USING STAKEHOLDER ANALYSIS FOR
INFORMATION SYSTEM
DEVELOPMENT FOR LAND USE
PLANNING

A case study of Land Use Planning in Nizamabad
District, State of Andhra Pradesh, India.

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Using Stakeholder Analysis for Information System Development for Land Use Planning  
(A case study of Land Use Planning in Nizamabad District, State of Andhra Pradesh, India)

By

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Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-Information Management for Rural Development and Resources Management

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Disclaimer

This document describes work undertaken as part of a programme of study at the International Institute for Geo-information Science and Earth Observation. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the institute.
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To my Lord God, thank you so much for being the leader of my life and all my success in life belongs to you. You are the God full of faith, honest and trust.
Abstract

With the introduction of geo-information system approaches, it has become highly relevant for planners to build a stakeholder information system to support planning and implementation of land use strategies containing objectives, perceptions and knowledge of the stakeholders. This thesis gives an account of the development and implementation of the Land Use Planning Information System for Nizamabad District, State of Andhra Pradesh, India.

Firstly the land use-planning context of the problem is addressed. Secondly the concept of stakeholder analysis (SA) as an approach to gain understanding of a system by means of identifying key actors or stakeholders and assessing their respective interest. The methodological approach for SA consisted of: (1) defining the purpose of the analysis, (2) stakeholder identification and classification, (3) stakeholder characteristics analysis and (4) identification of information flows and relations. SA has been used as a tool for defining information requirements and for system analysis for LUP information system development and implementation.

The developed system labelled “LUPIS” is a system to manage (processing, storing, retrieving, analysis, protection and communicate) data to provide information as input for land use decision-making. The database can be queried to answer questions, required for decision-making and display information as maps with the support of ArcView. Conclusions discuss the implication of SA for information system development, the performance of LUPIS, and database aspect regarding manipulating land use planning data.
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<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMSD</td>
<td>Integrated Mission for Sustainable Development</td>
</tr>
<tr>
<td>SA</td>
<td>Stakeholder Analysis</td>
</tr>
<tr>
<td>LUPIS</td>
<td>Land Use Planning Information System</td>
</tr>
<tr>
<td>LUP</td>
<td>Land Use Planning</td>
</tr>
<tr>
<td>SSDM</td>
<td>Structured System Development Methodologies</td>
</tr>
<tr>
<td>AO</td>
<td>Agriculture Officer</td>
</tr>
<tr>
<td>AEO</td>
<td>Agriculture Extension Officer</td>
</tr>
<tr>
<td>DFD</td>
<td>Data Flow Diagram</td>
</tr>
<tr>
<td>CDM</td>
<td>Conceptual Data Model</td>
</tr>
<tr>
<td>ERD</td>
<td>Entity Relationship Diagram</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>DDL</td>
<td>Data Definition Language</td>
</tr>
<tr>
<td>FTC</td>
<td>Farmers Training Center</td>
</tr>
<tr>
<td>DATT</td>
<td>District Advisory Technology Transfer</td>
</tr>
<tr>
<td>AMC</td>
<td>Agricultural Marketing Committee</td>
</tr>
<tr>
<td>DRDA</td>
<td>District Rural Development Agency</td>
</tr>
<tr>
<td>NABARD</td>
<td>National Bank for Agriculture and Rural Development</td>
</tr>
<tr>
<td>CPO</td>
<td>Chief Planning Officer</td>
</tr>
</tbody>
</table>
1. Introduction

1.1. General

Land-use planning is sometimes misunderstood as being a process where planners tell people what to do, i.e. a typical top-down situation. Land-use planning means the systematic assessment of physical, social and economic factors in such a way as to assist and encourage land users to select land-use options that; (i) increase their productivity, (ii) are sustainable and, (iii) meet the needs of society. Farmers and other land users can, and should, take an active part in land-use planning, bringing to bear their special knowledge of problems, constraints and needs for improvement (FAO, 1993).

Sustainable land use planning requires the individual farmers and other stakeholders not only to realise biophysical interdependencies of the agricultural system but also to co ordinate the planning ideas with that of other neighbouring farmers and other stakeholders (Ravnborg & Westermann, 2001). While land use planning is a complex process where the land must change to meet new demands, yet change brings conflicts between competing uses of the land and between the interests of the stakeholders. There is need for stakeholder analysis (i.e. open-ended constructivist inquiry) (Ravnborg & Guerrero, 1997), so as to identify the information flow, interest and objectives of the different farmers and other players in land use planning. As the size of the area, the number of people involved and the complexity of the problems increase, so does the need for information and rigorous methods of analysis and planning (FAO, 1993). Therefore the participation of stakeholders in the planning process is essential and this, (1) ensures that good land use plans remain intact over time, (2) reduces conflicts among them, (3) speeds the development process and reduces cost of good projects, (4) increases the quality of planning and (5) gives sense of responsibility and confidence to stakeholders.

1.2. Background

The Integrated Mission for Sustainable Development (IMSD), was set up by the Indian government to generate plans (at 1:50,000) for land and water resources development to be used by District Level planners. However these plans received low acceptance, by the stakeholders than expected. This could be because the primary stakeholders, secondary stakeholders and external stakeholders were de-motivated during plan preparation. On one hand it is because there was poor identification of the interest of the stakeholders, the impacts of the plans on them were not evaluated, the priorities of the plans to the stakeholders were not clear and their benefit from the plans were not clearly stated. On the other hand, it could be a combination of socio-economic and technical problems that caused the poor acceptance of the plans.

To establish the reasons for the lower acceptance of these plans a stakeholder analysis (SA) was carried out, in order to determine how the information flows within the sectors and among the
stakeholders in the agricultural sector. This is because stakeholder analysis is particularly useful in decision-making situations where various stakeholders have competing interests, limited resources, and needs that must be appropriately balanced (Gass, Biggs, & Kelly, 1997). According to (de Bie, 2000), much (relevant) land use information cannot be inferred from images, but from field surveys and this information must be used in analysis. Field surveys can only be done as part of stakeholder analysis.

While SA can be used for evaluating existing policies and institutions, it can be used to appraise possible alternate scenarios. It is about asking questions like: Whose problem? Who benefits? Who loses out? What are the objectives? What are the power differences and relationships between stakeholders? What relative influence do they have? (Grimble & Man Kwun, 1995) Analysis of answers to these questions enables the identification of institutions and relationships and information flow, which need to be developed or dealt with to avoid negative outcomes and enhance positive ones (Grimble, Chan, Aglionby, & Quan, 1994).

1.3. Problem statement

There is very little exchange of information among stakeholders in land use planning in Nizamabad District. This has contributed to the low acceptance of land use plans. Therefore an information system will seek to enhance the sharing of information for decision-making.

1.4. Research Objectives

The general objective of this research is to develop a prototype information system and prototype database that can be used in land use planning. A database that can be queried to answer questions of stakeholders regarding their activities in land use planning, i.e. regarding to their interest, objectives, incomes, etc.

1.4.1. Specific Objectives

More specifically the objectives of the study are:

1. Identify the stakeholders involved in land use planning.
2. Analyse the stakeholders’ objectives, interests and problems in relation to the current land uses
3. Determine the flow of data among the stakeholders in land use planning and design a prototype information system that can provide thematic and spatial data.
4. Generate a prototype database of stakeholders and their activities.
5. Test sample queries related to land use planning.

1.5. Research Questions

i. Who are the stakeholders in land use planning and what are their interests, objectives, problems, relations, and capacities in the land use plans?

ii. Which information and how does it flow among the stakeholders in land use planning?
iii. How can a prototype information system be designed to support land use planning and what are the process and data models, which can be incorporated into the information system.
iv. What kind of information can be stored in a database to aid in land use planning?
v. Can the physical database be queried to answer questions in land use planning?

1.5.1. Assumption

Stakeholder analysis is a unifying theme, a tool for decision makers and planners for identifying and describing stakeholders (A.M. Vos, J.Biesboer, & R. Oudman, 1998) on the basis of their attributes, interrelationships, and interests and information flow related to land uses.

1.6. Research Approach

The research was approached from a Structured System Development Methodology (SSDM) composed of four major components; namely; problem definition, system analysis, system design and system implementation (Hawryszkiewycz, 1998). SSD methodology allows for user participation and the use of associated tools and techniques that includes DFDs, decision trees that makes it suitable for this study. The study started by looking at the current land uses (Problem Definition) and then derive the stakeholders (System Analysis) from the current landuses. The research analysed the stakeholders’ interest and problems, etc to develop a stakeholder information system (System Design) that was in turn used to design the proposed database (System Implementation). The database was queried to answer questions concerning land use planning. The figure below shows the conceptual model of the research approach.

![Figure 1-1 The Conceptual Research Method](image)

The stepwise conceptual research method (figure 1.2) comprises of a literature review, analysis of the available land use data, developing research questions and of designing questionnaires to
be used in fieldwork. (i.e. literature review). Fieldwork, concerned verification of land uses, identification of stakeholders and recording their interests and objectives, and capturing of organisational structures and their mandates. Stakeholder analysis has been used as a system analysis tool that allows, the derivation of information (information requirements) from the people/organisations involved in the land use planning. The land use planning information system, integrates all the information from the different stakeholders. System analysis has been used for information analysis and data analysis for the designing of the LUP information system. The LUP information system, the conceptual model and logical data model are designed at this stage of system design. System implementation is composed of the design of physical database, data input and querying the database. During the implementation stage the physical database has been queried in conjunction with ArcView projects, which contains, land use planning base maps for the study area.

Figure 1.2 shows the stepwise implementation of the conceptual research model in this study. The step-wise implementation also is a diagrammatic representation of the thesis structure.

Figure 1-2 Step-Wise implementation of conceptual research method.

Open questions were used for data collection and the interviews focused on:

- The activities carried out by farmers.
- The activities carried out by other stakeholders concerned with land use planning.
- The kind of data they need for land use planning and how the information flows among them and to farmers (see appendix E, for fieldwork survey responses)
2. **The Study Area**

2.1. **State of Andhra Pradesh - India**

The state of Andhra Pradesh is located in the southeast of India and the capital city is Hyderabad. It has a total geographical area of 2 744 000 sq km (274.40 lac hectares). The State has abundant agriculture resources, blessed as it is with rich soils and plenty of perennial sources of water for irrigation and a range of agro-climatic conditions. Figure 2.1 shows the Andhra Pradesh state with its district. This study was carried out in Nizamabad district.

2.2. **Nizamabad District**

The geographical area is 7 956 sq km. The District lies between 18° 05’ and 19° 00’ of the Northern latitudes and between 77° 00’ and 78° 37’ of the Eastern longitudes (Chief Planning Officer, 1996). Figure 2.2 shows the district of Nizamabad with its distribution of the thirty-six mandals.

The table below shows a list of the mandals that are in Nizamabad District.

**Table 2-1 (Bichkunda, Birkoor, Kotgiri, Madnur, Jukkal and Pitlam were mandals which were visited during the fieldwork)**

<table>
<thead>
<tr>
<th>Mandal Code</th>
<th>Mandal Name</th>
<th>Mandal Code</th>
<th>Mandal Name</th>
<th>Mandal Code</th>
<th>Mandal Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RANJAL</td>
<td>13</td>
<td>YEDA PALLE</td>
<td>25</td>
<td>SADASIVANAGAR</td>
</tr>
<tr>
<td>2</td>
<td>NAVIPET</td>
<td>14</td>
<td>BODHAN</td>
<td>26</td>
<td>GANMDHARI</td>
</tr>
<tr>
<td>3</td>
<td>NANDIPET</td>
<td>15</td>
<td>KOTGIRI</td>
<td>27</td>
<td>BANSWADA</td>
</tr>
<tr>
<td>4</td>
<td>ARMUR</td>
<td>16</td>
<td>MADNUR</td>
<td>28</td>
<td>PITLAM</td>
</tr>
<tr>
<td>5</td>
<td>BALKONDA</td>
<td>17</td>
<td>JUKKAL</td>
<td>29</td>
<td>NIZAMSAGAR</td>
</tr>
<tr>
<td>6</td>
<td>MORTAD</td>
<td>18</td>
<td>BICHKUNDA</td>
<td>30</td>
<td>YELLAREDDY</td>
</tr>
<tr>
<td>7</td>
<td>KAMMAR PALLE</td>
<td>19</td>
<td>BIRKOOR</td>
<td>31</td>
<td>NAGA REDDIPE</td>
</tr>
<tr>
<td>8</td>
<td>BHEEMGAL</td>
<td>20</td>
<td>VARNI</td>
<td>32</td>
<td>LINGAMPET</td>
</tr>
<tr>
<td>9</td>
<td>VELPUR</td>
<td>21</td>
<td>DICHPALLE</td>
<td>33</td>
<td>TADWAI</td>
</tr>
<tr>
<td>10</td>
<td>JAKRANPALLE</td>
<td>22</td>
<td>DHAR PALLE</td>
<td>34</td>
<td>KAMAREDDY</td>
</tr>
<tr>
<td>11</td>
<td>MAKLOOR</td>
<td>23</td>
<td>SIRKONDA</td>
<td>35</td>
<td>BHIKNUR</td>
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<tr>
<td>12</td>
<td>NIZAMBAD</td>
<td>24</td>
<td>MACHAREDDY</td>
<td>36</td>
<td>DOMAKONDA</td>
</tr>
</tbody>
</table>
2.2.1. Climate

The climate in Nizamabad district is characterised by a hot summer and generally dry weather, except during the southwest monsoon. The climate is tropical as the district is situated at a
considerable distance from the sea (Chief Planning Officer, 1996). The normal mean minimum temperatures are about 13.7°C and mean maximum is about 39.9°C. The year may be divided into four seasons, December to February is winter; March to September, October post monsoon season, May to September is the summer season; May is the hottest month of the season. Figure 2.3 shows the monthly temperature variations in the Nizamabad District.

![Temperature variations in Nizamabad District](image)

**Figure 2-3 Min and Max Temperature of Nizamabad District** (Chief Planning Officer, 1996)

The rainy season commences, with the onset of the Southwest monsoon in the latter part of June and ends in October. In the part of Northwest and Northeast monsoon has a normal rainfall of 1081mm and this constitutes about 74% of the normal rainfall. Figure 2.4 shows rainfall distribution over the year.

![District Average Rainfall Season-wise & Year-wise](image)

**Figure 2-4: Average rainfall of Nizamabad District** (Chief Planning Officer, 1996).

### 2.2.2. Agriculture

In Nizamabad District paddy and sugarcane are the mostly widely grown crops, during the Kharif and Rabi season. These crops are rainfed and also irrigated during the dry season. The key strengths of the district are a wide range of agro-climatic conditions suitable for a variety of crops; extensive water sources; average rainfall of the State – 925 mm; a variety of natural sources and important rivers for irrigation and extensive irrigation canals.
Table 2.2 Main crops in Nizamabad District.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area as % of District total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>32.8</td>
</tr>
<tr>
<td>Jowa</td>
<td>9.24</td>
</tr>
<tr>
<td>Cotton</td>
<td>5.41</td>
</tr>
<tr>
<td>Turmeric</td>
<td>9.87</td>
</tr>
<tr>
<td>Maize</td>
<td>16.58</td>
</tr>
<tr>
<td>Arhar</td>
<td>0.64</td>
</tr>
<tr>
<td>Chillies</td>
<td>0.64</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>5.1</td>
</tr>
<tr>
<td>Sesam</td>
<td>0.32</td>
</tr>
</tbody>
</table>


Table 2.2 shows a list of crops grown in the district and their percentage contributions. Plate 2.1 shows one of the fields visited during the fieldwork. Mainly paddy fields and sugarcane fields dominate the study area as it was immediately after the monsoon season. Figure 2.5 shows the land uses in the study areas.

Plate 2-1 Paddy field, visited during fieldwork.

Figure 2-5 Current Land uses in the study area
2.2.3. Natural Resources

**Forest:** total area under forest in the district is 1,670 sq km forming 22% of the total geographical area. Eucalyptus and other plantations are being raised in large extents with a view not only to increase the forest wealth but also to provide employment for the rural communities (Chief-Planning-Officer, 1996). Other trees found in Nizamabad district are teak wood, ebony, black wood and nallamaddi.

**Soils:** the prevalent soils in the district are black soils and chalka (sandy loam) and they constitute 55 percent and 45 percent respectively of the total area of the District. The black soils are clay and they retain a lot of water and paddy and sugar is mainly planted in these soils. In the southwest part of the district the soil are black and mainly cotton and sunflower; green gram and black gram are grown since the area receives low rainfalls.

**Minerals:** the district in not rich in minerals. Only iron ore though of poor quality is found in Bhiknoor and Karedpally mandals. Granites of various quartzes and deccan trap rocks yield excellent materials for building (Chief-Planning-Officer, 1996). Granite quarrying is also prevalent in the Nizamabad district.

2.2.4. Physical Aspects

**Hills:** Nizamabad district is situated in the table land of deccan and hence hills of any considerable range are quite isolated peaks and rocky clusters occur frequently. The rocks are related to the Archean and Deccan trap formations. Generally the district is flat which makes it one of the most agricultural productive districts in the state of Andhra Pradesh.

**Rivers:** the principal rivers flowing in the district are the godavari river on the northern boundary and the manjira river, which is the chief supplier of water to the agricultural area in the study area. The manjira rises in Potoda taluk of Bhir district in Maharashtra, and crosses the district from southwest and joins godavari river in Ranjal Manadal. The district has a wide range of water tanks, which are used as supplementary, water for irrigation when the boreholes run dry and when the rainfalls are not good.
3. Methodology-Stakeholder Analysis

3.1. Introduction

Stakeholders or multi-stakeholder analysis can be defined as "an approach and procedure for gaining an understanding of a system by means of identifying the key actors or stakeholders in the system, and assessing their respective interests in that system" (Grimble et al., 1994). Stakeholder analysis assist in decision-making situations where various stakeholders have competing interests, resources are limited and stakeholder needs must be appropriately balanced.

In this study stakeholder analysis was carried out, as an approach for understanding the agricultural system, changes in it and land use plans, by identifying the stakeholders, the information flow among them, their relationships, interest and assessing their objectives in land use planning. SA has been used as a process for acquiring information from the stakeholders and further more it has been used as an information analysis tool (see figure 4.1) for the development of a land use planning information system. What makes stakeholder analysis a unique process in information system development is that, it is an iterative process and it allows the participation of the users of the system. SA is a method that is used in problem solving in any situation and it gives chances to the stakeholders in the system to identify their problems, objectives and analyses them.

3.2. How to do stakeholder analysis?

In this study stakeholders are people and organizations who matter in the land use planning system. The term thus includes policy makers, planners and administrators in government and other organizations, as well as commercial and subsistence farmers. Farmers, who as a group have formed an association to work on their unifying goals, were considered as the primary stakeholders during stakeholder analysis for land use planning. Open questions were used during the fieldwork and farmers were interviewed as group or individually.

Plate 3-1 Interview with farmers during fieldwork.
From this kind of interviews (figure 3.1) the farmers were able to identify other stakeholders they deal with in agricultural land use planning. Plate 3.1 shows some of the farmers (stakeholders) interviewed during the fieldwork.

In carrying out stakeholder analysis several steps are followed, as illustrated in figure 3.1. The first stage is defining the purpose of the analysis, is where there is need to clarify why stakeholder analysis should be done and this was done in the office after the analysis of the problems in the land use planning (see also section 3.3).

![Figure 3-1 Steps in carrying out stakeholder analysis (Modified from Grimble et al., 1994)](image)

Stakeholder identification was done during fieldwork and also the classification of the stakeholders. Interviews were used for characteristics analysis and information retrieval and also for identifying the relationships and interaction of the stakeholders.

### 3.3. Purpose of SA for LUP

Stakeholders can only be identified in relation to an issue or a problem situation (Groenendja, 2000). In order to be able to decide who are the stakeholders in a system, there should be an agreement on the nature of the problem. In this study the problem situation was that the IMSD plans for land and water resources development to be used by District Level planners received low acceptance from the farmers and other stakeholders at the district level. Therefore to ensure that the analysis was well focused and timely, a general understanding was needed of the key problems identified by some of the main groups and the basic interactions in the LUP system.

The problems identified were that; there were bottlenecks in the flow of information among the stakeholders; information was flowing in one direction; lack of information sharing for LUP. Therefore the analysis focused on the flow of information, identification of the key decision makers and their influences. As the farmers are the primary stakeholders in the agricultural
system, the analysis focused on who deals with the farmers, how do the farmers interact and how information from and to the farmer flows in the Agricultural department section. After understanding of the system and defining the purpose, listing and analysing the stakeholders follows, see section 3.4.

3.4. Who are the Stakeholders regarding LUP?

From the land use planning system we were able to identify, the stakeholders, who are the farmers and water users association as the primary stakeholders. As land use planning being the system, the primary stakeholders were able to identify other stakeholders, when asking questions, which are stakeholder self-selection. e.g. “which are the problems that you face in land use planning and whom do you share the information with” (Grimble & Chan, 1995). Stakeholder self-selection was used also as a data validation method. After the identification of the stakeholders with respect to the systems, there was need to categorise them as some are affected or affect the land use planning differently.

We grouped them into primary stakeholders, secondary stakeholders, external stakeholders and key stakeholders. Primary stakeholders are those individuals or groups who are ultimately affected by the systems (DFID-ODA, 1995). Secondary stakeholders are those who affect the system, acting as intermediaries between primary and key stakeholders. External stakeholders include those individuals, groups or organisations that are not directly involved but interested in the outcome of the land use systems (DFID-ODA, 1995). Key stakeholders are those who can significantly influence or are important to the system. Figure 3.2 below shows how stakeholders interact and linked to the LUP system.

![Stakeholders – System relationship.](image)
In general the primary stakeholders can be further divided into different groups, as shown in figure 3.3. They can be grouped according to the different situations and conditions in their fields.

Secondary stakeholders are those individuals or groups or organisations who affect the system (Gass et al., 1997), therefore they can be divided with respect to their functions in the land use planning system. See figure 3.4. Secondary stakeholders differs from the key stakeholders in the sense that key stakeholders influence the success of the LUP and the farmers (primary stakeholders) and they give guidance and also provide policies to the secondary stakeholders for the success of the LUP system.

3.5. Analysis of the stakeholders

During the fieldwork an analysis of the stakeholders was done, after the identification and listing of the stakeholders. The aim was to understand the interest, importance and the objectives of the stakeholders to the land use planning system. Ramirez & Buckles, (1999) gave the following reasons for analysing stakeholders: (i) Empirically to discover existing patterns of interaction; (ii) Analytically to improve interventions; (iii) as a management tool in policy-making; and; (iv) as a tool to predict conflict.

Different methodologies were employed in doing this analysis, depending on the type of stakeholder. During the analysis of the primary stakeholders; brainstorming was initially used, so as to generate ideas and issues within the farmers. Unstructured questions were used for the later part of the research, as they would allow a follow-up to all the questions, and farmers would have a chance to express any of their views with respect to the land uses and land use planning. Unstructured questions were also used for the other stakeholders. Stakeholder analysis matrix has been used to analyse the interests and importance of stakeholders to the systems. See the matrix table 3.1below.
<table>
<thead>
<tr>
<th>Stakeholder Class</th>
<th>Stakeholder Name</th>
<th>Institutional sector</th>
<th>Keys Interests</th>
<th>Importance to system</th>
<th>Influence on system</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Farmer (Ethonda village)</td>
<td>Small-scale farmer</td>
<td>-Crop production (paddy, sugarcane)</td>
<td>-Importance to productivity. -Vital to sustainability.</td>
<td>-Low will only co-operate and cannot intervene.</td>
<td>-Consulted were necessary in trying new varieties of crops.</td>
</tr>
<tr>
<td>Primary</td>
<td>Farmer (Chakpalle village)</td>
<td>Small-scale farmer</td>
<td>-Crop production. -Investment.</td>
<td>-Employment creation. -Vital sustainability.</td>
<td>-Middle. As he co operates and implements</td>
<td>-Implementation of new land use plans. -Advise other farmers on new technologies.</td>
</tr>
<tr>
<td>Primary</td>
<td>Farmer (Karegoan village)</td>
<td>Small-scale farmer.</td>
<td>-Crop production (paddy) -Financial benefit.</td>
<td>-Importance to productivity. -Vital to sustainability. -Important to equity.</td>
<td>-Low. Will only co-operate and produce enough to sustain the next season.</td>
<td>-Implement new varieties and methods.</td>
</tr>
<tr>
<td>Primary</td>
<td>Farmer (Kodcherlla village)</td>
<td>Large scale farmer</td>
<td>-Crop production (green gram, red gram &amp; paddy). -Land sustainability. -Investments.</td>
<td>-Importance to productivity. -Importance to sustainability. -Providing information to small-scale farmers. -Water use sustainability. -Provide local knowledge.</td>
<td>-High. Will participate on all land use planning activities. -Provide input into system coordination. -Main participants on agricultural demonstration plots.</td>
<td>-Implementation of new land use technologies. -Training of other small-scale farmers. -Leading on demonstration plots. -Local knowledge crop suitability.</td>
</tr>
<tr>
<td>Primary</td>
<td>Farmer (Karegoan village)</td>
<td>Large scale farmer</td>
<td>-Crop production. -Financial benefits. -Employment creation. -Land sustainability.</td>
<td>-Importance to productivity. -Provide inputs to the systems. -Has great impact on success of the system. -Represents the small farmers. -Will provide support and coordination for implementation of system. -Leaders in the system.</td>
<td>High. Main participants in agricultural demonstration fields. -Main participant in agricultural training. -Uses new technology and new variety of crops. -As leaders they teach other small-scale farmers.</td>
<td>-Uses their fields as experimental fields. -Participates in agricultural trainings. -Trains and lends money to other small-scale farmers. -Demonstrates the application of new technology and new variety crops.</td>
</tr>
<tr>
<td>Stakeholder Class</td>
<td>Stakeholder Name</td>
<td>Institutional sector</td>
<td>Keys Interests</td>
<td>Importance to system</td>
<td>Influence on system</td>
<td>Participation</td>
</tr>
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</tr>
<tr>
<td>Primary (indirect)</td>
<td>Farmers Training Centre</td>
<td>Trainings (government Depart)</td>
<td>-High crop production. -Land sustainability. -Technology transfer. -Management skills transfer.</td>
<td>-Technology transfer. -Sustainability.</td>
<td>High. On using new farm equipment technology. -New crop varieties and pesticides. -Management skills</td>
<td>-Trainings</td>
</tr>
<tr>
<td>Primary</td>
<td>Water users Association</td>
<td>Water supply for irrigation</td>
<td>-Crop production. -Sustainable use of water.</td>
<td>-Important to productivity. -Important to equity. -Important sustainability. -Development.</td>
<td>-High. On quantity of water to use. -Extent of land and land use.</td>
<td>-Determines type of land use per season. -Training on water management.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Electricity Board</td>
<td>Supply of electricity</td>
<td>-Financial benefit -Provides electricity for borehole pumping. -Subsidised power supply.</td>
<td>-Guaranteed supply of electricity. -Vital to productivity -Vital to sustainability.</td>
<td>-Have influence on type of land use. -Have influence on extent of land use.</td>
<td>-Supplying of electricity at a subsidised price.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Mandal Office</td>
<td>Record keeping (local government)</td>
<td>-Welfare of farmers. -Sustainability of farmers. -Accelerate change within the system. -Meet the national requirements.</td>
<td>-Will provide assistant to system. -Partner in land use change. -Information recording and updating of the system.</td>
<td>-Influence on guidelines and policies. -Will have influence on nature of support. -Coordination of the system for sustainability purposes.</td>
<td>-Lesson learning directed through it. -Coordination of training. -Information collection. -Record keeping. -Consultation on all aspects of the system.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Agricultural Officer</td>
<td>Agricultural Officers (government Department)</td>
<td>-Provides extension advice to farmers. -Consultation with the research station. -Quality control.</td>
<td>Important to productivity. -Important to equity. -Important sustainability. -Provides skills training.</td>
<td>-High. Type of land use. -Pesticides control. -Land management.</td>
<td>-Fieldwork with farmers. -On field training and demonstrations. -Working on demonstration fields.</td>
</tr>
<tr>
<td>Stakeholder Class</td>
<td>Stakeholder Name</td>
<td>Institutional sector</td>
<td>Keys Interests</td>
<td>Importance to system</td>
<td>Influence on system</td>
<td>Participation</td>
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</tr>
</tbody>
</table>
| Secondary        | Deputy director of Agriculture (Local government) | Agriculture Officers | -Finalise relevant regulations.  
- Accelerate implementations of the system  
- Finalise the necessary trainings needed.  
Provides capacity to Agricultural officers  
-Discussion with Research stations. | -Will provide leadership support on the land use system.  
- Have power to make decisions.  
- Supports the AOs  
-Delivers technology information to the AOs | -Have influence on all aspects of the system. | -Responsible for overall system.  
-Research participations.  
-Junior staff management for implementing system. |
| Secondary        | Joint director of Agriculture (district level, government) | Agriculture Officer | -Ensure government land use planning systems are completed.  
- Consolidate structures and other system with the agricultural system. | -Will provide leadership support. | -High.  
-Will have influence on all aspects of the policies in the system. | -Responsible for overall system and reporting. |
| Secondary        | District Advisory Technology Transfer | Soil laboratory | -Crop production.  
- Land use sustainability.  
- Environmental sustainability. | -Soil testing for farmers.  
- Vital to sustainability.  
- Vital to equity.  
- Information supply | High. Will have influence on the type of land use.  
- Influence on the type of crop to grow. | -Responsible for field soil test.  
- Recommendations to the farmers on how to treat the soils. |
| Key              | District of Rural Development Agency | Government (Rural development) | -Rural development.  
- Gender equity in the land use planning.  
- Financial support to small-scale farmers.  
Policy support of the system. | -Self-employment creation.  
- Sustainability.  
- Fund trainings to those in the system. | -High. Influence all aspect in the district.  
- As it funds most developmental projects it has power in influencing the agricultural system. | -Policy supporting.  
- Financial supporting.  
- Institutional building.  
- Trainings. |
| Key              | National Bank of Agriculture and Rural Development | Banking and financial sector | -Financial benefit.  
- Sustainability of farmers.  
- Promoting equitability.  
- Institutional building.  
- National & international | -Vital sustainability.  
- Importance to equitability.  
- Financial regulations and management.  
- Importance in research | High. Availability of funding.  
- Determines type crop to be funded.  
- Provides financial | -Field evaluation.  
- Financial management trainings.  
- Institutional trainings.  
- Regulating the bankers |
### Table 3-1: Stakeholders Analysis Matrix.

<table>
<thead>
<tr>
<th>Stakeholder Class</th>
<th>Stakeholder Name</th>
<th>Institutional sector</th>
<th>Keys Interests</th>
<th>Importance to system</th>
<th>Influence on system</th>
<th>Participation</th>
</tr>
</thead>
</table>
| Key               | Agriculture Research Station      | Scientific Crop Research (government) | -New crop variety production suiting climatic conditions.  
- Crop production.  
- Land sustainability.  
- Success achievement of objectives.  
- Quality control.  
- Research of new crop seeds.  
- Disease control.  
- Information providing for crop management and diseases. | -High. Determines the crops to plant as time changes.  
- Determines land use as different varieties suit different conditions. | -Production of new crop varieties.  
- Trainings in demonstration fields.  
- New technological applications. | -Production of new crop varieties.  
- Trainings in demonstration fields.  
- New technological applications. |
| Key               | Agricultural Market Committee     | Enterprises, buying products from farmers. | - Buying crop produces from farmers.  
- Financial benefit.  
- Farmer’s sustainability.  
- Sustainability of the system.  
- Optional to equity. | -High. Determines the crop to grow depending on the sales of the crops. | -Buying of farmers’ products.  
- Trainings on storing of goods. | -Buying of farmers’ products.  
- Trainings on storing of goods. |
| External          | Irrigation Department             | Water Supply.                      | - Sustainability of system  
- Supply of adequate water.  
- Maintenance for sustainability.  
- Water supply | -High. Maintenance of the supplies.  
- Water determines the production | -Supply of water to the agricultural system.  
- Maintenance of the reservoirs. | -Supply of water to the agricultural system.  
- Maintenance of the reservoirs. |
| Secondary         | Media Institutes                  | Information supply sector           | - Information dissemination to farmers and other stakeholders.  
- High. Timely information dissemination determines production. | -High. As farmers depends on the information supplied. | -Information supply. | -Information supply. |
| Primary (Indirect)| Village Secretary                 | Record keeping (information supply) | - Crop production statistics  
- Land availability.  
- Financial benefits  
- Supply of up to date farmer information.  
- Evaluate land availability.  
- Importance to sustainability of system.  
- Support and coordination to the system.  
- Gateway of information flow in the system. | -High. Supply of correct information.  
- Influence farmers to take good decisions.  
- Influence bankers to give loans as they supplies correct information to them | -Information collection  
- Record keeping.  
- Crop, water availability.  
- Record updating and information supply. | -Information collection  
- Record keeping.  
- Crop, water availability.  
- Record updating and information supply. |
3.6. Patterns, Relationships and interactions among stakeholders.

In stakeholder analysis there is a need to analyse and understand how stakeholders interrelate, what multiple "hats" they wear, and what networks exists (Ramirez & Buckles, 1999). Consider three blind people, each feeling different parts of an elephant - the trunk, the tail and the leg - and thereafter describing three very different "animals". They could bring together their descriptions and agree on one "common elephant" (Ramirez & Buckles, 1999), only if they share the information they obtained on the elephant (i.e. a system in which all the three have common understanding, goal and interests).

For the sustainability of land use planning, information sharing is the most important factor. Understanding of patterns, relationships and context of interactions between stakeholders is one of the key steps in stakeholder analysis.

In this study, the pattern among stakeholders is complex and the centre of all information is the farmer who is the primary stakeholder. The study analyses how information flows among the stakeholders and their interactions. Also the kind of information, which is shared between the different stakeholders in the land use planning, was analysed using a stakeholder relation matrix. Figure 3.5 below shows how the stakeholders, relate to each other, in terms of information sharing and lines of command within the land use sector at district level.

Figure 3-5 Schematic diagram of the LUP information flow at district level.
Stakeholder relational matrix is a useful analytical tool for identifying and assessing the significance of conflicts of interest and co-operation among the stakeholders and as a way of analysing information needs among the different stakeholders (Groenendja, 2000).

In this study a stakeholder relation matrix has been used as a way of analysing information sharing among stakeholders and how it flows. Table 3.1 is an illustration of a stakeholder relational matrix, which shows how the stakeholders interact, and their level of interaction. The bigger the circle the higher they interact with each other. This relational matrix illustrates who has contacts with whom, and how intensively, is the interaction. Also relational matrix can be used to analyse the kind of information, which can which can be shared among the stakeholders. Instead of showing the intensity of interaction between the stakeholders, information, which they share, can be put in the interaction box.

● = Strong interaction in information sharing. ● = Weak interaction in information sharing.
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Farmer(s) small scale</th>
<th>Farmer (Large scale)</th>
<th>Village Secret</th>
<th>FTC</th>
<th>WUA</th>
<th>Electricity board</th>
<th>Banks</th>
<th>NABARD</th>
<th>Mandal Office</th>
<th>Agric Officer</th>
<th>DDir Agric</th>
<th>DATT</th>
<th>DRDA</th>
<th>Research Station</th>
<th>AMC</th>
<th>Media Institute</th>
</tr>
</thead>
</table>

Table 3-2 Stakeholder relation matrix
3.7. Implementation of the findings of Stakeholder Analysis

Findings from the stakeholder analysis were recorded in tables and matrix diagrams as shown in section 3.6. With this stakeholder analysis provides a view of stakeholders and provides a means of developing an agenda of action in the land use planning. SA is a process for identifying information requirements for the development of an information system for land use planning. Information systems promote co-ordination and data sharing among different stakeholders whose information can only be retrieved by stakeholder analysis. Therefore the development of any information system and database design is a way of implementing the findings of a stakeholder analysis. Figure 3.6 shows how stakeholder analysis is a supporting tool for the development of an information system and databases.

![Diagram showing stakeholder analysis for information systems development and database design](image)

**Figure 3-6. SA supports Information Systems Development & Database Design. (Modified from Radwan, 2001)**

The figure is showing stakeholder analysis as a tool for information retrieval in the real world and also as a tool for providing information to the database and the information system. SA in this context is being used for data collection from the real world and also as part of system analysis in the development of an information system.
4. Information System Analysis and Development

4.1. Introduction

There is high correlation between quality information and the quality of any decision making process, be it strategic, tactical or operational. The correct use of information is highly dependent on the developed information system (Paresi, 2000). Land use planning requires the individual farmers and other stakeholders not only to realise biophysical interdependences of the agricultural system but also to co-ordinate the planning ideas with that of other neighbouring farmers and other stakeholders (Ravnborg & Westermann, 2001) and an information systems can be used to perform this function.

In this study an information system is defined as: a system to transform data\(^1\) in information (including collection, processing, storing, retrieving, analysis, protection and communicate on) as such that this information can be used as input for decision-making (Paresi, 2000). Structured Systems Development Methodologies are used in developing the information system in this study as they can deal with complex system, which other methodologies have difficult in dealing with. Due to their capabilities of using associated tools and techniques such as decision trees, decision tables, DFD and data dictionaries (Paresi, 2000), they are found suitable for developing land use planning information systems. This chapter will focus on information analysis and process modelling.

4.2. Building the Information System

The steps recommended by the structured system methodologies in building information systems consists of a set of iterative activities referred to as the System Life Cycle (Paresi, 2000). Paresi (2000) emphasised that the cycle occurs, when dealing with the next step and it is discovered that the previous step is incomplete and need enhancement. Figure 4.1 shows the iterative System Life Cycle used in this study.

**System strategy and planning** deals with the analysis of the problem on the ground and the identification of stakeholders. It looks at the possibility of carrying out the analysis. Stakeholder analysis has been applied for this stage as it is a tool for analysing and understanding a system and it has the steps for carrying out the analysis (see figure 3.1). **System analysis** deals with analysis of information that the system has to provide with and this done by the using decision trees (i.e. problem tree and objectives tree), see section 4.3. **System design** is when the information system is composed of, the context diagram, top-level diagrams and the lower level diagrams. At this stage, in system development, the conceptual and logical data models are designed. **System realisation**, is when the designed system is implemented, i.e. implementing the logical data model into an operational physical database, which is operational.
4.3. Information Requirements

Information requirements can be defined, as the information needs analysis where the goals or objective of the stakeholders are defined. A problem tree is used to analyse the real world problems and identify information needs. Figure 4.2 shows the problem tree derived from the SA during the fieldwork. First we look at the main problem and then the causes of the problem and their effects. The problem tree mainly focussed on the causes of lack of adoption land use plans by the farmers and also on the irrigation water problem. Problems related to the local government and the mandals/district were identified in the problem tree and also the effects of these problems at both levels, within the land use planning system. The main critical causes in the problem tree are the ones in double boxes in the problem tree, figure 4.2. From the problem tree, an objective tree is derived, which is a clarifying tool, for the specific objectives. The only difference between them is that the problem tree describes the causes of a problem, while the objective tree describes the same elements as proposals to solve the problem. Narrowing the components to a number that is manageable, within the context of an individual project may be obtained by preparing an objective tree and identifying priorities. Figure 4.3 below shows the objective tree, which has been derived from the problem tree. The objective tree act as a solution provider to the causes, problems and effects in the problem tree. The objectives are basically what the stakeholders expect as output in terms of information from the land use planning information system.

---

1 Data is representation of facts, concepts or instructions in a formalised manner suitable for communication.
2 Information is an answer to a specific questions, in problem solving in connection with decision-making.
Figure 4-3 The Land Use Planning Problem Tree
Figure 4-4. The land use planning objective tree.
4.4. **Analysis Modelling**

Analysis modelling consists of activities of discovering (i.e. done in fieldwork) and documenting the user requirements for the land use planning system, to produce a formal detailed model of what the users expect the system to achieve. Basically analysis modelling, consider the system inputs and outputs, roles of social system members, the value of social system members and the expectations of their participation in the system. Table 4.1 below summarizes the output and input expectations of the stakeholders to and from the system respectively.

The input requirements is the information that the stakeholders would input in the system and the output is the information that the stakeholders would want the system to provide and this information is retrieved by querying the database. Such a system would allow the sharing of information within the LUP, as it integrates all information from all stakeholders in LUP.

**Table 4-1 Data input and output requirements to the information system.**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Input Requirement</th>
<th>Output requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>-Soil sample data&lt;br&gt;-Pest and disease attack data.&lt;br&gt;-Field size and crop pattern data.&lt;br&gt;-Irrigation source/borehole information.&lt;br&gt;-Credit &amp; loans data.&lt;br&gt;-Lease/landholder hold data.&lt;br&gt;-Yield information.&lt;br&gt;-Land extent and type.</td>
<td>-Crop market prices&lt;br&gt;-New technology and seed variety information.&lt;br&gt;-Credit facilities&lt;br&gt;-Crop suitability information&lt;br&gt;-Pest and disease control information.&lt;br&gt;-Marketing skills information.&lt;br&gt;-Water/crop management.</td>
</tr>
<tr>
<td>NABARD</td>
<td>-Credit facilities information to commercial/society banks.&lt;br&gt;-Developmental activities information (financial management, institutional building)&lt;br&gt;-Regulation information.</td>
<td>-Repayments of credits.</td>
</tr>
<tr>
<td>DRDA</td>
<td>-Grants information for development.&lt;br&gt;-Trainings information in self helps projects.&lt;br&gt;-Institutional trainings information.</td>
<td>-Farmers groups data.&lt;br&gt;-Groups/society performance information.</td>
</tr>
<tr>
<td>Electricity Board</td>
<td>-Electricity bills&lt;br&gt;-Farmers’ records&lt;br&gt;-Electricity distribution data.</td>
<td>-Payment of bills&lt;br&gt;-Farmers’ financial status information.</td>
</tr>
<tr>
<td>Irrigation Department</td>
<td>-Water levels data&lt;br&gt;-Water management information and distribution.</td>
<td>-Water consumption data.&lt;br&gt;-Irrigated area extent.</td>
</tr>
<tr>
<td>DATT</td>
<td>-Soil/water analysis data.&lt;br&gt;-Fertiliser versus crop application data&lt;br&gt;-Farmer soils/water samples information</td>
<td>-Soil/water samples data&lt;br&gt;-New crop variety/fertiliser application data</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Information Requirements</td>
<td>Constraints</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| AMC                          | - Crop market prices data  
- Payment to farmers  
- Harvest storage information. | - Crop quantity deliveries information.                                     |
| State Bank of Hyderabad      | - Credit facilities information.  
- Crops to be financed information.  
- Credit cards & farmers information  
- Guideline, and policies on credit facilities. | - Title deeds and extent of land data.  
- Lease agreement information  
- Repayment of loans. |
| Mandal Office                | - Crop estimation/condition data.  
- Rainfall data.  
- Agricultural census data.  
- Land utilisation/extent/holder information.  
- Crop census, rainfall.  
- Population census. | - Payment of taxes.  
- Drought/crop condition reports. |
| Agriculture Department       | - Pest and disease control information.  
- Crop cultivation and latest technology.  
- Quality control of seeds.  
- Crop statistical. | - Pest and disease attack.  
- Farmer’s/crop performance.  
- Soil/water sample.  
- New crop varieties. |
| Water Users Association      | - Crops to grow/season  
- Irrigation water quantity available  
- Irrigation water management. | - Payment from members  
- Details of members |
| Agriculture Research Station | - New crop variety information  
- Crop suitability information.  
- Field visits on demonstration fields.  
- Pest and disease information. | - Pest and disease attacks.  
- Crop performances. |
| Farmers Training Centre      | - Crop cultivation and management.  
- Agriculture techniques trainings.  
- Seed rate/acre, labour/crop/acre information. | - Farmer’s problems and needs.  
- Farmers’ performance information. |
| Media Institutes             | - Weather forecast information.  
- Planting, crop management information. | - Crop yield.  
- Crop performance |
| Village Secretary            | - Farmers’ details.  
- Crops census data.  
- Irrigation facilities reports.  
- Drought reports.  
- Land extents and utilisation. | - Credit facilities available.  
- Seeds &fertiliser subsides. |

When inputs and outputs, information requirement to the land use planning information system, have been defined, the designing of the information system would follow. Section 4.6 deals with the development of the LUP information system.

### 4.5. Information Requirement Constraints

In every system, there is bound to be information constraints where, information is not flowing efficiently among the stakeholders. During the fieldwork, it was discovered that there were areas
were information flow was inefficient, as it was flowing in one direction and not much feedback from the other side. Information sharing is one of the most relevant aspects for sustainable land use. The information constraint identified was that the information was flowing in one direction and there was no much feedback. Those at the bottom are information starved, since they cannot get any feedback from the top level. Figure 4.4 shows information constraints (one directional information flow) discovered during the fieldwork. Information systems are solutions information requirement constraints as all the users of the system can have access to information without much of consulting other stakeholders. An information system makes the accessibility of information easier.

Figure 4-5 Information constraints in CPO’s offices and agriculture department

4.6. System Development

System development is a method of diagrammatically showing how data flows from one process to another in LUP. Data Flow Diagrams (DFDs) are used to describe the processes of a system, showing how these processes link together through data stores and how these processes relate to the stakeholders (i.e. users of the system - outside world). Data Flow Diagrams is a means of representing a system at any level of detail with a graphic network of symbols showing data flows, data stores, data processes, and data sources/destinations. In developing the land use planning information system data flows diagrams have been designed after the context diagram, because the context diagram functions as the basis of the data flow diagram.

4.6.1. Context diagram

Context diagram is an approach to model the whole land use planning system in one process. It shows all the externalities that interact with the system and the data flows between the external entities and the system. Figure 4.6 shows the context diagram developed in this study, which models the land use planning system. In the context diagram the information received and provided to the land use-planning domain is identified. The arrows represent the information being received or generated by the land use-planning domain. The closed boxes represent the set of sources and sinks of information (i.e. stakeholders).
The model shown in figure 4.6 does not describe the land use planning information system in detail, it only shows the main process, which is land use planning. For more details, it is necessary to identify more processes within the land use planning system and come up with a DFD made up with these processes and the data flows between them. The context diagram is only composed of the main process, data flows and the external entities, which are the stakeholders.

**External Entities**: are outside of the system, but they either supply input data to the system or use output data from the system. They are entities which the designer has no control over them (Hawryszkiewycz, 1998). In the context of this research the external entities are called sources when they supply data to the system and are called sinks when they receive data from the system.

**Figure 4-6 Context Diagram**

### 4.6.2. Data flow diagram

DFDs use a number of components to represent information systems (Hawryszkiewycz, 1998). The system components are; process, data flow, data stores and the external entities (Perera, 2002). These components are represented diagrammatically in figure 4.5.
i) **Processes:** show what the system does. Each process has an identifier (a number: indicating the process’s place in sequence) and a unique name (i.e. the action: specifying the act and the data on which it is performed). Each process has one or more data inputs and produces one or more data outputs (Hawryszkiewycz, 1998).

<table>
<thead>
<tr>
<th>Process</th>
<th>Shows what the system does.</th>
</tr>
</thead>
<tbody>
<tr>
<td>External entity</td>
<td>Source or destination of data that is external to the system.</td>
</tr>
<tr>
<td>Data store</td>
<td>Manual or computer storage of data.</td>
</tr>
<tr>
<td>Data flow</td>
<td>Data transfer in the direction shown by arrow. Each arrow should be labelled to show or indicate what is being transferred.</td>
</tr>
</tbody>
</table>

**Figure 4-7 Components of the DFD.**

ii) **Data stores:** contains data that is retained in the system. They can be manual files or computer files. Processes can enter into a data store or retrieve data from a data store (Hawryszkiewycz, 1998). A data store is never the direct recipient of unprocessed data from external sources or from other data stores nor is data from a data store ever directly delivered to an external source; there must be a process in between.

iii) **Data flows:** models the passage of data in the system and they are represented by arrows which links; i) two processes, ii) data store and a process and iii) process and external entities. The arrow indicates the direction of flow of data. We have no control over flows between external entities, so we do not model them (Hawryszkiewycz, 1998).

DFDs that show the major system processes are called the top-level DFD (figure 4.7). The top-level DFD contains the five major processes of the land use planning information system. Each of the processes has a unique name and number. The numbers start from one until all the processes have been numbered sequentially (Hawryszkiewycz, 1998). The major processes in this LUP information system are; crop cultivation, farming system analysis, data collection and dissemination, land use plan preparation and investment and operation. These processes describe the land use planning information system to a certain level, where for a more detailed explanation of the system, sub-processes of each process should be described.

The sub-processes are derived from decomposing the five main processes in the land use planning information system. The major processes are composed of different number of sub-processes, with data flows and data stores (see appendix C).

---

3 Farmers have been defined as an entity because, they have been defined as a group with the same input to the system and requires same outputs from the system. Usually entities are considered as organisations in information system development.
There are a number of advantages in decomposing the processes to sub-processes or even to n-levels of DFDs, namely:

i. Provide ease of understanding.

ii. It falls naturally into line with analyst’s top down approach to decomposition.

iii. The various levels represent the various degrees of detail by which the system is represented. This is very useful during discussions with users, either in fact finding or getting agreement about system specification. Different users may want to view the system at different levels of detail.

iv. By the incorporation of different levels, the DFD can provide the view of the whole system or of an area of interest.

Table 4-2 shows the matrix of information flow principles. The table represents the flow of information between external entities, processes, and data stores.

Table 4-2 Matrix of information flow principles.

<table>
<thead>
<tr>
<th></th>
<th>External entity</th>
<th>Process</th>
<th>Data store</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Entity</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Process</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Data store</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

In developing lower-level DFD from top-level, the principles of the flow of information are still maintained and guide the decomposition. Table 4.2 shows the matrix of information flow principles in the DFDs of the land use information system.
4.6.3. Sub-level processes

Sub-level processes gives, more detailed information about the land use information systems. They show all the stores, which are in the system. Figure 4.9 below shows an example of the sub-level processes.

Each process in these detailed DFDs is labelled firstly with a number from the top-level DFD, and then followed by a number to show that each is an expansion of the process in top-level. For other lower level DFDs please refer to appendix B. Figure 4.9 is a DFD lower level of the Farming System Analysis process in the top level DFD.

Figure 4.9 Lower-level diagram

4.7. Metadata

Metadata can be defined literally as “data about data,” but the term is normally understood to mean structured data about digital (and non-digital) resources that have been used to help support a wide range of operations. It is helpful to think of metadata as ‘tongs’ with which we can handle raw data. Without metadata, the data is meaningless. We do not even know where it is, or how much of it to use?

Meta data includes; (i) information about data elements or fields (Column Name, Business Name, Description, Length, Format); (ii) files or table (Name, Contents (subject area)); (iii) system (Name, Contents and Processes); (iv) environment (Flat files, Mainframe, Data Warehouse). In this study the information in the appendices is an example of metadata.
5. Data Modelling

5.1. Introduction

DFDs model the process view of a system and include some consideration of the data used by the system and the contents of data stores and data flows. To determine the file structures that will be needed to support the new system’s procedures it is necessary to examine the data more closely and to subsequently model it more rigorously. In this study, the entity relationship modelling, (a top-down approach) has been used for data modelling.

The top-down approach of **Entity-Relationship modelling** is a valuable technique for giving a high-level, conceptual view of a database structure (Lee, 1998). It is a tool that helps to focus on three major elements that must be incorporated into the final database system: entity types, relationship types and existence conditions.

The ERM can be used as a modelling technique, both for the conceptual and logical modelling (Lee, 1998). This technique produces a good database structure such that the data is stored and can be retrieved in a more efficient way.

5.2. Steps of Developing a Database

In developing the database, this study uses the following steps: conceptual design, logical design and physical design of the database as shown in figure 5.1. The stages of database development shown in figure 5.1 are stepwise processes, as the first stage will lead to the next stage. They simplify the process of database development; reduce redundancy in the database and in turn the memory space of the physical database. Following these steps will ensure a well-designed database, which is efficient in retrieving data, since all redundancy is removed.

![Figure 5-1. The phases of database design process. (Modified from Ellis, 2002)](image-url)
5.2.1. Entity Relationships Diagram Concepts

The three basic components of the ERD are entities, attributes and relationships. These components are represented by various symbols within the ERD. Table 5.1 below shows the symbols that were used in this study. Using these concepts conceptual database schema of the land use planning was derived.

Table 5-1 ERD concepts.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
<td></td>
<td>Specific objects or things in the mini-world that are represented in the database e.g. Farmer, Village.</td>
</tr>
<tr>
<td>Attribute</td>
<td></td>
<td>Properties, which are used to describe the entities, e.g. Farmer-name = Andrew, village_name, village_Id.</td>
</tr>
<tr>
<td>Primary key</td>
<td></td>
<td>An attribute or combination of attributes that uniquely identifies one and only one instance of an entity, e.g. Village_Id</td>
</tr>
<tr>
<td>Relationship</td>
<td></td>
<td>A data relationship is a natural association that exists between one or more entities; a farmer lives in a village.</td>
</tr>
</tbody>
</table>

5.3. LUP Conceptual Data Model [LUPCDM]

The conceptual model is based on a view of the real world and on understanding the data. A CDM, typically called an Entity Relationship Diagram (ERD), contains business information and structure without regard to physical storage concerns. Business items become entities and are described by attributes. Typically no indexes, foreign keys or table space information are included in the conceptual model (Lopez, 2001).

According to (Dorion, 1996) the Conceptual Data Model represents the way the user perceives the data; it describes all business information that is currently being used or will be used by the organization in the future. The Conceptual E/R diagram (i.e. conceptual database design) represents a high-level view of the data entities and their relationships required in the system to be developed, as well as some of the attributes required to support each data-entity.

Figure 5.2 shows the land use planning conceptual data model, derived from the information in the lower level DFDs. The data stores in the lower levels and other data elements become entities in the conceptual method. The information from the lower DFDs is also used to model the relations among the entities. At this stage there are no attributes to be assigned to the entities. The conceptual model only shows or explains the relationship amongst the identified entities. The derived entities from the lower level DFDs are specific objects or things in the mini-world that are represented in the database. Figure 5.2 shows the relationships among the identified entities.
5.4. Logical Data Model

The Logical Data Model is a more detailed version of the Conceptual Data Model. Attributes are assigned to entities based on rules of normalization. These rules help define the primary key of an entity and ensure that all attributes are totally dependent on the primary key (Dorion, 1996). A normalized Logical Data Model eliminates redundancies in data storage and capture. The normalized...

---

4 Normalization is a process for insuring well-structured relations (tables.) It is the process used to assign attributes to entities. These attributes will transform into column names and the entities will transform into relations.
Logical Data Model serves as the basis for the Physical Data Model. Rules of normalisation which are used in the logical data model are:

i. 1NF (First Normal Form): (i) elimination of repeating groups in individual tables, (ii) creating a separate table for each set of related data, and (iii) identifying each set of related data with a primary key.

ii. 2NF (Second Normal Form): (i) Creating separate tables for sets of values that apply to multiple records, and (ii) relating these tables with a foreign key.

iii. 3NF (third Normal Form): eliminating fields that do not depend on the key. No duplicate information is permitted.

The logical model depicts the true relationships of attributes as they are grouped into entities, relating attributes to attributes and entities to entities. Logical models are not concerned with implementation, storage mechanisms (figure 5.3). In developing the logical modelling, it is a one-to-one mapping of the conceptual data model. The entities, which have been identified in the conceptual model, are now arranged and show the relationships among them, though some of the entities can be converted into relationships.

5.4.1. LUP Logical Data Model

The logical data model is a more detailed version of the Conceptual Data Model. Several activities are involved in the development of the Logical Data Model; the methodology used in this study has divided the development into two distinct parts. The development processes is iterative, so as to perfectise the logical model. **Part one** of the development used the activities shown in figure 5.4, which is self-explanatory.

![Figure 5-3 First stages Logical Data Modelling]

![Figure 5-4 Stage two of the development of the logical model.]

The second stage of logical data model development is more detailed than the first stage as on this stage, all the issues which had not been dealt with in stage one are done here. This is the stage, which the logical model is finalised. Figure 5.6 shows the steps used in developing the land use planning logical model, stage two.
After the completion of stage one and two, the result is a logical data model in the form of an ER diagram. Figure 5.5 shows the logical data model of land use planning, showing the entities and their relationships.

In this study due to the many number of entities it is not possible to show the attributes of entities on the ER diagram. The attributes can be conveniently represented in the form of a set of normalised skeleton tables. Skeleton tables in the database context are sets of tables that show entities with their corresponding attributes in the normal form and that helps to transform the ER diagram into a computer compatible form (Perera, 2002).

![Figure 5-5. The logical data model](image)

The skeleton tables are the representation of the physical database tables in the Microsoft access. The attributes of all the entities are shown in the skeleton tables. And each table should have primary key, which could be one column (field) or set of columns, that allows each row in the table to be uniquely identified.
5.4.2. Primary and foreign keys

Primary and foreign keys define the relational structure of a database. These keys enable each row in the database tables to be identified, and define the relationships between the tables. The information in one table is related to that in other tables by foreign keys. No two rows in a table with a primary key can have the same primary key value. If no primary key is assigned, all the columns together become the primary key. It is good practice to keep a primary key for each table as compact as possible. These set of tables define the relational database.

5.4.3. Skeleton tables

The basic skeleton tables for the entities and their attributes in the normal form of the proposed database system are indicated below. The primary keys are in bold and underlined, whilst the foreign keys are in italics and bold.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>Farmer_Id, Farmer_name, Farmer_address, Village_Id.</td>
</tr>
<tr>
<td>Village</td>
<td>Village-name, Village_Area, village_Id, Mandal_Id.</td>
</tr>
<tr>
<td>Mandal</td>
<td>Mandal_Id, Mandal_name, Revenue-village, Area, Population,</td>
</tr>
<tr>
<td></td>
<td>Rainfall_Station_name, Rainfall-amount (yr).</td>
</tr>
<tr>
<td>Land_Utilisation</td>
<td>Mandal_Id, Mandal_name, Geographical_Area, Forest, Barren-</td>
</tr>
<tr>
<td></td>
<td>Uncultivated, Non-Agricultural, Pastures, Tree-Crops, Culturable-waste,</td>
</tr>
<tr>
<td></td>
<td>Fallow, Current-Fallow, Area-sown, Tot-Cropped-Area.</td>
</tr>
<tr>
<td>Village_account</td>
<td>Village_Id, Farm_Id, Field_size, Cultivated-size, Uncultivated_size,</td>
</tr>
<tr>
<td></td>
<td>Land_type, Irrigation_source, Farmer_Id, Farmer_name, Raised_Crop, Vill-</td>
</tr>
<tr>
<td></td>
<td>Secr inspection date.</td>
</tr>
<tr>
<td>I_B_account</td>
<td>Account_Id, Farmer_Id, Farmer_name, Farm_Id, Land_type,</td>
</tr>
<tr>
<td></td>
<td>Tax_amount, Land_value, Village_name, Ownership_type, Mandal_name.</td>
</tr>
<tr>
<td>Water_User_account</td>
<td>Water_Id, Farm_Id, Cultivated_size, Uncultivated_size, Land_type,</td>
</tr>
<tr>
<td></td>
<td>Tax_amount, Irrigation_Source, Irrigated_area, Farmer_name, Farmer_Id,</td>
</tr>
<tr>
<td></td>
<td>Witness_name, Witness_Id, Farmer_Witness_Relationship, Field_Id,</td>
</tr>
<tr>
<td></td>
<td>Season, Crop_name, Total_Crop_area, First_Crop_area, Second_Crop_area,</td>
</tr>
<tr>
<td></td>
<td>Estimated_yield.</td>
</tr>
<tr>
<td>Credit_account</td>
<td>Credit_acc_Id, Limit_Sanctioned, Farm_Size, Land_type, Farmer_name,</td>
</tr>
<tr>
<td></td>
<td>Farmer_name, Farmer_address, Farmer_Id, Expiry_Date, Branch_Name, Debit,</td>
</tr>
<tr>
<td></td>
<td>Credit, Balance.</td>
</tr>
<tr>
<td>Soil_Water_account</td>
<td>Lab_num, Farmer_name, Village_Name, Farmer_Id, Farm_Id,</td>
</tr>
<tr>
<td></td>
<td>Field_Size, Texture, Effervescence, pH, Electrical_conductivity,</td>
</tr>
<tr>
<td></td>
<td>Organic_carbon (N), Phosphorus (P), Potassium (K), Lime.</td>
</tr>
<tr>
<td>Field_utilisation</td>
<td>Mandal_Id, Paddy_Kharif, Paddy_Rabi, Jowar_Kharif, Jowar_Rabi, Bajra_</td>
</tr>
<tr>
<td></td>
<td>Kharif, Bajra_Rabi, Maize_Kharif, Maize_Rabi, Pulse_Kharif, Pulse_Rabi,</td>
</tr>
<tr>
<td></td>
<td>Sugarcane_Kharif, Sugarcane_Rabi, Turmaric_Kharif, Turmaric_Rabi,</td>
</tr>
<tr>
<td></td>
<td>Groundnut_Kharif, Groundnut_Rabi, Cotton_Kharif, Cotton_Rabi, Total_Kharif,</td>
</tr>
<tr>
<td></td>
<td>Total_Rabi.</td>
</tr>
<tr>
<td>Crop</td>
<td>Field_Id, Crop_name, Crop_Id, Area Cultivated (yr), Production (yr),</td>
</tr>
<tr>
<td></td>
<td>Yield (yr).</td>
</tr>
<tr>
<td>Field</td>
<td>[Field_Id, Field_size, Wet/Dry_classification, Soil_type, Mandal_name,</td>
</tr>
<tr>
<td></td>
<td>Village_name, Village_Id, Farm_Id, Irrigation_Source.</td>
</tr>
<tr>
<td>Farm</td>
<td>Farm_Id, Farm_Name, Farm_Size, Farm_address, Farmer_name, Farmer_Id,</td>
</tr>
<tr>
<td></td>
<td>Village_name.</td>
</tr>
</tbody>
</table>
### Table 5-2 Skeleton tables for the land use planning database.

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation_source</td>
<td>Source_Id, Source_name, Capacity, Farm_Id, Irrigated_Area, Expense_Bill.</td>
</tr>
<tr>
<td>Mandal_Machinery</td>
<td>Mandal_Id, Wooden_Ploughs, Iron_Ploughs, Irrigation_Diesel, Irrigation_Electrical, Tractor, Cane_Crusher.</td>
</tr>
<tr>
<td>Exist_land_use</td>
<td>Area, Land_Id, Land_Use, Land_cover, Land_use_season, Village_Id, Village_name, Mandal_Id, Field_Id.</td>
</tr>
<tr>
<td>Ncou_Cuu</td>
<td>N_Area, NLand_Id, Nland_Use, Nland_Season, Village_Id, Village_name, Capability_Use, Nland_cover.</td>
</tr>
<tr>
<td>Potential_Land_uses</td>
<td>P_Area, Pland_Id, Pland_Use, Pland_cover, Pland_season, Village_Id, Village_name, Mandal_Id.</td>
</tr>
<tr>
<td>Farm_machinery</td>
<td>Machinery-name, Machinery_Id, Farmer_Id, Field_Id, Farm_Id, Quantity.</td>
</tr>
</tbody>
</table>

### 5.5. Physical Database Model

Physical modelling involves the actual design of a database according to the requirements that were established during logical modelling (Stephens & Plew, 2001). The physical model deals with the conversion of the logical model, into a relational database model. During physical modelling, objects such as tables and columns are created based on the entities and attributes that were defined during logical modelling (see figure 5.6 with tables created in the MS Access).

Translation rules that have been applied in designing the physical database namely:

i. Entities become tables in the physical database.

ii. Attributes become columns in the physical database. Choose an appropriate data type for each of the columns.

iii. Unique identifiers become columns that are not allowed to have NULL values. These are referred to as primary keys in the physical database. Consider creating a unique index on the identifiers to enforce uniqueness.

iv. Relationships are modelled as foreign keys.

#### 5.5.1. Creating Tables

Data Definition Languages (DDL) have been used to create the physical tables, that means developing the physical relational database begins with the creation of the tables in which the data will be entered. DDL statements for creating tables must contain the column names, their data types and the sizes of the data to be entered. The syntax used for developing tables in the physical relational database is expressed as follows:

```sql
CREATE TABLE tablename
    (Column1_name datatype (datasize))
```
Column2_name datatype (datasize)

......................

ColumnN_name datatype (datasize)

SQL Query 1

The results of the SQL syntax statement above are a set of tables in the database, with empty columns only. Figure 5.6 shows one of the tables created using the query above, where tablename is CREDIT_ACCOUNT, column1_name is credit_acc_ID, column2_name is limit_sanction, etc and the datatype is number or text.

![Figure 5-6 Database table.](image)

In creating this database tables, some of the columns are repeating in other tables and the following syntax was used to transfer the columns from the existing table to the new one.

CREATE TABLE new_tablename (column1, column2, ..., columnN)

AS

(SELECT column1, column2, ..., columnN)

FROM exist_tablename

WHERE condition)

SQL Query 2

After creating the tables the data needs to be inserted into the tables to create the rows (records). DDL INSERT command was used to insert the data in the records and the following syntax was used for inserting the data into the database tables and an example of the result is shown in figure 5.7.

INSERT INTO tablename (column1_name, column2_name, ..., columnN_name)

VALUES (‘value1’, ‘value2’, ..., ‘valueN’)

SQL Query 3

The SQL Query 3 was used to insert data only in specified columns whose data was available and for inserting data into all the columns and multiple rows the syntax expression below was used.

INSERT INTO tablename

VALUE (‘value1’, ‘value2’, value3, ..., ‘valueN’)

SQL Query 4
The result of the above SQL DDL expressions is a database with all the tables filled with the respective data. After executing the above expressions the physical database is now ready for refinement.

Figure 5-7 Physical Database Tables.

In the physical database model all the pieces come together to complete the process of defining a database for a business (Stephens & Plew, 2001). All the tables created are linked as they are defined in the logical data model. Figure 5.8 shows a table in its design view, where n_land_use_Id is the primary key and mandal_Id or village_Id are foreign keys to this table. The foreign keys link this table to the village and mandal tables in the physical database.

Figure 5-8 Physical Database Table in the Design Form.

Figure 5.9 shows the relationship links in the physical database. Relationships are modelled by adding a foreign key to one of the tables involved in the relationship. A foreign key is the unique identifier or primary key of the table on the other side of the relationship.
The most common relationship is the 1-to-M relationships. These relationships have been mapped by placing the primary key on the "one" side of the relationship into the table on the "many" side. Picking one of the tables and giving it a foreign key column that matches the primary key from the other table have mapped 1-to-1 relationships. But in theory, it does not matter which table is chosen, but practical considerations may dictate which column makes the most sense as a foreign key.

Figure 5.9 shows the tables, which are linked, in the physical database. It is the physical representation of the logical data model, where the entities have their attributes as columns and the entity name is now the table name. After the development of the physical database, manipulation of data follows as the queries are now used to answer questions that arise in land use planning. Chapter 6 looks at the manipulation of the physical database.
6. Data Manipulation

6.1. Database querying

In this chapter of the study, the MS Access database is evaluated through posing typical questions, as required to support land use planning and decision-making. The questions were based on what the stakeholders expected in land use planning. Stakeholders expected real time information and therefore the database should be able to provide this, when posed with the kind of information required. This section reviews possible questions, which arise in land use planning, and the database will be queried to retrieve the data from the tables. These tabled answers are linked with attribute tables’ in ArcView and the answers are also produced in map form. At the initial stage of data manipulation, the whole database was linked to ArcView (see appendix A, for the linking process).

SQL queries are used to retrieve data from database tables. An SQL query is a query created by using an SQL statement. Examples of SQL-specific queries are the union query, pass-through query, data-definition query, and sub query. (See MS Access and ArcView documentation).

As part of data manipulation, below are the typical questions in land use planning, which the database and ArcView should be able to answer. The answers, which are produced in MS Access by querying the database, are also produced in ArcView by query the attribute tables, which have been joined with those of the MS Access database. The themes are manipulated to produce the answers in map form. Below are questions, which the stakeholders may want to have answers to:

LUP-Question-1: (This is a farmer’s typical question)

What type of potential alternative land use (according to IMSD) can be implemented in areas were the land is considered not capable but is over-utilised and where cropping takes place during kharif and rabi (double cropping) What are the sizes of the areas? Show the land use identification of these potential alternative land uses.

Figure 6.1 shows the query in MS access that has been developed using the data definition language query. The query will select areas, potential alternative land use, the area of land uses and the land use identification numbers of the areas. The answers are retrieved from the tables in the database.

![Figure 6-1 SQL query to answer question 1](image-url)
On running the query in figure 6.1 in MS Access database, it will retrieve the information, shown in figure 6.2 below from the database. This tabular result information can also be represented in ArcView, since the databases table have been exported to ArcView and joined with the attribute tables in ArcView. The same query conditions are applied in Arcview, to produce the answer in map form.

Figure 6-2 Answer to Query in figure 6.6.

Figure 6.3 and 6.4 show the maps of potential land use, which can be implemented, and the current land uses respectively. These two input maps have been used as query input to generate figure 6.5, which is the map representation of the query result of question one.

Figure 6-3 Potential land uses (Input map).
Figure 6-4 Existing land uses (Input map).

Figure 6-5 Map SQL Query result (Alternative land uses)
Figure 6.5 shows the potential alternative land use and the type of agriculture activities are double cropping and/or agro-horticulture with ground water exploitation, horticulture and intensive agriculture.

**Question 2:** (Typical question from the Director of Agriculture)
(i) Which areas can be used for intense agriculture and for horticulture? (ii) Which areas are suitable for agriculture, but not being used for agriculture and show the road network within these area and the settlements around. (iii) In case of monsoon failure what are the alternative crops.

Solution for (i) is as shown below:

```sql
SELECT DISTINCTROW [potential_land_use].[p_land_use], [potential_land_use].[p_area],
[potential_land_use].[land_descript], [potential_land_use].[p_land_cover],
[ncou_cuu].[capability_use]
FROM potential_land_use INNER JOIN ncou_cuu ON
[potential_land_use].[p_land_use_Id]=[ncou_cuu].[n_land_use_Id]
WHERE ((([potential_land_use].[p_land_use])='intensive agriculture')) Or
((([potential_land_use].[p_land_use])='horticulture') And
(([ncou_cuu].[n_land_season])=[p_land_season]));
```

*SQL Query 5*

![Figure 6-6 SQL Query 6 results.](image)

The above query retrieves, the potential land uses, the size of the area, land description and the capability of the areas as shown in figure 6.8. The areas are now shown in map form in ArcView after applying the same conditions as in query 6. Figure 6.9 shows the intensive and horticulture areas.
Also the above map gives answer to question 3(iii), as in case of monsoon failure, crops which needs to be grown should be in the intensive agriculture area and the type of crops which can be grown are sorghum, safflower, cotton, redgram, groundnut, and sunflower as these crops need less water.

Solution 3(ii)

```
SELECT DISTINCT exist_landuses.landuse, potential_land_use.p_land_use, potential_land_use.p_area, potential_land_use.p_land_use_id
FROM exist_landuses, potential_land_use
WHERE (((exist_landuses.landuse) Not Like 'agriculture') AND ((potential_land_use.p_land_season)= [landuse_season]));
```

*SQL Query 6*
In the result above it shows the current land use and the p_land_use is the potential alternative land uses, which can be implemented. The map in figure 6.11 shows the potential agriculture areas and the road network.

Areas, which need immediate attention for soil conservation, are (question 2(iii)) retrieved from the database using SQL query 9 and the answers are shown in figure 6.12 and figure 6.13 and the SQL query is shown below.

```
SELECT DISTINCT soil. SERIES, soil. FAMILY_TEX, 
soil. GR_GROUP, soil. NAME, soil. location 
FROM soil 
WHERE (((soil. LCC)>'vies'));
```

*SQL Query 7*

![Map showing potential agriculture areas and potential alternative land uses](image)

**Figure 6-9** Suitable agricultural areas and the type of land use

![SQL Query 7 result. Areas which need immediate soil conservation](image)

**Figure 6-10** SQL Query 7 result. Areas, which need immediate, soil conservation.
**Question 4:** (farmer’s land utility question)

What is the best approach to increase my income, i.e. for parcel A and B, what is the agro-economic suitable land?

This question can be answered using the database, when all the income, expenditures and investments data of the previous years is available. Though in this thesis this question could not be answered as the data was not provided and due to time limitation it was not possible to collect, the production data by fields.

Questions that can be answered by the database and ArcView can be generated during the process of stakeholder analysis. At this stage the stakeholders are able to list what their expectations are in land use planning. And with the land resources available the LUP information system should be in a position to carry this information such that the database can answer the questions. Below is a continuation of the questions, which were collected during the fieldwork and that the stakeholders expect the database to answer. The answers are in appendix B.

**Questions**

1) What is the extent of the wastelands in the study area and a perspective plan for their development? Show their categories and priorities them for development.

2) How do the information flow between the different departments and highlight the bottlenecks for agricultural development? (Answer, see figure 3.5 and figure 4.4 respectively).

3) What is the statistical land utilisation for the study area for the year 2000-2001 and what is the statistical area for the principal crops (rice, wheat and jowar) for the year 2000-2001?
6.2. Views

As the database is a multi-user system, there is need for views that can provide different users to see the same data in different ways. Views are data manipulation tools, which are more convenient working entities than tables. As the LUP database grows it is more convenient to work with a view, consisting of selected columns from a table rather than the whole table. The relational database can be used to create views. The SQL query below is used to manipulate the database for creating the views:

```
CREATE VIEW viewname [(view target list)]
AS
SELECT column1_name, column2_name, . . . , ColumnN_name
FROM tablename
WHERE condition
[WITH CHECK OPTION;]
```

*SQL Query 8*
7. Conclusion and Recommendation

7.1. Conclusion

This study concerns land use planning information system development and database design, which can be used by stakeholders and decision-makers for sustainable land use planning. The thesis focused on the use of stakeholder analysis as a tool or a set of tools commonly used within the most collaborative planning processes. The success and failure of land use planning simply lies in knowing the advocates and opponents of LUP and understanding their respective needs and objectives. Stakeholder analysis as a tool has achieved this in this study. The result of stakeholder analysis include information for the additional tools that have proved valuable for land use planning, namely the information system and the database.

The objectives of the study has been achieved; identification of primary, secondary, external and key stakeholders in land use planning in Nizamabad District and the analysis of their interest and objectives to land use planning. Information requirements for an information system on land use planning were determined (using stakeholder analysis), which resulted in the developing, implementation and testing of the system.

The research questions have been answered; stakeholders were identified and of importance, farmers were identified as a group with same problems, interests, and objectives in land use planning in Nizamabad District. Information flows, analysis of the information and relations among the stakeholders were retrieved using the SA. An information system and a database, which is able to answer questions, in land use planning has been developed and is operational.

It can also be concluded that the assumption statement holds stakeholder analysis is a unifying theme for decision makers and planners. SA has proved this as it can be used for (i) identifying the stakeholders and their objectives, interrelationships and information flows and (ii) information requirements analysis and system analysis using the principles of stakeholder matrixes as part of system development using the SSD methodologies.

SA has proved that it’s a technique that can be applied in any situation to retrieve qualitative and quantitative data from stakeholders. A technique, which allows stakeholders to identify each other and the kind of information they share. It is a data validation tool.

Using the SSD methodologies, a land use planning information system has been developed and tested. SA, problem tree and objective tree analysis have been used for information requirement in system analysis. While system design and realisation was part of database design and querying. The system has integrated data from all the relevant stakeholders in land use planning.
The system is capable of providing information on existing land uses, alternative land uses to different fields and provide maps for all the type of information required for LUP. In addition the system is able to provide information on farm equipment, farmers detail, villages and mandals, irrigation sources, in the study area upon querying the database. The information system is capable of providing real time information, since it is an integrated information system, composed of information from all the stakeholders in land use planning.

The LUP information system cannot only be used for Nizamabad District but can also be used elsewhere in land use planning as it gives room for modification to suit the area. The capability of the system to work with ArcView has proved to be a worthwhile system in LUP, as requested information could be produced in map form.

7.2. Recommendations

The development and implementation of the complete LUP information system is an absolute requirement for information sharing in land use planning in Nizamabad District. With input of all quantitative data in the database, and maps in ArcView, the system is able to all answer questions that may arise for land use planning.

It is well recommended that the information in the databases be upgraded and the tables, be filled with data so that the system is able to answer all questions, for LUP decision-making. As many stakeholders will use the system, data quality and simplicity should be given high consideration. SA should preferably be used for collection of qualitative information. Group dialogue should also be used in carrying out SA, besides individual interviews only.

It is well recommended that the system be a network system such that only one organisation is responsible for collecting, updating and maintaining the system. Whilst other organisation could be able to access the data in the database, they should not be able to change the database.
References


Appendix A: Linking MS-Access Land Use Database to ArcView for Manipulation

A-1 Linking MS-Access Land use Database to ArcView for Manipulation

Implementation is aimed at turning to fruition all that has been put down to paper in the previous phases. As part of the implementation of the database, the tables created in the MS access Database (see figure 5.6), during the physical design stage; have been loaded to ArcView so that these tables can be combined with themes in ArcView. ArcView SQL connection feature has been used to load the Dbase IV, tables to ArcView.

Figure 6.1 shows the SQL connection dialogue box showing all the tables, which are in the database, which had been created. This gives the way on the tables, which can be loaded and joined to attribute tables of themes in ArcView.

![SQL connector](image)

Figure A 1 SQL connector

In this SQL query (figure 6.1) the records for four columns in the Village table are brought to ArcView, and the output table in ArcView is villageSQ see figure 6.2. The villageSQ table can now be added to the village map by joining it to attribute table of the village-visited theme.

![SQL connector resultant table](image)

Figure A 2 SQL connector resultant table.

In this study the tables in MS Access database have been uploaded to ArcView and joined to the corresponding attribute table of the maps, which are to be manipulated in section 6.2. The joins are
based on the values of the fields that can be found in both tables, which have to be the same. Using
the SQL connector, selected columns from the MS Access can also be imported to ArcView and
these can be joined with the attribute whose theme needs to be manipulated. Figure shows 6.3 shows
one of the results of joining the ExistsSQ that is a result of the SQL connector from the
Exist_land_use table in MS Access database to the attribute table, existing landuses.shp in ArcView.
Then figure 6.4 shows the query builder with the query, which has been used to manipulate the
joined table and figure 6.5 the results in map form when the joined table is queried using a query
builder in ArcView.
The conditions used in the Arcview query builder are columns of the table in MS Access, which have been joined with the attribute table existlanduses in ArcView. The resultant of query in map form is figure 6.5. This shows how data collected in the field for land use planning can be incorporated into Arcview for manipulation, through the development of a database to store the data.

![Query Result](image)

Figure A 5 Query results.

All these processes help in land use planning where questions raised can be answered in MS Access databases to give tabular data and also in Arcview to give the answers in map form.
Appendix B: Answers to the stakeholders’ questions.

Answers to Questions in section 6.1

Answer 1: SQL Query

SELECT DISTINCTROW potential_land_use.p_area, potential_land_use.p_land_use, potential_land_use.land_descript, ncou_cuu.village_name, ncou_cuu.capability_use, potential_land_use.p_land_season, ncou_cuu.n_land_use
FROM potential_land_use INNER JOIN ncou_cuu
ON potential_land_use.p_land_cover = ncou_cuu.n_land_cover
WHERE ((potential_land_use.p_land_cover)='land without scrub' Or (potential_land_use.p_land_cover)='land with scrub') AND ((ncou_cuu.n_land_season)='land with scrub' Or (ncou_cuu.n_land_season)='land without scrub');

And the table result of the query is shown below:

![Query Result Table]

Figure B 1

The map below is the query result, in Arcview. And from the analysis of the maps, those areas deemed wastelands are the areas which also have been considered, capable but being under-utilised and also not capable but being over-utilised. The map shows the land uses, which can be implemented in areas where currently, are wastelands.
Figure B 2 Answer to question 1.

Answer 3. SQL query.

```
SELECT crop_name, area2001, yield2001, and prod2001
FROM crop
WHERE crop_name = 'rice' or crop_name = 'jowar' or crop_name = 'wheat'
```

Principal crops statistical area

Figure B 3

SQL Commands

Table B 1 Adapted from (Hursch & Hursch, 1988)

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Table</td>
<td>Creates a table and defines it’s columns and other properties.</td>
</tr>
<tr>
<td>Create View</td>
<td>Defines a view on to one or more tables and/or other views.</td>
</tr>
<tr>
<td>Delete</td>
<td>Deletes row from a table.</td>
</tr>
<tr>
<td>Insert</td>
<td>Adds rows to a table or view</td>
</tr>
<tr>
<td>Select</td>
<td>Selects rows and columns from one or more tables.</td>
</tr>
<tr>
<td>Update</td>
<td>Changes the value of one or more fields in a table.</td>
</tr>
<tr>
<td>From</td>
<td>Indication of the table where data should be collected.</td>
</tr>
<tr>
<td>Where</td>
<td>Condition of the data to be retrieved.</td>
</tr>
</tbody>
</table>
Appendix C: Lower Level DFDs

Other lower level processes of the context diagram, which were developed and used in the development of the physical database, for the land use planning.

1) The lower level DFD for the crop cultivation process.

Figure C 1
The figure C1 shows other sub processes and the data stores in the crop cultivation process of the land use planning information system.

2) The lower-level DFD for the land use plans preparation process.

Figure C 2
3) The lower-level DFD for the data collection and dissemination process.

![Figure C 3](image)

4) The lower-level DFD for the investment and operation process.

![Figure C 4](image)
Appendix D: Base Data

Decision Guidelines for Action Plans

Table D 1

<table>
<thead>
<tr>
<th>No</th>
<th>Land Use Type</th>
<th>Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agro-horticulture (rainfed)</td>
<td>Mango, guava, Pomegranate, Sapota</td>
</tr>
<tr>
<td>2</td>
<td>Hortipasture (rainfed)</td>
<td>Custard apple, Ber, guava, Karonda</td>
</tr>
<tr>
<td>3</td>
<td>Horticulture (irrigated)</td>
<td>Mango, Guava, Sapota, Orange</td>
</tr>
<tr>
<td>4</td>
<td>Agro Horticulture (irrigated)</td>
<td>Mango, Guava, Sapota, Orange</td>
</tr>
<tr>
<td>5</td>
<td>Intensive agriculture</td>
<td>Sorghum, safflower, cotton, redgram, groundnut, sunflower, rice, sugarcan.</td>
</tr>
</tbody>
</table>

Information describing the land type for the different land uses in Nizamabad District.

Table D 2

<table>
<thead>
<tr>
<th>Land form class</th>
<th>Ground potential</th>
<th>Soil association units</th>
<th>Slope category</th>
<th>Land use/landcover class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hort-pasture (rainfed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buried pediment-shallow</td>
<td>Medium-poor</td>
<td>8,9</td>
<td>1-3%, 3-5%</td>
<td>Land with scrub</td>
</tr>
<tr>
<td>Pediment, pediplain</td>
<td></td>
<td>20, 23, 16</td>
<td>3-5%, 5-8%</td>
<td>Land with scrub</td>
</tr>
<tr>
<td>Plateau-low/high mesa</td>
<td>Moderate-poor</td>
<td>17, 21, 24, 15</td>
<td>1-3%, 3-5%</td>
<td>Land with scrub</td>
</tr>
<tr>
<td>Denudational slopes-high/low</td>
<td>Poor-nil</td>
<td>4, 16, 21, 10, 17, 24</td>
<td>5-8%, 8-15%</td>
<td>Land with scrub</td>
</tr>
</tbody>
</table>

AGRO FRORETRY/AGROHORTICULTURE

| BPP-S                          | 6,8               | 1-3%, 3-5%            | SCA, fallow    |
| Pediplain/pediment Picomplex   | 4, 11, 12, 16, 20, 23 | 1-3%, 3-5%          | SCA, fallow    |
| Plateau-high/low mesa          | Poor              | 15, 17, 24            | 1-3%, 3-5%     | SCA, fallow             |
| Denudational slopes, high/low  | Poor              | 4, 16, 21             | 3-5%           | SCA, fallow             |

AGRO HORTICULTURE (RAINFED)/AGROFORESTRY

| Buried pediment-shallow        | Medium-poor      | 6,9                    | 1-3%, 3-5%     | SCA, fallow             |
Buried pediplain medium | Good-moderate | 6,8,9,21,22 | 1-3% or more | SCA
Plateau-low/high mesa | Moderate-poor | 21,15 | 1-3%, 3-5% | SCA, fallow
Denudational slopes-high/low | Poor | 10,17,24 | 3-5% 5-8% | SCA, fallow
Pediplain, pediment Inselberg complex | | 10, 13 | 1-3%, 3-5% | SCA, fallow

**AGROHORTICULTURE (IRRIGATED)**
Flood plain-old | Very good | 6,7 | 0-1% | Plantation
Buried pediplain medium | Good-medium | 21,22 | 0-1% | SCA, plantation

**HORTICULTURE (IRRIGATED)**
Buried pediplain shallow | Medium-poor | 13,19,21,22 | 1-3%, 3-5% | SCA
Buried pediplain medium | Good-moderate | 6,8,9,21,22 | 1-3% | Land with scrub
Pediplain, PIC, pediment | Moderate-poor | 4,13,10,11,12 | 0-3%, 1-3% | Land with scrub.

**INTENSIVE AGRICULTURE**
Flood plain-old | Very good | 6,7 | 0-1% | SCA
Buried pediplain medium | Good-medium | 6,8,9 | 0-1% | SCA

**Base maps used in the data manipulation**

**Table D 3**

<table>
<thead>
<tr>
<th>No</th>
<th>Element</th>
<th>Type</th>
<th>Feat-Code</th>
<th>Attrib-Table(s)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LUSE</td>
<td>Poly</td>
<td>LU-code</td>
<td>LUSE.LUT</td>
<td>RS</td>
</tr>
<tr>
<td></td>
<td>Land use cover map</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SOIL</td>
<td>Poly</td>
<td>SOIL-Code</td>
<td>SOIL-LUT</td>
<td>RS Soil agencies</td>
</tr>
<tr>
<td></td>
<td>Soil type, depth, texture etc, for associations/series/family etc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>DISTRICT</td>
<td>Poly</td>
<td>D-Code</td>
<td>Toposheet</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>VIL</td>
<td>Poly</td>
<td>S-Code</td>
<td>Census maps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Village boundaries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>LRDP</td>
<td>Poly</td>
<td>Lrdp_sub</td>
<td>Topo-sheet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land resources map</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>Mandal</td>
<td>Poly</td>
<td>Mandal.shp</td>
<td>Topo-sheet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mandal in the district</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Study Area</td>
<td>Poly</td>
<td>Study area.shp</td>
<td>Topo-sheet</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Canal-sub</td>
<td>Poly</td>
<td>Canal-area.shp</td>
<td>Topo-sheet</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Fieldwork Stakeholders’ Survey Response

Stakeholders’ Survey Response

Data, which have been collected during the fieldwork and used in the development of the land use planning information system. This information is the original data from the open interview contacted during fieldwork.

Table D 4

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Information</th>
<th>L</th>
<th>D</th>
<th>F</th>
<th>B</th>
<th>I</th>
<th>n</th>
<th>v</th>
<th>E</th>
<th>m</th>
<th>p</th>
<th>l</th>
<th>Y</th>
<th>e</th>
<th>Y</th>
<th>A</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer (Ethonda village, kotgiri)</td>
<td>- has own land and equipment.</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td></td>
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<tr>
<td></td>
<td>- grows paddy and sugar cane (karif), jowa and wheat(rabi)- all rainfed</td>
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<tr>
<td></td>
<td>- Farmer has borehole</td>
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<tr>
<td></td>
<td>- receives training from the FTC, Research station and AO. Shares</td>
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<tr>
<td></td>
<td>information on how to grow with fellow farmers.</td>
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<tr>
<td></td>
<td>- Gives information to AO, pest attack on his field, diseases in fields,</td>
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<tr>
<td></td>
<td>soil samples</td>
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<tr>
<td></td>
<td>- Gets info from AO, fertilizer application, pesticides application,</td>
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<td>- Limitations: technology know-how, inaccessibility to new varieties of</td>
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<td>rice’s. Not getting responses in time.</td>
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<td>Preferable crops: groundnuts, sunflower or else rice-rice, rice-groundnuts.</td>
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<td>- Fruits: mango.</td>
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<td>Doing agriculture for financial benefit, then as investments, with option</td>
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<td></td>
<td>- due to in accessibility to AO farmer doesn’t want to change as he will</td>
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<td>not find advice in raising the crops</td>
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<td>Farmer (Chakpalle)</td>
<td>- has own land and equipment.</td>
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<td></td>
<td>- grows paddy and sugar cane (karif), jowa and wheat(rabi)-</td>
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<td>farmer has 4 boreholes</td>
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<td></td>
<td>- Receives training from the FTC, Research station and AO. Shares</td>
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<td>information on how to grow with fellow farmers and big farmers.</td>
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<td>- Gets credits from big farmers.</td>
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<td>- Gives information to AO, pest attack on his field, diseases in fields.</td>
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<td></td>
<td>- Gets info from AO, fertilizer application, pesticides application,</td>
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<td>- Limitations: technology know-how</td>
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<td>- Not getting responses in time from AO on problems in fields.</td>
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<td>Preferable crops: sunflower or else rice-rice/fallow.</td>
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<td>- Fruits: non</td>
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<td>Doing agriculture for employment (7) for my kids/ financial benefits.</td>
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<td>- farmer refuses to grow new crops be cause of no knowledge in the other</td>
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<td>Farmer-1 (Kodcherilla)</td>
<td>4 ha, 2 ha grows paddy- paddy for karif and rabi seasons, 2 ha laying</td>
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</table>
grows green, red gram (on dry land)
-has borehole,
-After paddy farmers grows groundnuts/sunflower in rabi season.
-Grows paddy because it is easy to grow and gives quick returns.
-Preferable crops and fruits are groundnuts, sunflower and mango,
guava, pomegranate. Farmers prefer horticulture as it doesn’t need much
labour, though late return.
-Problems are land become short, due to increased family members.
Farmer refusing to change, as he doesn’t want to change because of the
risks involved, and afraid of making loss.
Stakeholders information sharing
i) Farmers – which crops to grow information, how to grow crops
advice.
-Get money from big farmers. Market prices information.
ii) AO – diseases and pest information.
-Farming practice advice, fertilizer application, pesticides
application, planting dates and harvesting dates of different crops.
-Technology information of farm implements.
-Crop suitability information
-Water samples and soil samples for testing and feedbacks with
recommendations.
iii) Businessmen’s: crops demand information, payment information,
and market prices data.
iv) Village Secretary: farmer’s land particulars, crops yields
information, landholder/lease information, source of irrigation data,
extent of land, survey #, cultivated/uncultivated land, classified land
(dry/wetland), farmers’ name, crops raised.
v) FTC: cultivation info, dates of planting, pre-season training on crops
to plant. Growing of new crop variety information. Technical
information on pre-cultivation.

<table>
<thead>
<tr>
<th>Farmer-2 (Kodcherlla)</th>
<th>16 acres of land all with paddy and sugarcane.</th>
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<tr>
<td></td>
<td>-Has borehole</td>
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<td></td>
<td>-Grows rice-rice (kharif and rabi)</td>
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<td></td>
<td>- Rice-sugarcane. (Farmer permanently growing these two crops)</td>
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<td></td>
<td>-Farming his source of employment,</td>
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<td>- No change of crops if rain, available or else groundnuts, wheat/sunflower.</td>
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<td></td>
<td>- Fruits prefer mango and guava because it needs less management.</td>
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<td>- I haven’t seen the AO, agriculture information from fellow farmers.</td>
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<td></td>
<td>-No change to crops as he is getting good returns from sugarcane and paddy.</td>
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<td></td>
<td>-Lack of knowledge of other crops. -Limitations are lack of advice from AO.</td>
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<td></td>
<td>-Farmer keeps register of planting dates, pesticides application dates, harvesting dates</td>
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<tr>
<td>Information sharing.</td>
<td>i) Co-operative society: credit availability information, payment information, pesticides information, and crop disease information.</td>
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<td>ii) State Bank of Hyderabad- agriculture loans, availability. Payment of loans data, credits cards for money withdrawal.</td>
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<td>iii) Electricity Board- gets electricity and bills info. Regulations of availability of electricity for irrigation.</td>
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<td>iv) DATT: soil samples and water samples from my field and borehole. Gets recommendations on what to do with soil and whether the water is</td>
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good for use or not good to use for the fields. Nutrient/pH state of the farmer’s soil.

| Farmer-1 (Karegoan) | -4 acres, 2 paddy, 2 fallow (coz lack of rain)  
| -the problems more expenditure and less profits (low market prices)  
| -if changing crops farmer prefers sunflower, because of less investments involved and labor or else wheat but only for household consumption.  
| -change crops for financial benefit and high production, no market influence.  
| -normally karif season ploughs paddy and rabi season ploughs sunflower.  
| -communicates with the cooperate bank for financial advice, and getting loans from the bank and payment data.  
| -gets information on curing pest and diseases from other farmers.  
| -gets information on how to store the crops from the advertisements from the Agricultural Marketing Committee (AMC).  
| -the Agriculture Officer (AO) does not come to us because we are small farmers only goes to the big farmers.  
| -farmers make his own decision on crops to grow, depending on his experience in the crops.  
| -farmer preferring to change to horticulture because rain is always becoming scarce and prefers, mango trees. |

| Farmer-2 (Karegoan) (Big Farmer) | -110 acres, 80 acres paddy, 15 acres sugarcane, 15 acres fallow.  
| -mosquito problems, report to AO, and also discuss with other farmers facing same type of problems.  
| -Farmer has boreholes.  
| Farmer has credit facilities from the state bank of hyderabad.  
| He keeps records of soil and water samples test from DATT.  
| -farmer has the know-how on farmer cultivation, soils and equipment so no need of AO.  
| -he sends his soil samples for testing and also water samples to DATT.  
| -for pest and diseases, which he doesn’t know, he calls AO, but rarely do the AO come.  
| -therefore he contacts other big farmers as they have a big farmers association.  
| -where they discuss, they’re problems they are facing, pest, insecticides application, and how to grow other crops.  
| -he gets loans from the banks (huge amounts of loans for buying farm equipment and implements).  
| -he keeps information all cultivation, investments expenditures and harvesting dates.  
| -farmer has laborers and the amount of labor he applies and cost determines what to grow.  
| -his crop preferences are paddy, sugarcane, and groundnuts. Prefers these crops because of the type of soil and there is less risks (in terms of losses) and also less soil fertility loss. He uses his experienced knowledge in all aspects.  
| -fruit trees he prefers mango and guava.  
| -he goes to research station for advice on new varieties and gets information on their benefits and how to grow them.  
| -goes to agricultural demonstration fields to see how different crops are grown and how pesticides are applied and get information on it.  
| -he gives advice to small farmers on how to grow other crops and also |

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| 4 | 6 | 7 | 5 | 6 | 6 |
lends money to small farmers.
- he is facing payments problems with Sugar mills as they are not paying him in time so that he can pay his laborers.
- farmer has reduced sugarcane because the non-viability which is affecting the sugar factory.
He is intending to grow mango because he has seen how successful are his neighbours becoming.
- he does agriculture as investment and also to employment.
- farmers who cannot payback the money landed will give big farmers a piece of land.
- he gets information on marketing and storing of harvested crops from AMC.
- from TV stations and radio he gets information on how to plant and the rainfall information, weather forecast and this also determines what he grows depending on weather.
- we decide crops to grow after we discuss on water availability at the water users association meeting.
- president of the water users association (WUA) give us information when he obtains it from the distributory committee.
- WUA tell us amount of water available and time of availability and when to irrigate.
- gets electricity bills and time when electricity will be available.

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<tr>
<th>Farmer</th>
<th>Area of Land</th>
<th>Borehole</th>
<th>Labour</th>
<th>Management Information</th>
<th>Crops</th>
<th>Water Management</th>
<th>Pest Management</th>
<th>Solar Power</th>
<th>Electricity Bills</th>
<th>other Farmers</th>
<th>Planting Information</th>
<th>Other Advice</th>
<th>Water Samples</th>
<th>Pesticides</th>
<th>Other Farmers</th>
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<tbody>
<tr>
<td>Rampur village</td>
<td>4 acres</td>
<td>Yes</td>
<td>As per</td>
<td>FTC</td>
<td>Groundnuts, Sunflower</td>
<td>Water</td>
<td>Pesticides</td>
<td>Yes</td>
<td>Yes</td>
<td>Minimum Prices</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Padampalle village</td>
<td>25 acres</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Green gram, Black gram, Sunflower</td>
<td>High interest</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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Farmer-1
not enough for him.
-he gives farming advice to other small farmers.
-he gets advice from the demonstration fields of the Agriculture dept
and also new variety crops from the Research station.
-farmer communicates with the banks to get some crop loans and
equipment loans.
-the bankers they come to verify his field status whether he is the owner
or he is leasing the land and how many hectares of land he does have.
-bankers also get farmers’ personal information and takes land as
mortgage for loans.
-the farmer interchanges the crops he grows and he is facing labour
shortage as all his family members are going to the urban areas.
-For fruits he will prefer, mango as he has some few plans of mangos
now, which are producing enough for him to sell them.
Prefers mango because less investment and not labour intensive.
-prefers sunflower as it gives him much profit.
-they do have village meetings were they give each other farming
advices, prevailing pest and diseases and which pesticides to apply.
How to keep the crops after harvesting them.
-lending money to each other and charges profit of 3% per month.
-they discuss market prices.
-their market is far away from them so business people come to buy
their crops.
-with business people the discuss market prices, crop demand and
supply availability.
-some business people give good payment.
-also for him to get loans he gives his field to the bank as mortgage and
bank insures the field of behalf of the farmer.
-every year he grows 4 acres of cotton and due to water shortages,
market problems lack of know-how he doesn’t any other crops.
-Farmers have no health facilities near them.
-He receives his electricity bills monthly and pays, but at times he fails
to pay and he is cut out, so that will affect his production.
-His family discusses on what to grow and keeps records of this.
-FTC gives him some training, but AO doesn’t even come.
His soil is loosing fertility and he also sends soil samples to DATT for
testing.

Farmer-2
(Padampalle
village)

-2 acres of land
-greengram and black gram (this season) last season he grew cotton.
-only the above crops because they receive low rainfall and also
because of the soils.
-farmers keep records of planting and harvesting, credits and debits
records, investment and expenditure records crops wise.
-gets information on when to apply insecticides to cotton from the FTC
and AO and from other farmers.
-FTC and AMC tell us how to harvest and store our cotton.
-preferably he would want to grow paddy if water is available.
-all his land is dry land.
-no information sharing among themselves because if crop fails they
will fight.
-he gets information on which crop to grow, from the high priest that
comes and opens his bible and gives him advice on what type of crop to
grow.
-fruit trees preferably mango and guava.

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<td>Farmer-2</td>
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<td>(Padampalle</td>
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<tr>
<td>village)</td>
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</tbody>
</table>
- Village secretary collects information about his land status and also
  village secretary give recommendations of the farmer to the bank when
  he is borrowing money from the bank.
- He also gets loans from other farmers.

<table>
<thead>
<tr>
<th>Other stakeholders in agriculture</th>
<th>Importance to Agric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity board</td>
<td>1 7 7 2 1 1</td>
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<tr>
<td>Farmers come to apply for agriculture electricity.</td>
<td></td>
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<tr>
<td>farmer fills in application form and shows proof of his title deeds.</td>
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<tr>
<td>EB does the costing of material and labours and gives it to the farmer.</td>
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<tr>
<td>the farmer should pay for all the costs.</td>
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<tr>
<td>farmers will have to pay monthly electricity bills@ 1.35 Rs/unit.</td>
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<tr>
<td>EB supplies electricity to the farmer.</td>
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<tr>
<td>EB sends bills to the farmer.</td>
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<tr>
<td>9hrs of supply of electricity.</td>
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<tr>
<td>farmers are not paying their bills in time and some politicians are telling farmers not to pay the bills.</td>
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<tr>
<td>smaller farmers gets 50% subside on their bills for initial installation.</td>
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<tr>
<td>big farmers there are no subsiding.</td>
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<tr>
<td>record keeping is like: Name of farmer; location; sub-station #; father’s name; village name; survey #; farmer Id #; bills payment, dues; status.</td>
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<tr>
<td>farmers they get from the village secretary and also his character information.</td>
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<tr>
<td>State bank of hyderabad</td>
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<tr>
<td>all farmers are treated equally.</td>
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<tr>
<td>has contacts with Agric dept, irrigation dept, co-operative banks, farmers organizations.</td>
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<tr>
<td>scale financing depends on how many acres and depending on the type of crop e.g. paddy = 7000 Rs/acre, sugarcane = 12000 Rs/acre.</td>
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<td>financing for paddy is for 6 months.</td>
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<td>July- Sept financing and January-March financing periods.</td>
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<tr>
<td>bankers consider title deeds and size of land.</td>
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<td>also with lease agreements one can get loans from the bankers.</td>
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<tr>
<td>bankers do field visit and check water availability, state of crop, size of land, find farmer’s character from village secretary and then evaluate for funding.</td>
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<tr>
<td>financing which is less than 25000 Rs no mortgage.</td>
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<tr>
<td>more than 25000 Rs mortgage needed.</td>
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<tr>
<td>farmers insure their crops thru the bank when they are applying the loans.</td>
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<tr>
<td>bank gives insurance insurance status and costs.</td>
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<tr>
<td>interest rate 10.5%/year.</td>
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<tr>
<td>Gives notices to farmer upon failure to pay.</td>
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<tr>
<td>keeps records of farmers who fail to pay for further recommendations to other banks.</td>
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<td>gives credits cards to farmers and registration form.</td>
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<td>they get feasibility certificates of boreholes from the EB.</td>
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<tr>
<td>farmers should submit credit plans to the banks to get loans.</td>
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<td>agreement form registers, lease agreement register.</td>
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<tr>
<td>get information from DRDA fro appraising agriculture sector development activities.</td>
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<tr>
<td>banks also do suitability test to see viability of any crops/ fruits proposed by farmer.</td>
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<tr>
<td>they get guidelines, policies and regulations on agricultural loans from NABARD.</td>
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<tr>
<td>banks make follow up on defaulters and collects the monies.</td>
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</tbody>
</table>
| funding construction of rural storehouses for farmers to keep their agriculture.
harvest.
-funding construction of cold storage houses to keep fruits of farmers, thus giving farmers a chance to wait for good market prices for their fruits.
-farmers can use the stored goods as mortgage to get another loan for the following season.
-sugar factories get loans from the banks and they also act as guarantors for farmers to take loan, farmers give his sugarcane field to the sugar factory as mortgage to get loan from the farmer.

-AMC buys farmers’ harvests.
-rice millers association buys rice from farmers
-sugarcane factories also buy cane from farmers.
-gvt sets the minimum support prices of all harvested crops.
-Duties of AO: provides quality seeds to farmers
-quality control of seeds
-technical guidance in farming.
-latest technological information to farmers and varieties.

Banks finance for purchasing of farm equipment depending on acreages.
-Provide funds for motorbikes to farmers.
-banks allow jointly bank loans.
-banks give moneys to rural banks, farmers’ banks and cooperative banks.
Gets loans and grants from NABARD to finance the farmers.

<table>
<thead>
<tr>
<th>Mandal Office (revenue officer and statistical officer) to MRO</th>
</tr>
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</table>
| -crop estimation data for every crop/village
| -rainfall data everyday.
| -get agriculture census data from village secretary.
| -land utilization data/farmer/village.
| -use of land/farmer.
| -season-crop reports.
| -dates of harvest of crops and plot yield/village.
| -irrigated areas and unirrigated areas data.
| Revenue information from the village secretary (VS).
| -sources of irrigation data.
| Area under crops and fallow and type of crop.
| -farmers’ serial #, farmer’s land extent.
| -Land holding information.
| -Financial information on farms.
| -Collects water taxes from farmers.
| -Information on farm equipments.
| -crop monitoring information
| -# of boreholes/farmer them village wise.
| -receives instructions from the district officers.
| -yield information.
| -crop condition data.
| -sends all the information to district collector.
- crop list in mandal and condition/per season.
- declaration of good/bad condition of crops.
- current yr & previous year comparison data.
- change of name or leaseholders on fields.
- gives acts information to farmers.
- keeps records of every farmer and send notices to farmers for any unpaid bills.
- land taxes.
- farmer’s name, location, serial #.
- comments of village secretary and mandal officers.
- Drought reports (how is the extent, and how many farmers are affected and how much they might need to be compensated.
- farmers needs and problems,
- bank loans applications
- house taxes, cleaning of irrigation canals

Agriculture Officer
- information on last varieties of crops, advantages of crop, planting methods, nutrients applications, pesticides application, harvesting techniques.
- crop monitoring and pest monitoring.
- 20 days/month field visits. To give advice.
- carrying out, new varieties demonstrations on demonstration fields in conjunction with the FTC.
- from farmers: prevailing crop diseases and pest. Reports on progress after using pesticides. Feedback on new crop variety trial on a farmer.
- technical guidance in planting.
- knowledge on latest farm implements.
- Quality control of seeds and fertilizers.
- round checks on seeds in shops and those being used by farmers.
- latest farming technology and new agricultural schemes
- gives crop suitability information to farmers.
- collects soil and water samples from farmers for testing to DATT.
- gives advice on remedies to take on receiving the results of the soil and water samples.
Crops problem and crop statistical data..
- gives training to farmers..
- maintenance of quality seeds and harvests.
- review of seasonal conditions and crop performance.
- Problems being faced by farmers.
- new varieties
- new technological information.

ADA gives all information discussed at the meetings with the Research station
- crop estimation information data.
- integrated pest management guidelines.
- they share yield data.

Water Users association
- Composed of 1-president and 6 six directors.
- conduct meeting at the beginning of each season.
- discuss on what crop to grow.

<table>
<thead>
<tr>
<th></th>
<th>Farm</th>
<th>AE</th>
<th>AO</th>
<th>Ass Dir</th>
<th>Dy Dir</th>
<th>Research</th>
<th>Joint Dir</th>
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7777 31
-discuss levels of water availability in the reservoirs and that determines the crop to grow.
-discusses water management aspects. Farmers pay 200Rs/acre/irrigated area/season/farmer.
-distributions committee advises the WUA the amount of water available and how to distribute the water.
-WUA is composed of farmers and the engineer and AO are the ex-officials to help the farmers.
-if farmers are not using the water no charge of the 200 Rs.
-main purpose of WUA is the irrigation of crops of farmers.
-if growing dry crops there will be supply of water for 30 days only.
-farmers in WUA agrees to grow one type of crop only.
-rice gets full water supply until harvesting season.
-non-common areas are areas, which are not irrigated.
-the engineer give technical advice on how to maintain canals and repairs. He give cost estimates on all the engineering works involving the canals. He attends to canal damages problems and he gets reports from Gangmen and the Nurides.
-gang men and nuredis give details of water levels in farmer’s canals, and damages and any other problems with the irrigation system.
-sugarcane & paddy have 90days of water supply.
-any other crops 30 days supply and farmer will pay 100Rs/acre.
-defaulters get penalties.
-for one to become a member the association gets detailed information from the village secretary. Who has records of every farmer.
-the money is kept with state bank of hyderabad and is withdrawn to use on repairing the canals.
-president advises farmers on water availability.
-farmers contact the president on any problems related to irrigation they will be facing.
-water releasing time and dates and how to maintain the canals.
-directors represent an area of 400 acres and being a representative of the farmers in those areas.

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<tr>
<th>Farmers</th>
<th>Directors</th>
<th>President</th>
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- water demand information
- water supply data.
- crops to be grown data. Water levels data.
- financial transactions (50 Rs/farmer to PC and 50 Rs/farmer to DC).
- AO as member specialize in giving advice in crop area specialization.
- PC is the main planner of the water, releases water from the tanks, dams and major canals.
- PC does maintain the dams, canals and the dams.
- Dc deals with the distributotry canals and maintain them.
- All these committees also get advice from the Irrigation department, thus technical know-how.
| **DRDA** | -finances farmers’ groups to have other income other agriculture.  
- economic empowerment trainings.  
- financial management trainings.  
- contour trenching to prevent erosion in fields.  
- soil and water conservation trainings.  
- Communities’ support in terms of funds.  
- Funds transport sectors of the communities.  
Gives training to the people whose projects has been selected for funding.  
- Also funds water distribution systems.  
It encourages group working.  
- Mainly focusing on income generating projects. |
| **NABARD** | - Gives credits to commercial banks, regional, rural and co-operative banks.  
- farmers do not have access to funds from NABARD directly.  
- its purposes are giving (i) credits, (ii) development functions and (iii) regulatory inspections to other banks.  
- gives money to NGOs as grants for development purposes.  
- funds the self-help groups.  
- gives institutional trainings to other bankers.  
- funds other banks for their programs especially those related to agriculture.  
- it gives money to groups and not individual farmers, but there are conditions, which the group should satisfy.  
- it finds all the irrigation schemes (e.g. WUA)  
- aims to reduce poverty.  
- creation of employment.  
- funds water distribution/drinking projects.  
- give guidelines to state banks and other banks on projects funding.  
- give guidelines to land based activities.  
- gives crop loans to other banks.  
- is the chairman of the district technical committee, which evaluates crop funding and other agricultural related projects.  
- funds horticultural projects.  
- give training to farmers in agricultural techniques.  
- agribusiness centers gets funds and management techniques from NABARD.  
- technical guidance to agriculture.  
- disbursements of loans is poor as farmers are not paying back the loans in time.  
- gives guideline on how to get loans.  
- farmers lack collateral security to secure loans.  
- Gives loans for farmer mechanization.  
- gives credit cards to farmers.  
- gives loans for non-farm activities to unemployed youths. |

| **Agriculture Research Station** | - works in collaboration with the agricultural university, colleges and polytechnic.  
- gives new varieties of sugarcane and paddy. |
-gives crop yield forecast information.
-give research results to farmers.
-give detailed explanations of each of the different varieties.
-advise farmers to grow for dry land crops.
-crop suitability based on soil analysis and analysis.
-research station problems are mainly pests.
-works in conjunction with DATT and advises farmers on which fertilizers to apply to which soils, pesticides to apply and other agricultural techniques.
-conduct farmer’s field trips in conjunction with FTC, to train farmers.
-works in relation to AMC::: advice on type pest which can attack harvested crops, way to keep the crops, insecticides application.
-fills the gap on the crop management.
-do field visits to assess the performance of farmer’s fields under crop variety test.
-they have a diagnostic team which analysis soils, pest attacks and disease attacks and on how to apply remedies.
-have TV programs where they announce new varieties and how to grow them.
-have radio programs where the give guidelines to farmers
-change of crops is lowly accepted by the farmers.
Gives farmers the disadvantages of continuously using uria.
-research station gets info from farmers on their status of experimental fields.
-they use cell phone communication with other farmers.
-gives advice on crop rotation and advantages.
-farmers resist change because they only consider their staple food.
-farmers prefer high crop production against soil and water conservation.
On the TV programs there are discussions of problem which farmers are facing/season (e.g. lack of water).
-work in relations with AO, ADA and other stakeholders in agriculture.
-plant protection information.
-how to improve soil fertility whilst increasing production.
-choosing crop vesas pest attack information.
-clear cultivation for next crop to break pest cycle.
-soil test for farmers is also done and how to apply organic manure & green manure.
-disease, pest prone areas advice.
-supply of breeder seeds only but to agents only who will supply to farmers.
-Transplanting information
-pest management, chemical application & time to transplant.
-advice farmers to go for germinating seeds.
-pre-planting preparation advice.

<table>
<thead>
<tr>
<th>Irrigation Department</th>
<th>-maintain dams and major canals.</th>
<th>Gives advice on how to maintain canals to WUA.</th>
<th>-water management trainings.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-technical guidance in maintenance and construction of canals.</td>
<td>-guideline on how to carry out participatory irrigation management.</td>
<td>-keeps dams, tanks and main canal levels data.</td>
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<td></td>
<td>-gives water levels data to the WUAs.</td>
<td></td>
<td>-gives water levels data to the WUAs.</td>
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Farmers Advise farmers on cultivation problems.
| Training Centre | -give info about crops.  
|                | -farmers ask about hybrid varieties and on how to grow them  
|                | -crop suitability information.  
|                | -seed treatment data to farmers.  
|                | -seed rate/acre and spacing info.  
|                | -labour data/crop/acre.  
|                | -chemical weeding information.  
|                | -trainings on improved agricultural techniques.  
|                | -supply of farm implements on subside.  
|                | -FTC -JD -Agents – farmers.  
|                | -provide plant protection equipment.  
|                | -trainings on how to use farm implements.  
|                | -chemicals/acre mixing information.  
|                | -date of spraying vs. effects or results.  
|                | -trainings on record keeping.  
|                | -provide advice on cultivation, pest types, protection etc on radio and television.  
|                | -field demonstrations of pesticides application.  
|                | -crop rotation information.  
|                | -advice farmers to go for mango, guava fruits and for maize, vegetables, rice.  
|                | -give trainings on all the new crop varieties And how to implement them.  
|                | -conduct market trainings.  
|                | -they give farmers test seeds.  
|                | -have contacts with WUA.  
|                | -info on plant population/acre.  
|                | -water management information to farmers vs. soil conservation.  
|                | -critical stages information when crops need water.  
|                | -growing crops vs. water requirement information.  
|                | -organise agricultural exhibitions, were farmers can share information.  
|                | -produce a monthly bulleeting for farmers and advices on farmers.  
| Agriculture Market Committee | -publish prices of crops.  
|                            | -buy crops from farmers in bulk and give farmers payment for their crops.  
|                            | -provides selling facilities for farmers.  
|                            | -training farmers on packaging the crops and also how to keep them safe.  
|                            | -advice on which crops to plant and which crops have good returns.  
|                            | -Training farmers on when to sell crops.  
|                            | -Market prices information.  
|                            | -Insecticides to use when storing the harvest.  
|                            | -How to grade the crop harvest.  
| District Advisory Technology Transfer | -gets soil sample for testing from farmers and AO  
|                                      | -give information on nutrients in the soil sample to the farmer  
|                                      | -gets water samples from the farmers and do some analysis also.  
|                                      | -give recommendations on soil and water samples -they keep records of all soil samples and water samples.  
|                                      | Record keeping: Serial #; lab #; Name of farmer; Village name; Survey #; Texture; effervescence; pH; electrical conductivity; N; P; K; name of crop in field; Recommendations (N; P; K); farm manure; green manure; gypsum; lime; |