CHAPTER-III

MATERIAL AND METHODS

The present investigation was undertaken in order to access various physicochemical properties, available nutrient status in the soil of irrigated and non-irrigated farmlands of Upper Kundalika Project, Beed District. The materials used and method adopted are discussed in this chapter under the following appropriate heads.

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3.1 Material

3.1.1 Geography and climate of Beed district

Beed district is located between 18° 28’ to 19° 28’ North altitude and 74° 54’ to 76° 57’ East latitude. It is surrounded by Aurangabad and Jalna in the North, Parbhani and Latur in the East, Ahmednagar and Osmanabad in the south. The geographical area of the district is 10615.3 sq. km and it is 3.44 per cent of Maharashtra state. The annual rainfall of this district is in between 458 mm and 814 mm. The maximum and minimum temperature of this district is 40.40°C and 17.68°C, respectively. The elevation is 530 m from mean sea level. Beed is located on the Deccan Plateau, on the banks of `Bendsura` a sub-tributary of Godavari river. It is situated in the ranges of Balaghat.

3.1.2 Soils of Beed district

Soils of Beed district belongs to order Vertisols, Inceptisols and Entisols. The soils were varied in colour due to presence of different types of minerals like plagioclase, augite, calcite, dolomite, magnetite etc. The soils in the area vary widely in both texture and depth. The soils of the area is rough and rocky largely consisting of basalt. Thin deposits of fertile black soil are found in the northern part and in the south at the western bank of Bendsura. Most of the land of the district is full of rock
and thin layers of soil except Georai and Majalgaon where the land consists of rich
fertile black cotton soil. The total land is rocky and thin-layered.

3.1.3 Selection of site

The selected site was command (irrigated farmland) and uncommand (non-
irrigated farmland) area of Upper Kundlika Project, Upali Tq. Vadvani Dist.Beed.
Irrigated and non-irrigated farmlands were identified for collection of soil samples.

3.1.4 Collection of soil and water samples

In order to study the fertility status of soils from area of Upper Kundlika
Project, Upali Tq. Vadvani Dist.Beed, twenty five surface soil sample were collected
from 0 to 22.5 cm depth and 10 samples of water each from irrigated and non-irrigated
farmlands were collected for three seasons (i.e. monsoon, winter and summer).

The map showing the location of irrigated and non-irrigated farmland of
Upper Kundlika Project, Upali Tq. Vadvani Dist.Beed is depicted in plate 1. While
the locations of samples collected from study area is shown in plate 2.

3.1.5 Preparation of soil and water samples

Soil samples collected from study area were brought to the laboratory,
thoroughly mixed, air dried in shade, ground with porcelain mortar and pestle and
passed through 2 mm sieve. The sieved soil samples were stored in cloth
bags/polythene bags with proper labeling for subsequent analysis. All the precautions
outlined by Jackson (1973) were scrupulously followed in order to avoid
contamination.

Collected irrigation water samples from study area were brought to the
laboratory on same day and proper labelling was carried out for each sample.

Collected water samples were stored in refrigerator and analysis was carried
out on the next day. The standard methods of analysis as described by Jackson (1973)
and Richards (1954) and have been employed throughout the investigation.

3.2a Methodology - Soil analysis

The standard methods were followed for determination of chemical properties
and available nutrients in soil are given below.
3.2.1 Physical properties

Physical properties of soil were studied in the field and profile description was done as per the procedure suggested by USDA and Soil Survey Staff (1975).

3.2.1.1 Soil Colour

The soil colour was determined *in situ* by using Munsell and names and Munsell colour notations from Munsell soil colour chart (Yadav and Khanna, 1979).

3.2.1.2 Density of Soil

Partial density and Bulk density of soil were estimated by pycnometer and Clod coating method, respectively (Piper, 1966).

3.2.1.3 Porosity of soil

It was calculated by following formula

\[
\% \text{ Porosity} = \left(1 - \frac{\text{Bulk density}}{\text{Particle density}}\right) \times 100
\]

3.2.1.4 Particle size distribution analysis

The particle size distribution analysis was carried out as per the international pipette method (Jackson 1979).

3.2.1 Chemical properties

3.2.1.1 Soil pH

It was determined in soil: water suspension (1:2.5) using glass electrode pH meter (Jackson, 1973).

3.2.1.2 Electrical conductivity

It was estimated from supernant solution of soil water suspension (1:2.5) by using conductivity bridge (Jackson, 1973).

3.2.1.3 Organic carbon

Modified method of Walkley and Black (1934) as described by Piper (1966) was used for determination of organic carbon.

3.2.1.4 Calcium carbonate

Free calcium carbonate was determined with rapid titration method as outlined by Piper (1966).
3.2.1.5 Cation Exchange Capacity (CEC):

It is the degree of which soil can absorbed and exchange cations (positively charged ions). Hence, this test measures the soils ability to hold cation by electrical attraction. The CEC was calculated by following formula (Daji, 1954).

\[
\text{CEC (meg/100g)} = \frac{\text{Na concentration of extract of soil}}{\text{weight of soil (grams)}} \times 100
\]

3.2.2 Available nutrients in soils

3.2.2.1 Available nitrogen

It was determined by alkaline permanganate method as suggested by Subbiah and Asija (1956).

3.2.2.2 Available phosphorus

It was determined by using 0.5 M sodium carbonate as an extractant as outlined by Olsen’s method (Olsen et al. 1954) as described by Jackson (1973).

3.2.2.3 Available potassium

The soil were treated with normal ammonium acetate and the K was determined from the extract using Flame Photometer (Jackson, 1973).

3.2.2.4 Exchangeable Ca & Mg

It was determined by Versanate titration method (Jackson, 1973).

3.2.2.5 Available sulphur

It was determined by using turbidity method (Jackson, 1967).

3.2.3 Available Micronutrients in soils

Available micronutrient i.e. Fe, Mn, Zn and Cu was determined by DTPA (Dithylene Triamine Pentacetic Acid) extractant which consist of 0.005 M DTPA, 0.1 M triethanolamine and 0.01 M CaCl$_2$ and measured on atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

3.2.4 Soil Nutrient Index and preparation of fertility map

Nutrient index was calculated as per the formula suggested by Ramamoorthy and Bajaj (1969) and the values for low, medium and high will be taken as <1.67, 1.67-2.33, >2.33, respectively.
Nutrient Index Value (NIV) = \frac{\text{No. of samples Low} \times 1 + \text{No. of samples Medium} \times 2 + \text{No. of samples High} \times 3}{\text{Total number of samples}}

**Rating of NIV:**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Low</td>
<td>&lt; 1.67</td>
</tr>
<tr>
<td>2.</td>
<td>Medium</td>
<td>1.67 – 2.33</td>
</tr>
<tr>
<td>3.</td>
<td>High</td>
<td>&gt; 2.33</td>
</tr>
</tbody>
</table>

Fertility map of nutrient status of soils from study area of Beed district were prepared in photoshop by using rating for different nutrients.

### 3.2.4 Sodium Absorption Ratio (SAR)

The index is used for predicating the sodium hazard of water in agricultural use. It is the concentration of sodium and the proportion of sodium to calcium and magnesium. SAR was calculated as,

\[
\text{SAR (meq/l)} = \frac{\text{Na}_i}{\text{Ca}_i + \text{Mg}_i}
\]
3.2.2 Electrical conductivity (EC)

Electrical conductivity of water sample was determined by using EC meter (Jackson, 1973) and these samples were categorized as per the classification based on salinity hazard (Richards, 1954). He suggested the following five classes in Table 3.1 for irrigation water on the basis of salinity hazard. Accordingly the water having generally EC more than 3.0 dSm\(^{-1}\)at 25\(^{0}\)C in general is considered to be unsuitable for irrigation. The detail classification is as follows.

**Table 3.1: Classification of irrigation water based on salinity.**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Salinity</th>
<th>EC (dSm(^{-1}))</th>
<th>Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>C(_1)</td>
<td>&lt; 0.25</td>
<td>Safe for use</td>
</tr>
<tr>
<td>2.</td>
<td>C(_2)</td>
<td>0.25 to 0.75</td>
<td>Need moderate leaching</td>
</tr>
<tr>
<td>3.</td>
<td>C(_3)</td>
<td>0.75 to 2.25</td>
<td>Cannot be used on soils with restricted drainage</td>
</tr>
<tr>
<td>4.</td>
<td>C(_4)</td>
<td>2.25 to 3.00</td>
<td>Unsuitable under ordinary condition</td>
</tr>
<tr>
<td>5.</td>
<td>C(_5)</td>
<td>&gt; 3.00</td>
<td>Unsuitable for irrigation</td>
</tr>
</tbody>
</table>

3.2.3 Soluble Cations

**Calcium and Magnesium (Ca\(^{++}\) and Mg\(^{++}\))**: These were estimated by Versenate (EDTA) titration method (Richards, 1954).

**Sodium and Potassium (Na\(^{+}\) and K\(^{+}\))**: Sodium and potassium content in water samples were determined by using flame photometer (Jackson, 1973).

3.2.4 Soluble anions

**Carbonates and Bicarbonates (CO\(_3^{--}\) and HCO\(_3^{-}\))**: The carbonates and bicarbonates from water samples were determined by titrimetric method (Richards, 1954).

**Chlorides and Sulphate (Cl\(^{-}\) and SO\(_4^{2-}\))**: Chlorides and sulphates were determined by the Mohr’s titration method and Turbidity method, respectively (Richards, 1954).

The suitability for irrigation water on the basis of chloride content was proposed by Mass (1990) and presented in Table-3.2.
Table 3.2. Classification of irrigation water based on chloride.

<table>
<thead>
<tr>
<th>Chloride (ppm)</th>
<th>Effect on crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 70</td>
<td>Generally safe for all plants</td>
</tr>
<tr>
<td>70-140</td>
<td>Sensitive plants shows injury</td>
</tr>
<tr>
<td>141-350</td>
<td>Moderately tolerant plants show injury</td>
</tr>
<tr>
<td>Above 350</td>
<td>Can cause severe problems</td>
</tr>
</tbody>
</table>

3.2.5 Sodium Adsorption Ratio (SAR): It was computed by the formula (Richards, 1954) as given below. He suggested the following classes of water (Table 3.3) on the basis of SAR.

\[
\text{SAR} = \frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}}
\]

Where, all cations are expressed in me L\(^{-1}\)

Richard (1954) suggested the following four classes of water on the basis of SAR presented in Table 3.3 accordingly the water having generally SAR more than 26 in general it is considered to be unsuitable for irrigation purpose.

Table 3.3: Classification of irrigation water based on SAR.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Class symbol</th>
<th>Class of water</th>
<th>SAR values</th>
<th>Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>S(_1)</td>
<td>Low sodium</td>
<td>&lt; 10</td>
<td>Can be used safely</td>
</tr>
<tr>
<td>2.</td>
<td>S(_2)</td>
<td>Medium sodium</td>
<td>10-18</td>
<td>May be used on coarse textured soil</td>
</tr>
<tr>
<td>3.</td>
<td>S(_3)</td>
<td>High sodium</td>
<td>18-26</td>
<td>Ordinarily unsuitable water</td>
</tr>
<tr>
<td>4.</td>
<td>S(_4)</td>
<td>Vary high sodium</td>
<td>&gt; 26</td>
<td>Unsuitable</td>
</tr>
</tbody>
</table>

3.2.6 Residual Sodium Carbonate (RSC)

RSC was calculated by the following formula

\[
\text{RSC (me L}^{-1}\text{)} = (\text{CO}_3^{--} + \text{HCO}_3^-) - (\text{Ca}^{++} + \text{Mg}^{++}) \]

Where, all cations and anions are expressed in me L\(^{-1}\)

Eaton (1950) introduced the concept of Residual Sodium Carbonate (RSC) keeping in view, the importance of relative proportion of Ca\(^{++}\) + Mg\(^{++}\) in bicarbonate rich water. Further he suggested limits for classification of water according to RSC values given in Table 3.4.
Table 3.4: Classification of irrigation water based on RSC.

3.2.7 Soluble sodium percentage (SSP):
It is the percentage of sodium concentration to sodium, calcium and magnesium concentration and was calculated by following formula.

\[
\text{SSP (meq/l)} = \frac{\text{Sodium concentration}}{\text{Sodium, Calcium, and Magnesium concentration}}
\]

3.2.8 Kellys Ratio or Kellys Index (KR/KI):
It is the percentage of sodium concentration to calcium and magnesium concentration was calculated by following formula.

\[
\text{KI (meq/l)} = \frac{1}{N}
\]

3.2.9 Schollers Index (SCI):
This is the proportion of excess concentration of chloride to sodium and potassium to chloride and was calculated with following formula.

\[
\text{SCI (meq/l)} = \frac{\text{Chloride concentration}}{\text{Sodium and Potassium concentration}}
\]
Photo no. 1: Photograph showing field visit of upper Kundalika dam area.
Photo no. 2: Photograph showing close view of upper Kundalika dam at Upali.

Photo no. 3: Photograph showing irrigated farm land of study area.
Photo no. 4: Photograph showing nonirrigated farm land of study area

Photo no. 5: Photograph showing collection of soil sample form irrigated farm land of study area