# 3. METHODOLOGY

The methodological framework given to the project is traditional, in the sense that it goes through the normal steps of data acquisition, analysis and conclusions. However, some of the data acquisition and manipulation procedures can be considered to be an innovative element in this particular field of research, as they make use of remote sensing and image processing, as well as structuring the data in a shared GIS environment.

Remote sensing and GIS were introduced in the project at a stage when relevant experience and information had already been acquired and there was already enough knowledge of the circumstances to formulate a number of hypotheses for the various anomalies in terms of development of the crops and production levels on the pivots. For example:

- The variability of the crop canopy at Pivot Tweefontein can be attributed to the non-uniform creation of the soil profile when the land was reclaimed after open cast mining and the dump heaps were levelled.
- The location of areas with different levels of soil compaction should be identified by the profile and reflected on the surface by the variability in the crop canopy.
- The variability of the crop canopy for Pivot Major may also be due to the presence of an impermeable plinthic layer, which in this case is not due to anthropogenic activity.

On the basis of all this, the following tasks were performed:

1. <u>Data acquisition</u>: This phase consisted of the following actions
    - Acquisition of aerial imagery which included:
        - The repeated aerial survey of the two pivots using the STS-DMSV sensor (See section 4.1.2).

  - The pre-processing, processing and enhancement of the acquired data and the production of images.

- Acquisition of all available information describing the two pivots and collected by other participants to the project. These were:

  - Ground truth measurements for ground cover, top dry matter production and leaf area.
  - Penetrometer readings, by Dr. Simon Lorentz. (Un. of Natal, Faculty of Engineering and Environmental Hydrology)
  - Soil depth acquired through field 'augering' by Prof. Andries Claassens. (University of Pretoria, Dept. of Plant Production and Soil Science)
  - Data logging from the harvester for yield and crop moisture contents.

2. <u>Data processing and management</u>: The data collected by the other participants to the project were supplied in the most diverse formats and therefore had to be processed in order to be brought to a shared geographic reference scheme and to a common format (maps) for the ensuing analysis phases. Databases for static and dynamic data were then created and these databases were integrated in a GIS. Before embarking on the proper data analysis, it was also necessary to derive from the remotely sensed data, indicators of crop performance and variability that could guarantee consistency and repeatability. The preferred indicators were specific enhancements of the images of the fields as well as outputs of the data logger mounted on the harvester.

3. <u>Data analysis</u>: The analysis focused on highlighting possible differences in crop canopy over different seasons and, over the two pivots, within the same season. The effort was aimed at finding ways to graphically demonstrate the variability and, possibly by so doing, explaining the causes of difference and variability between the

'virgin' Major and the rehabilitated Tweefontein. The most important steps of this analysis can be summarized as follows:

- Compare the performance and variability of summer (maize/beans) and winter crops (wheat) within the same pivots.
- Compare the summer and winter crop variability and performance between the two pivots.

The flow chart of the methodology is shown in Fig. 1 and the various elements will be defined and explained in detail in the following chapters.

**Fig. 1: Flow chart of the methodological approach**