

## CHAPTER 3

### RESEARCH METHODOLOGY

#### 3.1. SITE SELECTION

Ten wineries from the Western and Northern Cape were included in the study. The wineries were selected from all the main wine production areas in these two provinces. Only wineries that were willing to participate voluntarily were included in the study.

Because of the sensitivity of the data the names of the wineries are not given. A code numbering system will only be used to identify them. The code number, code name and disposal method used at each winery is given in Table 3.1.

Table 3.1: Code numbers, code names and disposal methods of wineries included in the study

Code number	Code name	Disposal method
Paa1	Paarl 1	Irrigation
Paa 2	Paarl 2	Irrigation
Paa 3	Paarl 3	Ponding
Stell	Stellenbosch	Irrigation
Rob 1	Robertson 1	Irrigation
Rob 2	Robertson 2	Ponding
Worc	Worcester	Irrigation
Berg	Berg river	Irrigation
Olif	Olifant river	Ponding
Oran	Orange river	Ponding

#### 3.2. EFFLUENT SAMPLING AND ANALYSIS

Effluent samples were collected from each winery on a monthly basis from December 1999 to July 2000. The effluent was collected from the ponds or tanks

where it was stored before being disposed onto the land disposal area. Samples of 200ml and 700ml respectively were collected each time. The 200ml samples were sent to CSIR for COD analysis, using the 5220 B open reflux method (Clesceri, Greenberg & Eaton, 1998). BOD was not determined. The 700ml samples were sent to ARC-Infruitec for the analysis of pH, Electrical conductivity, Na, K, Ca, Mg, Fe, Cl and B. The elements were determined on an ICP spectrometer (Association of Official Analytical Chemists, 1990).

### 3.3 SOIL INVESTIGATIONS AND ANALYSES

#### 3.3.1 Soil sampling

Soil sampling was done with a soil auger at each winery on a monthly basis from December 1999 to July 2000. The samples were taken from the areas where the effluent is disposed. The soil was sampled at three depths, i.e. 0-30, 30-60 and 60-90 cm. The soil samples for **May** were sampled differently from other months due to soil classification. *Samples were collected in profile pits and not by auger and sampling depths differed from the other months.*

A control site was selected outside the disposal area in soil closely related to that at the disposal site. It was sampled once at each winery at depths of 0-30, 30-60 and 60-90 cm.

#### 3.3.2. Soil analysis

The soil samples for each winery were prepared and sent to ARC-Infruitec for analysis on a monthly basis. The soil samples were analysed for pH, electrical resistance, stone%, P, Na, K, Ca, Mg, Cu, Zn, Mn and B. pH was determined in a 1:2,5 soil:1M KCl suspension. The Ammonium Acetate (1 mol.dm<sup>-3</sup>, pH 7) method was used to extract Ca, Mg, K and Na. They were determined by either flame emission or atomic absorption spectroscopy.

The Di-Ammonium EDTA method was used to extract the micro-elements (Cu, Mn and Zn), which were determined in the extracts by means of ICP. Boron was extracted

with 0.02M CaCl<sub>2</sub> and determined in the extracts by means of ICP. The Bray 1 method (The Non-affiliated Soil Analysis Work Committee, 1990) was used to determine plant-available phosphorus. Electrical resistance was determined by means of the soil paste method.

### **3.3.3. Bulk density determinations**

Bulk density sampling was done once at each winery. It was done on the top and subsoil on the area where the effluent is disposed and also on the control sites. Undisturbed core samples were collected by means of sampling rings. After removing the samples from the rings, they were dried in an oven at 105<sup>0</sup>C for 7 hours, allowed to cool and weighed.

The Bulk density was calculated using the following equation:

$$\text{Bulk density} = \text{Mass of dry soil (grams)} / \text{Total volume (cm}^3\text{)}.$$

This was then converted to the conventional expression of bulk density in kg.m<sup>-3</sup>.

### **3.3.4. Soil classification**

Modal soil pits were located at representative sites. One profile pit was dug at each winery in the area where the effluent is disposed. The soil classification was done during May 2000 at 8 wineries. The two wineries where classification was not done are Paarl 3 and Robertson 2. These wineries dispose their effluent into evaporation dams that are in very rocky areas.

Profiles were described and classified according to the taxonomic soil classification system for South Africa (Soil Classification Working Group, 1991). Each master horizon of each modal profile was sampled separately. The samples were sent to the laboratory of ARC-Infruitec to be analyzed for pH, electrical resistance, P, K, Na, Ca, Mg, Zn, Mn, B and particle size distribution. pH, electrical, P, K, Na, Ca, Mg, Cu, Zn, Mn and B were determined according to the methods described in Section 3.3.2. Particle size distribution was determined according to the hydrometer method.



### **3.3.5 Sampling of black soil layers**

During the studies of the modal profiles, black soil layers were found at certain depths in the soils of the disposal sites at Robertson 1, Stellenbosch, Olifants River and Orange River wineries. The water dispersibility of the organic matter in these samples was determined in the laboratory by means of addition of distilled water to the samples in beakers, stirring and decantation. This step was repeated until all black material was removed from the soil.