4</td>
<td>3,015</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Maneb + Zinc F4</td>
<td>3,453</td>
<td>21</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Dithane M22</td>
<td>825</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>190</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>#3 Maneb 80</td>
<td>493</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>MF-4</td>
<td>221</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Maneb + Zinc F4</td>
<td>1,091</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Dithane M22</td>
<td>115</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 10. Methods of land preparation and disease rank.

<table>
<thead>
<tr>
<th>Tillage Type</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Mold</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chisel plow</td>
<td>59</td>
<td>53</td>
<td>47</td>
<td>59</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>33</td>
</tr>
<tr>
<td>Rust</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chisel plow</td>
<td>55</td>
<td>57</td>
<td>50</td>
<td>58</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>8</td>
<td>0</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>37</td>
<td>43</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>Bacterial Blight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chisel plow</td>
<td>55</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>37</td>
<td>42</td>
<td>42</td>
<td>48</td>
</tr>
<tr>
<td>Alternaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chisel plow</td>
<td>55</td>
<td>54</td>
<td>35</td>
<td>53</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>7</td>
<td>0</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>38</td>
<td>46</td>
<td>41</td>
<td>47</td>
</tr>
<tr>
<td>Root Rot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chisel plow</td>
<td>54</td>
<td>71</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>39</td>
<td>22</td>
<td>40</td>
<td>41</td>
</tr>
</tbody>
</table>

* Number is % of designated acres.
per harvested acre) in 1987 compared to a more typical year 1985 (1,270 pounds per harvested acre). Rainfalls were frequent and extended wet periods within plant canopies were not uncommon. Moderate temperatures favored bean blossom retention and inoculum was plentiful due to an epidemic of white mold in various susceptible crops in 1986.

Although there was much grower concern about white mold, only about 18,000 acres were treated with a fungicide for white mold control. This represents 16 percent of the 114,681 acres identified as having white mold as most serious (#1) problem (Table 3). This may also indicate that once growers recognized their white mold problem, it was too late to attempt control or that fungicide costs are perceived to be too high. For those growers who recognized white mold as their #1 problem and attempted control, most applied fungicide only once. The average of 93 growers applying fungicide was 1.1 sprays. Label instructions generally recommend two applications.

The data (Table 5) indicate reduced white mold under irrigation. The survey did not request information on the irrigation amount, scheduling, etc. In this wet year it is likely that many fields received little supplemental water, yet were classified as irrigated. Most of the irrigated acreage is in Minnesota, and the cultivar mix under irrigation (Table 2) is probably different than the mix on dryland.

Hail was apparently associated with increased intensity (measured as acres affected) of bacterial blight, rust and root rot. Since rain splash spreads bacterial pathogens, rain generally accompanies hail and hail provides wounds needed for pathogen ingress, this association was predictable. The relationships between rust, root rot, and hail are less clear. As an obligate pathogen, U. appendiculatus does not require wounds for host penetration. Severe wounding with defoliation can force plant regrowth which provides susceptible tissues longer in the growing season.

Generally the effects of root rot are most severe during drought. In dry soil, adventitious roots form poorly and lack of functional roots above lesioned areas places significant stress on plants. In 1987, moisture was abundant to excessive in some fields and plants were often in standing water for several days following rains. Beans do not tolerate anaerobic, water-logged soil conditions well. Root stress in anaerobic soils may predispose plants to root rots, especially those caused by *Pythium* spp. It is difficult to separate plant death caused by drowning from plant death caused by *Pythium* as a result of excess water.

If hail defoliates plants in their reproductive phase, there is less photosynthate to be partitioned between pods and the plant's metabolic machinery. The amount of photosynthate in the roots could become critically low, the root metabolism become impaired, and root rots become more prevalent.

### WEEDS

Weeds were designated as the most serious production problem by 28 percent of all dry bean producers, 23 percent of North Dakota producers and 42 percent of Minnesota producers surveyed (Table 1). Diseases were rated as the most serious problem by 39 percent of all dry bean producers, 45 percent of North Dakota producers, and 18 percent of Minnesota producers. More producers ranked disease as the most serious production problem in North Dakota, while more producers ranked weeds as the most serious production problem in Minnesota. However, diseases were rated the most serious problem on more acres than weeds in Minnesota. The different response between North Dakota and Minnesota growers concerning the worst production problem in dry beans might reflect a difference in the type and severity of weed and disease problems encountered in the two states.

Wild mustard was ranked as the worst weed problem in dry beans by more producers than any other weed in North Dakota or when combined over the two states (Table 11). Wild mustard, foxtails (pigeongrass), and redroot pigweed were frequently mentioned in both North Dakota and Minnesota as the worst weed problem. These weeds are prevalent over the entire region, are often present at high densities, and will cause significant dry bean yield reductions if left uncontrolled. However, all three weeds can be effectively controlled with herbicides in dry beans.

Black nightshade was listed most frequently as the worst weed problem for Minnesota growers. Black nightshade probably is more common in Minnesota than North Dakota because of different cropping systems (more soybean and row crop production) and herbicide use patterns. Season-
long black nightshade control is difficult to obtain in beans because nightshade continues to emerge throughout the growing season. In addition, black nightshade causes harvest-related problems such as plugged combines and stained beans, which lowers the quality and value of the crop. Therefore, black nightshade is a very serious problem in dry beans. A higher frequency of nightshade in Minnesota than North Dakota might help explain why more Minnesota farmers perceived weeds to be their most serious production problem.

Kochia was listed as the worst weed problem more frequently by North Dakota than Minnesota growers, while common lambsquarters and common cocklebur were listed more frequently by Minnesota growers (Table 11). Common cocklebur and common lambsquarters commonly infest soybean growing areas and grow better with good soil moisture than in dry conditions, while kochia is a more drought tolerant weed better adapted to the drier environment in North Dakota. When growers were asked to list their three worst weed problems (Table 12), the results were similar to the response concerning the worst weed problem.

Herbicide use patterns reflected the most common weed problems and economics of treatment. Treflan, Sonalan, and Basagran were the most widely used herbicide treatments for weed control (Table 13). Treflan and Sonalan are similar herbicides used preplant incorporated for annual grass and broadleaf weed control including foxtails, redroot pigweed, kochia, and common lambsquarters. Treflan and Sonalan are effective and less costly than some other comparable treatments. Basagran is the only herbicide labeled as a postemergence treatment in dry beans and controls several broadleaf weeds, including wild mustard, which is not controlled adequately by most other herbicides used in dry beans.

Amiben, Lasso, and Dual use was greater in Minnesota than in North Dakota, perhaps due to the greater frequency of black nightshade and greater precipitation in Minnesota. Amiben, Lasso, and Dual are effective for early season black nightshade control in dry beans but require greater moisture for activation and consistency as compared to Sonalan or Treflan.

Table 12. Weed species listed as one of the three most serious weed problems in dry beans in 1987.

<table>
<thead>
<tr>
<th>Weed Species</th>
<th>Total</th>
<th>North Dakota</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growers</td>
<td>Acres</td>
<td>Growers</td>
</tr>
<tr>
<td>Wild mustard</td>
<td>57</td>
<td>64</td>
<td>65</td>
</tr>
<tr>
<td>Foxtails (pigeongrass)</td>
<td>42</td>
<td>44</td>
<td>42</td>
</tr>
<tr>
<td>Redroot pigweed</td>
<td>30</td>
<td>33</td>
<td>29</td>
</tr>
<tr>
<td>Kochia</td>
<td>24</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Wild oats</td>
<td>23</td>
<td>25</td>
<td>28</td>
</tr>
<tr>
<td>Common cocklebur</td>
<td>18</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Common lambsquarters</td>
<td>16</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>Black nightshade</td>
<td>14</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Canada thistle</td>
<td>6</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Common ragweed</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 13. Treatments used for weed control in dry bean fields in 1987.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total</th>
<th>North Dakota</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growers</td>
<td>Acres</td>
<td>Growers</td>
</tr>
<tr>
<td>Treflan</td>
<td>61</td>
<td>43</td>
<td>61</td>
</tr>
<tr>
<td>Sonalan</td>
<td>48</td>
<td>43</td>
<td>51</td>
</tr>
<tr>
<td>Prowl</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Amiben</td>
<td>7</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>EPTC</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Lasso</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Dual</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Basagran</td>
<td>56</td>
<td>38</td>
<td>56</td>
</tr>
<tr>
<td>Sodium chlorate</td>
<td>10</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Post-Plant cultivation</td>
<td>49</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>16</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Herbicides may have been applied as a tank-mixture with other herbicides.
The most widely used herbicide tank-mix reported in the survey was a Treflan-EPTC combination, applied by 4 percent of the growers to about 4 percent of the acreage (data not presented). Other tank-mixtures were used on less than 2 percent of the dry bean acres. However, over half of the Amiben was applied as a tank-mixture with various herbicides to improve the spectrum and consistency of weed control compared to Amiben applied alone.

Spring applications of EPTC and Treflan were more common than fall application. Approximately 10 percent of the total EPTC used was applied in the fall, while about 15 percent of the total Treflan used was applied in the fall (data not presented). The majority of growers rated weed control good or excellent with most herbicides (data not presented).

Cultivation was used on approximately half of the acres for weed control. Cultivation remains one of the cheapest and most effective methods for controlling weeds between the rows. Handweeding was utilized by 16 percent of the growers for weed control on 5 percent of the acres. Handweeding might be the best method for control of light infestations of herbicide tolerant weeds but often is impractical for larger fields or heavy infestations.

Sodium chlorate, which had a Section 18 Emergency Use registration in Minnesota and North Dakota for preharvest desiccation in dry beans in 1987, was applied to 4 percent of the acreage in North Dakota and 11 percent of the acreage in Minnesota (Table 13). More sodium chlorate use in Minnesota might reflect greater weed problems and wetter conditions than in North Dakota. When questioned about the need for a desiccant, 47 percent of the producers indicated no need for a desiccant, 42 percent indicated a need for a desiccant, and 10 percent indicated a desiccant was needed some of the time (Table 14). Minnesota producers perceived a greater need for a desiccant in dry beans than North Dakota farmers. Full label registration presently is being pursued for the use of desiccants in dry beans.

ACKNOWLEDGEMENTS

Inputs of Minnesota scientists Dick Meronuck, Bev Durgan, Ken Ostlie, and Lee Hardman and North Dakota scientists Ken Grafton and Dean McBride are gratefully acknowledged. Steve Venette assisted in data entry and Lon Tonneson mailed the survey forms.

The survey was funded in part by the Northarvest Bean Growers Association, the North Dakota Agricultural Extension Service and the North Dakota Agricultural Experiment Station.

REFERENCES


Table 14. The need for a desiccant as a pre-harvest aid in dry beans.

<table>
<thead>
<tr>
<th>Need for desiccant</th>
<th>Total</th>
<th>North Dakota</th>
<th>Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growers</td>
<td>Acres</td>
<td>Growers</td>
</tr>
<tr>
<td>No</td>
<td>47</td>
<td>52</td>
<td>31</td>
</tr>
<tr>
<td>Yes</td>
<td>42</td>
<td>38</td>
<td>26</td>
</tr>
<tr>
<td>Sometimes</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

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