Background Information

- Dry beans, an annual crop high in protein content and with considerable dietary benefits, are native to Central and South America.
- They come in many different types and colours (cf. Photo 1), with the small white as well as red speckled (sugar beans; Photo 2) belonging to the *Phaseolus vulgaris* species while large white kidney beans belong to the *P. coccineus* species (Liebenberg, 2002).
- Within each of these two main species of dry beans there are many seed types differing in size, shape or colour, and within each type there are, in turn, many different cultivars from short season (85 - 94 days) to long season (105 - 115 days) varieties which also differ in adaptability to climatic conditions and to disease resistance (Liebenberg, 2002).

Site Requirements for Dry Beans

- Dry beans require a MAP of 600 - 650 mm, of which optimally 400 - 500 mm should fall into their summer growing season (Smith, 1994; 1998).
- Excessive rain, however, causes flower drop and promotes diseases.
- Mean daily relative humidity should be between 50% and 60% (Smith, 1994).
- The ideal temperature range for dry beans is 18 - 24°C.
- Yields are reduced when daily temperature maxima are > 30°C for *P. vulgaris* and > 25°C for *P. coccineus* (large kidney beans) during the flowering period as a result of abscission of flowers and a low pod set (Liebenberg, 2002).
- Dry beans are highly sensitive to frost, as flowers are damaged at temperatures < 5°C (Smith, 1994).
- Maximum temperatures below 20°C delay maturity and cause empty mature pods to develop (Liebenberg, 2002).
- Dry beans require 1 100 heat units (base 10°C) in their growing season (Smith, 1998).
- With respect to soils, dry beans prefer deep (0.9 m, minimum 0.5 - 0.6 m) sandy loams, sandy clay loams and clay loams with a clay content of 15 - 35%.
- Soils should be well drained, since dry beans are very sensitive to waterlogging (Smith, 1994; 1998).
- When soils are too sandy, on the other hand, nematode damage may occur (Liebenberg, 2002).
- Dry beans prefer soils with a pH of 5.8 - 6.5 and are very sensitive to acid soils (pH < 5.2) as well as to compacted soils (Liebenberg, 2002).

Dry Bean Production in South Africa

- On average in the RSA, ~ 50 000 ha are planted to dry bean varieties each year (Figure 16.9.1; NDA, 2006), of which 65 - 75% are red speckled beans, 10 - 20% small white beans and 5 - 10% kidney beans (Liebenberg, 2002).
- About 1/6 (16%) of area planted is under irrigation, and the remaining 84% is rainfed, i.e. dryland (Statistics SA, 2002).
Determination of Dry Bean Yield Estimates, Based on Smith’s Climatic Criteria

Areas were considered climatically unsuitable for dry bean production when accumulated October to March rainfall was < 400 mm or > 1300 mm and accumulated heat units (base 10°C) for the same period were < 1000 or > 2800 degree days.

Using Smith’s (1994) climatic criteria only, without cognisance of the soil properties or level of management, dry bean yield was calculated as

\[ Y_{db} = P_{eom} \cdot P_{su} \cdot D_{db} / 100 \]

where

- \( Y_{db} \) = dry bean yield (t.ha\(^{-1}\).season\(^{-1}\))
- \( P_{eom} \) = effective rainfall factors for October to March
  - \( 0.60 + 0.00125(P_{su} - 480) \) for \( 400 < P_{su} < 720 \)
  - \( 0.90 - 0.00063(P_{su} - 720) \) for \( 720 < P_{su} < 1300 \)
- \( P_{su} \) = accumulated rainfall (mm) for October to March
- \( D_{db} \) = yield index for dry beans
  - \( 0.20 + 0.00025(H_{su} - 1100) \) for \( 1000 < H_{su} < 1600 \)
  - \( 0.33 + 0.00013(H_{su} - 1600) \) for \( 1600 < H_{su} < 1800 \)
  - \( 0.35 - 0.00013(H_{su} - 1800) \) for \( 1800 < H_{su} < 2200 \)
  - \( 0.30 - 0.00025(H_{su} - 2200) \) for \( 2200 < H_{su} < 2800 \)
- \( H_{su} \) = accumulated heat units (base 10°C) in degree days for the period October to March

Dry Bean Yield Estimation

Using Smith’s (1994; 1998) climatic criteria, yields of dry beans are estimated using the effective rainfall for October to March and heat units (base 10°C) for the same period, with modifications to yield made for soil properties and levels of management. Rainfall values were derived from the 1 arc minute (1° x 1° latitude x longitude) median monthly rainfalls generated for South Africa by Lynch (2004), as described in Section 2.2, while heat units were computed from the 1 arc minute daily temperature series for the 50 year period 1950-1999, derived by Schulze and Maharaj (2004), as described in Section 2.1.
Adjustment of Dry Bean Yields for Management Levels and Soil Characteristics

Climatically derived dry bean yields may be further adjusted for soil characteristics by the following multiplication factors (Smith, 1994):

<table>
<thead>
<tr>
<th>Variable</th>
<th>Well Drained Soils</th>
<th>Soft Plinthic Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 15% Clay</td>
<td>15 - 35% Clay</td>
</tr>
<tr>
<td>MAP (mm)</td>
<td>Rooting Depth (mm)</td>
<td></td>
</tr>
<tr>
<td>&gt; 775</td>
<td>1000</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.7</td>
</tr>
<tr>
<td>&lt; 775</td>
<td>1000</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Suggested yield adjustment factors for levels of management are as follows (Smith, 1994):

<table>
<thead>
<tr>
<th>Management Level</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>1.0</td>
</tr>
<tr>
<td>Excellent</td>
<td>0.9</td>
</tr>
<tr>
<td>Very good</td>
<td>0.8</td>
</tr>
<tr>
<td>Good</td>
<td>0.7</td>
</tr>
<tr>
<td>Average</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Citing from this Section of the Atlas

When making reference to this Section of the Atlas, please cite as follows:


References (In the sequence in which they appear in this Section, with the full references given in Section 22)

4. NDA (2006)
6. NDA (2005)

Photos:
1. www.extension.umn.edu/images