

## Internship report

### “The factors of change in South India agriculture”

#### SHIVA Project



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## Acknowledgments

I would like to thank all the friends, colleagues, students and farmers I met in India. They made my stay in India really unforgettable and helped me to understanding the India I know and like today.

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## Internship background

This internship was coordinated by the BRGM (Bureau de Recherches Géologique et Minière) over 6 months. The first month took place in Montpellier and the five following months in Hyderabad, Andhra Pradesh, India, where I worked at the IFCGR (Indo-French Centre for Groundwater Resources) hosted by the NGRI (National Geophysical Research Institute).

I went to the field twice in the course of this internship, each time for 15 days: I took advantage of the fact that a BRGM team was conducting a piezometric campaign in the area to do my own work at the same time. My field work consisted in conducting surveys about farming and livelihood strategies. I spent the rest of the time working on the model and studying literature at IFCGR.

The working conditions were globally very good at IFCGR and there was a very good team spirit!

## Abstract

Indian farmers are continuously under the stressors of global changes. Globalization and climate change put a high pressure on natural resources, especially on groundwater. Irrigation through the increasing number of borewells jeopardizes water tables level. In this context, farmers have to find the best livelihood strategies in order to cope with these changes. The aim of this study is to identify the global changes currently happening in South India and describe the livelihood strategies followed by farmers in these conditions.

Indian farmers are classified within 5 categories following their operated area size (marginal, small, semi-medium, medium and large): The final objective of this study is to assess the evolution of the farmers' population in terms of operated area, and to identify the profiles, reasons and percentage of farmers who are going to migrate from one category to another by following a particular livelihood strategy.

## Keywords

Farming system, sustainable livelihoods approach, adaptation capacity, coping strategies, livelihood strategies, global changes, South India.

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# 1 Introduction

## 1.1 Background

Agricultural intensification started in India through the Green Revolution in the mid-1960s: the aim for the government was to become self-sufficient in food grains and to eradicate starvation. The revolution implied increased farming areas, introduction of mixed-cropping techniques, improved seeds, new cultivation technology and practices (Guerrin 2009).

Ensuring food security and eradicating poverty in the second most populated country of the world (1,13 billion people in 2007) are still the main objectives of current Indian agricultural policies. In 2005-2006, agriculture contributed to 20% of the PIB and was employing 60% of the labor force. Moreover, India is a net exporter of agricultural products thanks to high subventions and the poor value of the Indian rupee (OCDE 2007).

India is constituted of 20 big states, 10 small states and 5 Union Territories. However, there are high disparities between states concerning the importance of agriculture: it represents 40% of Punjab GDP but less than 2% in Delhi. Although rural population decreased over the last 25 years, it still represents 70% of the people living in India (OCDE 2007).

### Agriculture in India: Global facts

Five categories of farmers are usually identified by the Indian agricultural authorities, depending on their land holding size: marginal (<1ha), small (1 to 2ha), semi-medium (2 to 4ha), medium (4 to 10ha) and large (more than 10ha). Table 1 illustrates the distribution of land holdings in Andhra Pradesh in 2005-2006.

Size of holdings	No. of holdings (lakhs)	% to total	Area operated (lakhs ha)	% to total	Average size of holdings (ha)
Marginal (below 1ha)	7418	62	3290	23	0.44
Small (1-2ha)	2639	22	3731	26	1.41
Semi-medium (2-4ha)	1444	12	3834	26	2.66
Medium (4-10ha)	487	4	2757	19	5.66
Large (10ha and above)	56	0	877	6	15.64
<b>Total</b>	<b>12044</b>	<b>100</b>	<b>14489</b>	<b>100</b>	<b>1.2</b>

Table 1: Distribution of land holdings in Andhra Pradesh in 2005-2006 (DoA-AP 2010)

In India, most of the agriculture (more than 2/3 total operated area) is achieved by marginal farms (<1ha) and on a family scale. There are more than 100 million holdings in India (Dorin and Landy 2002). Only 1% of the households run more than 10 ha. Most of the holdings are not economically viable because they usually use only 3/5 of the cultivated area to grow one

crop during one season and let the fields unattended for the rest of the year (OCDE 2007). Moreover, since the last decades, there is a “splitting up” phenomenon among the holdings: the reasons are economic development and successional sharing between sons of a same family.

Vegetable production still represents 70% of the global production. The main cultures in India are cereals, fruits, vegetables and oleaginous plants. Cereals stand as a basic food supply for households. 50% of the cultivated area is made of rice and wheat. Livestock farming represent 27% of the agricultural production value and the main products are milk, mutton and poultry. India is the world first milk producer (OCDE 2007).

There are two seasons in India. *Kharif* season happens during the monsoon and seeds are planted in October-November. *Rabi* season is the dry season and happens after the *kharif* season: the harvest takes place in February and March. Finally, the summer season happens from March to Mai and at that time irrigation is needed (Dupard 2009).

About 40% of the cultivated area in India is irrigated. The rest of the fields depend on rainfalls. Sugarcane (92%), wheat (88%), rice (52%) and cotton (33%) are the main irrigated crops (OCDE 2007). 83% of the total pumping in India is used for irrigation.

The contribution of India to the global market is increasing. India stands as a net exporter of agricultural products. Imports involve edible oil, cashew nut and legumes.

Because of the high exportation growth in other sectors than agriculture, the share of agricultural exports decreased by a half between 1995 and 2005. Exports involve cereals (20%), cashew nut, tea, fruits and vegetables and one third goes to USA, Saudi Arabia, Japan, UAE and Bangladesh (OCDE 2007).

The share of manufactured products is still poor compared to the international level. The reason is that products are directly consumed by households or mostly sold on primary market (OCDE 2007).

Moreover, the critical lack of modern infrastructures in India prevents the agricultural sector to further develop: regular electricity supply, good-quality roads, markets, storage capacities and processing industries are still missing all over the country. The current land tenure prevents mobility and doesn't help to improve infrastructures (OCDE 2007).

### Consequences on natural resources

The increasing agricultural productivity put a high pressure on land and natural resources, and especially on water. Most of the fresh water in India is used for irrigation purposes (83%); the rest is shared between drink and municipal use, industry, energy development and other minor uses (Sharma and Kumar 2007).

This should be viewed in relation to the particular geology of India: two thirds of the total surface of the country is made up of hard rock aquifers (Maréchal, Dewandel et al. 2004). A hard rock aquifer is defined by the alteration of an igneous or metamorphic rock (Ahmed, Jayakumar et al. 2008). The water can seep into the rock and circulate thanks to the fissures.

Consequently, the availability of groundwater and the recharge capacity of the aquifer depend on the rock's characteristics.

In South India, where the climate is mostly semi-arid, this recharge capacity is particularly limited. Combined with large quantities of water extraction for irrigation purposes, it makes South Indian aquifers especially prone to depletion. In AP, for example, more than 70% of the water resources come from the ground. Thereof AP farmers are subjected to droughts and severe groundwater depletion. The number of borewells keeps increasing over time but a lot of them get dry rapidly (Maréchal, Dewandel et al. 2004). There are a lot of losses because of the poor efficiency of the irrigation network. Water and electricity are over-subsidized in India, which does not help to better manage the water resources. Small and marginal farmers remain the most affected. Indeed, access to water is before all restricted to land owners who enjoy the underground usufruct. Moreover, smaller farmers don't have enough money to invest in wells that become each year deeper and deeper. The social impact is severe, because a large part of the farmers has debts and are forced to migrate to urban areas in order to earn a living. Moreover, it is not rare that some farmers commit suicide (Dev 2007).

## 1.2 Global changes

Our work will be achieved within the IPCC A2 scenario framework. Indeed, countries' visions for the future (and Indian vision in particular) totally meet the IPCC expectations for the A2 scenario.

The A2 storyline and scenario family describes a very heterogeneous world and "consolidates" into a series of economic regions. With the emphasis on family and community life, fertility rates decline relatively slowly, which makes the A2 population the largest among the storylines (15 billion by 2100) (IPCC 2001). With substantial food requirements, agricultural productivity in the A2 world is one of the main focus areas for innovation and research, development, and deployment (R&D) efforts, and environmental concerns. Initial high levels of soil erosion and water pollution are eventually eased through the local development of more sustainable high-yield agriculture (IPCC 2001).

In this particular context, global changes are happening. Researchers notice crucial climate and economic changes (among others).

### 1.2.1 Climate changes

Scientific evidences tell us that climate is going to change over time and in many places in the world. Some impacts will also occur at the local scale in areas such as rural India.

If we downscale the global A2 scenario, it seems that the following events are going to happen. First, the temperature is going to increase (+ 2°C). Besides, the monsoon will become hard to predict and delayed. The rainfall pattern is changing as well: the number of rainy days is decreasing. Finally, more frequent extremes of weather will occur (e.g. more severe droughts and floods). (Cf work of N. Vigaud).

## 1.2.2 Economic changes

### a) Agricultural sector

In terms of agriculture, the rural South is currently subjected to fundamental changes as (Rigg 2006) noted: first, occupations and livelihoods in the countryside are diversifying. Moreover, the balance of household income is shifting from farm to non-farm. Livelihoods and poverty are becoming delinked from land (and from farming). Lives are becoming more mobile and livelihoods correspondingly delocalized. The average age of farmers is rising. Finally, cultural and social changes are being implicated in livelihood modifications, and in new ways.

In Asia, researchers noticed that cropping areas keep increasing although the total available (and farmable) land is limited and natural resources are becoming scarce. Urbanisation keeps gaining ground (Dorin and Paillard 2009).

In terms of food security, India has moved from food deficits (before the Green Revolution) to food surpluses, reducing poverty significantly and reaching a per capita income higher than in most parts of Sub-Saharan Africa. Yet it remains home to 210 millions undernourished people and 39% of the world's undernourished children (WB 2008).

At the Indian scale, a declining trend can be noticed in the average farm size and the cropping pattern (production of high value crops) (Abrol and Sangar 2006). The number of holdings that run less than 2 ha in size is expected to grow over time. For them farming is the mainstay for subsistence. Most of the marginal farmers (less than 1 ha) are net buyers of food (Jha, Bhattacharyya et al. 2009)

The main objective announced by Indian government is to ensure food security to the whole country and to reduce poverty. The skills are distributed among the central government (Essential Commodity Act – ECA 1955) and the states governments (Agricultural Produce Market Regulations Act – APMRA). Cereals, legumes, edible oils, cotton, sugar and jute are regulated under ECA through licenses, permits, prices and storage controls (OCDE 2007)

The 10<sup>th</sup> five-year plan (2002-2007) tried to improve the global agricultural productivity. This was implemented through mixed farming, better quality inputs and increase of high-value crops. Livestock farming should progressively be eliminated. Modifications have been introduced in the ECA, helping the free traffic and storage of cereals, sugar and edible oily products (OCDE 2007). The 11<sup>th</sup> five-year plan carries on the same objectives and wishes to reduce disproportionate subsidies and develop credit opportunities for the farmers.

In Andhra Pradesh, the agricultural sector is going to achieve an average growth rate of about 6 percent in real terms by 2020 (Pimbert and Wakeford 2002). Agriculture will move from being a subsistent activity to an economic one (i.e. transition into an international, market-based economy and shift to high value crops) (Go-AP 1999).

Agricultural intensification is therefore expected.

## **b) Urban sector**

Urbanization keeps gaining ground on the best farming areas, in spite of the development of food industries in peri-urban and urban areas, and the attempts in relieving the city congestion (Dorin and Paillard 2009). Rural areas are absorbed through the cities expansion (especially the peri-urban areas).

In India, the share of rural population still represents 70% of the total population. However, the UN estimates that urban population should represent at least half of the total population by 2025-2030; Delhi would gather 40 million of inhabitants; Mumbai 30-35 million, Kolkatta 20-25 million; Bangalore, Surat, Hyderabad, Chennai, Puna, Ahmedabad 10-15 million each. Urban infrastructures are not prepared for these changes (Cavalier 2006). Moreover, population forecasts tell us that there will probably be around 1,5 billion people in India by 2050.

Finally, the share of employment in agriculture will decline from its current 70% of the AP population to 40-45% over the next 20 years (Go-AP 1999). Rural employment and opportunities will have to be developed in order to repress rural depopulation and control urbanization (Dorin and Paillard 2009).

## **1.3 SHIVA project and global issue**

### **1.3.1 SHIVA project**

The SHIVA project (Socio-economic assessment of the rural Vulnerability of water users under stressors of global changes in the Hard rock Area of South India) is a research project funded by the French national research agency within the VECS Program (“Vulnerability: Environment, Climate and Societies”). The project is coordinated by the BRGM (French Geological Survey) and gathers several partners:

- SIRS (Systèmes d’Information à Référence Spatiale), an independent company working with Geographic Information Systems tools;
- LMTG (Laboratoire des Mécanismes et Transferts en Géologie – Laboratory for Mechanisms and Transfers in Geology), part of the Indo-French Cell for Water Sciences (IFCWS) hosted by the Indian Institute of Science (Bangalore, India);
- CSH (Centre des Sciences Humaines – Centre for Human Sciences) located in New Delhi, India;
- IFP (Institut Français de Pondicherry – French Institute of Pondicherry) regarding Remote Sensing activities;
- the National Geophysical Research Institute (NGRI) through the Indo-French Centre for Groundwater Resources located in Hyderabad, India;

-the Centre for Economic and Social Studies (CESS) located in Hyderabad, India.

The project comes from the assumption that global changes are already impacting water resources and uses in water-stressed regions all around the world, and that this impact will increase significantly in the near future especially in developing countries, such as rural southern India, where changes are happening quickly and at a large scale (BRGM 2008). Changes such as climate variation and globalization are affecting the context under which farmers in the developing world participate in the agricultural sector. Global changes will have direct impacts on local lives. While some farmers will benefit from these shiftings, others already vulnerable might see their condition worsen (Leichenko and O'Brien 2002).

SHIVA project aims at assessing the rural vulnerability of water users under stressors of global changes in the hard rock area of South India from a socio-economic point of view. Another objective is to evaluate the possibilities to modify this baseline rural vulnerability through improved water management policies or initiatives.

Indian farmers are divided into 5 categories depending on their operational area size. These categories are: *marginal* (<1ha), *small* (1-2ha), *semi-medium* (2-4ha), *medium* (4-10ha), *large* (more than 10ha). Using the first results of the SHIVA project, a vulnerability score has been associated to each category. This score has two major components: sensibility and adaptation capacity (Guerrin 2009).

Indian farmers are going to live under stressors of these global changes. The question is now to understand how their livelihood strategies are going to be affected. Will they keep farming or end their activity and migrate to an urban area? Is their farming system going to evolve? The final objective of this specific report is to describe the changes in terms of farming population and to identify the profile, reasons and percentage of farmers who are going to migrate from one category to another. Then a vulnerability score will be associated to these new categories as well.

Thanks to this part of the project, it will be possible to compare between current and future agricultural water users vulnerability and to characterize and map the *winner*s and *loser*s of global changes through a GIS approach, and study the evolution of geographical distribution of the global changes victims. Finally, a cost-benefit analysis will enable to identify the areas where action could be undertaken to mitigate the negative impact of global changes on farmers (BRGM 2008).

The SHIVA project is carried out in South India as it represents a water-stressed region where climate changes impacts associated with the huge and rapid social and economic changes currently occurring, are likely to seriously affect the region at a large scale.

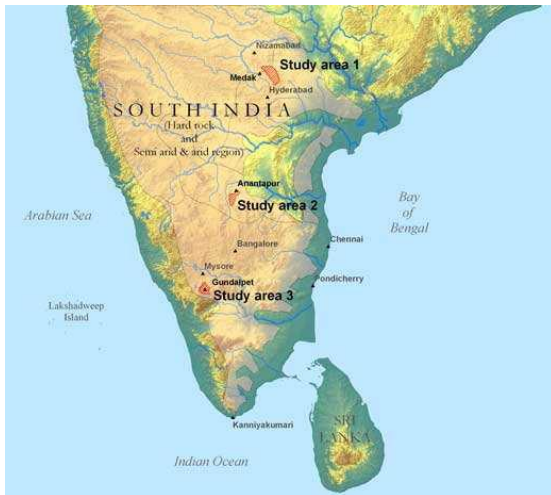
Three pilot sites were defined by the project as representative of the South India area: “(i) *the hard rock geological context: the groundwater cycle is very specific in this context since the recharge depends on a fissured layer that must be characterized; (ii) the semi-arid climatic context. Rainfalls are spreading from 600mm in the middle of the area to 1100 mm in the North-East and South-West; (iii) the reliance on groundwater resources. Irrigated perimeters with surface water are excluded of the research area as it is considered that*

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*farmers’ vulnerability needs a specific approach in this case. Mandals (Indian municipalities) relying by more than 80% on groundwater resources are part of the project area” (Aulong, Borne et al. 2009).*

These three pilot sites represent watersheds of around 650 to 800 km<sup>2</sup>. They appear in the map below with red circles. *“They are representative of the climatic gradient of the project area. Two are located in Andhra Pradesh (Kudaliar and Padam Eru watersheds) and the third one near Mysore in Karnataka (South Gundal watershed). They are all located in rural zones relying on agriculture, mainly cropping and small breeding” (Aulong, Borne et al. 2009).*



**Figure 1:** Map of SHIVA project pilot sites in India ([www.shiva-anr.org](http://www.shiva-anr.org))

### 1.3.2 Consequences on Indian farmers: creation of a model

In order to face these global changes, farmers will have to adapt their way of living, in other words their “livelihood strategy”.

(Chambers and Conway 1992) define a “livelihood” as following: “a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base”.

Several frameworks have been proposed for the analysis of livelihoods: The most well-known – the Sustainable Livelihood Framework - has been described by the Department for International Development (DFID) (Carney 1998, Carney 1999b, (DFID 1999). This framework is based on the Institute of Development Studies work (Scoones 1998). The SL Framework helps us examine poverty issues in relation to five “capital assets” (physical, financial, natural, human and social) identified in the framework (Carney 1998, Davies 1996, Soussan et al. 2000).

There are also the Framework for Thinking about Diverse Rural Livelihoods (Ellis 2000) and Bebbington’s (1999) Capital and Capabilities Framework. Ellis in his definition of a

“livelihood” has placed more emphasis on the *access* to assets and activities that is influenced by social relations (gender, class, kin, and belief systems) and institutions. He has excluded any references to capabilities and sustainability. He assumes that the asset status of the poor is fundamental to understanding the options open to them, the strategies they adopt to attain livelihoods, the outcomes they aspire to and the vulnerability context under which they operate (Ellis 2000). Bebbington (1999) pays particular attention to the importance of social capital as an asset through which people are able to widen their access to resources and other actors.

We chose to base our work on the Sustainable Livelihood Framework developed by (Carney 1998; Carney 1998; Soussan, Blaikie et al. 2000) and Scoones (1998).

In this study, we will try to understand the reasons why farmers are going to modify their livelihood strategies under the stressors of global changes, how these modifications will happen and with which consequences. The core of our analysis will be the “farming system” as described below. In order to assess the consequences of global changes on this farming system, we chose to build a economic model that will show its evolution on a medium time scale (by 2020- 2030).

## 2 Conceptual framework

### 2.1 Conceptual diagram

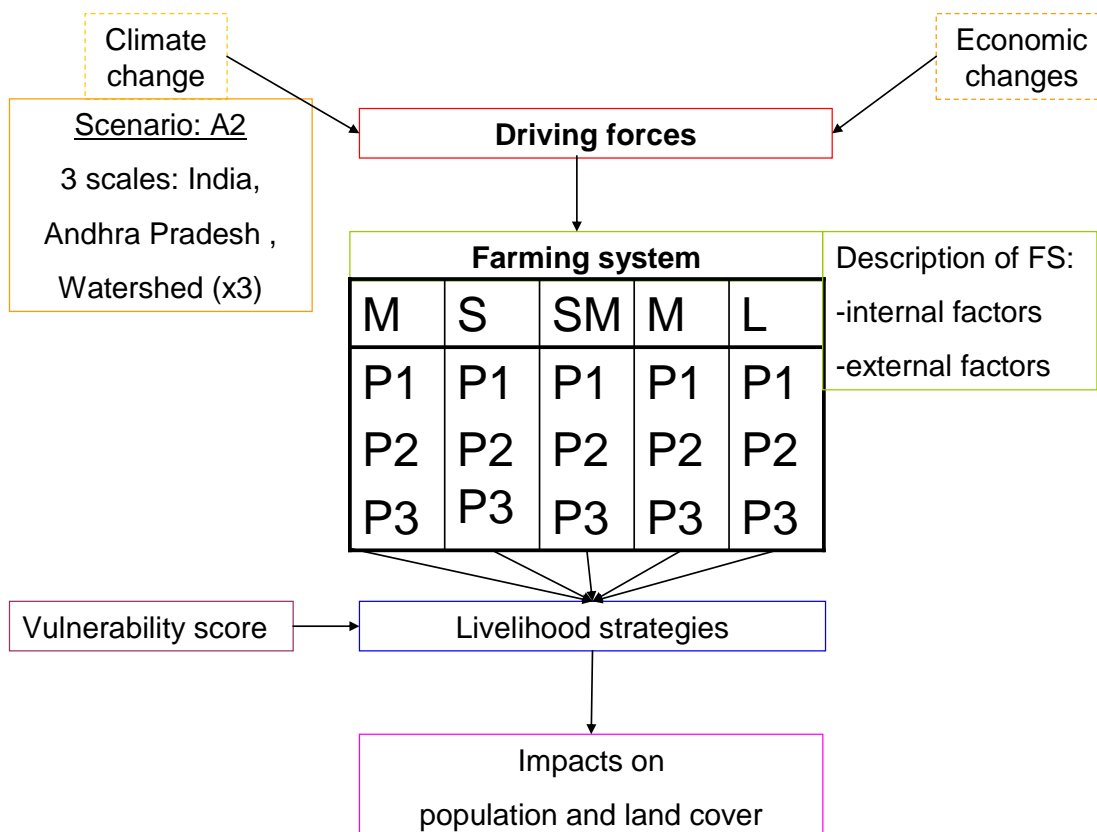


Figure 2: Conceptual Diagram

### Conceptual diagram: legend

The *farming system* will be the central unit of our study. The farming system (i.e. the farm and its environment) will be described through the concept of *internal* and *external factors* (Vandermeulen, Gellynck et al. 2009). *Global changes* (i.e. climate change and economic changes) are influencing the farming system evolution over time through the action of *driving forces*. As a consequence, the farming system will have to adapt: farmers will have to modify their current *livelihood strategies* in order to survive, and these strategies will obviously have *impacts* on demographics and land cover.

## 2.2 Farming system: definition

A *system* is a group of interacting, interrelated, and interdependent elements forming a complex whole. The farming system will be defined according to that definition. (Ikerd 1993) actually uses it to characterize his “sustainable agricultural model”.

Considering the hypothesis that Indian agricultural sector is going to move towards an economic and market-based economy, we assume that future Indian farming systems will behave as small “firms”. Given this hypothesis, agricultural systems can’t be seen as autonomous systems anymore. Agricultural systems must be linked to their local and international economic environment in which they have more or less comparative advantages and then more or less opportunities and vulnerabilities. Farming systems will be subjected to competition and will have to adapt to their political and economic environment, as a firm would do.

In the following report, this complex whole –the *farming system*- will be described by what will be called “*internal factors*”. Internal factors refer to the household characteristics, the cropping pattern, the farm resources... and will be described through the five capitals framework coming from the Sustainable Livelihoods Approach (Davies 1996; Carney 1998; Soussan, Blaikie et al. 2000). The farming system is also in interaction with its environment and continuously needs to adapt in order to survive. This environment is made of opportunities and threats and will be described through what will be called “*external factors*”. We will use Porter’s Diamond method (1990) to describe these factors.

NB: The *farming system* is different from the *household* concept: according to (Reenberg and Paarup-Laursen 1997), a household can be defined as the family members who eat together, jointly cultivate the fields and keep the harvest in a common storage place.

## 2.3 External factors

External factors can be described through “*Porter’s Diamond model*” (Porter 1990; Vandermeulen, Gellynck et al. 2009).

Porter’s diamond model originally helps to understand the competitive position of a nation in global competition (it can also be applied to major geographic regions). He introduces the concept of “clusters”, or groups of interconnected firms, suppliers, related industries and institutions that arise in particular locations. All these firms can be influenced in a pro-active

way by the government. Another variable, not explicitly mentioned in the model but that needs to be taken into account, is “chance”. Indeed, firms are subjected to unpredictable events that could influence the global system. Both chance and government can influence on any four components of the diamond.

This model enables Porter to analyse why some nations are more competitive than others are, and why some industries within nations are more competitive than others.

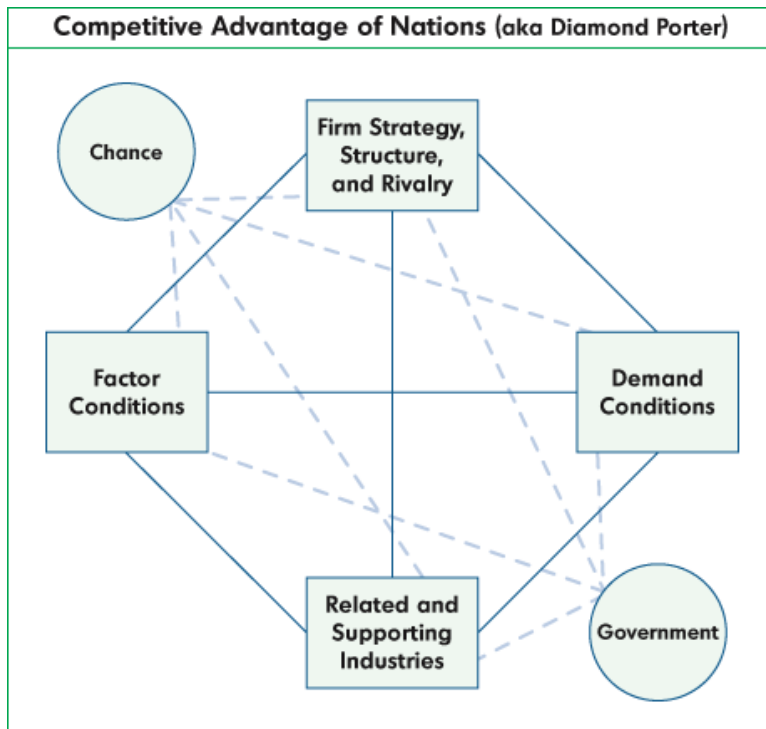


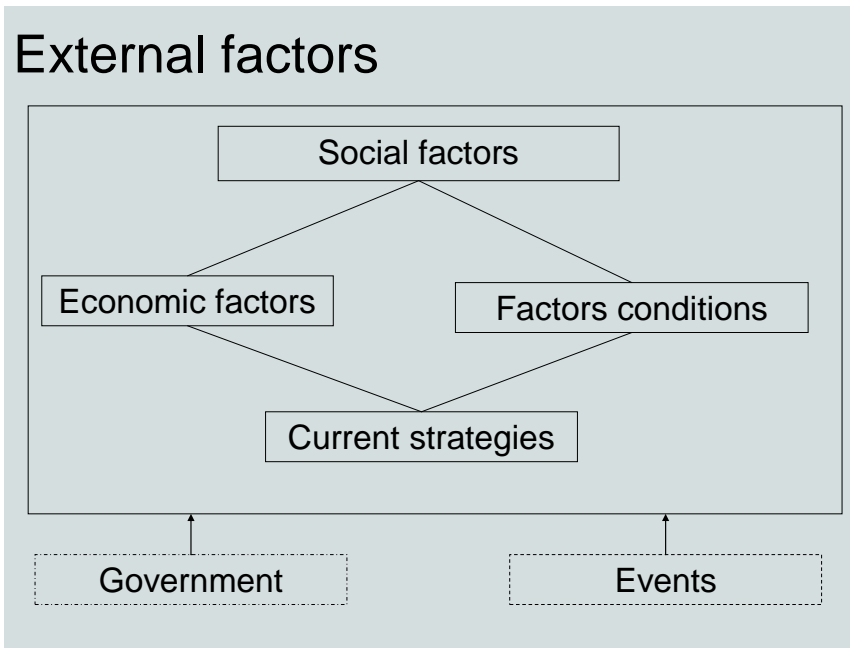
Figure 3: Competitive Advantage of Nations  
(Adapted from (Porter 1990))

Vandermeulen et al. (2009) modified Porter’s diamond in order to adapt it to the agricultural sector.

In their model, demand conditions are called *social factors*, related and supported industries are now defined as *economic factors*, factor conditions can be related to *limitation of land, labour, and capital* and *government* refers to politico-economic factors, institutional background, environmental policies, etc. *Strategies* will be defined as current trends in the agricultural sectors, competition between farms on market, etc. *Chance* refers to unpredictable events (economic and climatic).

Consequently, we chose to keep this vision in our methodology and apply it to the farming system: indeed, a given farming system is going to evolve over time within an environment of external factors: social, economic, political, environmental, unpredictable events... These internal factors represent the current external environment of the farmers.

The following diagram represents the agricultural adaptation of Porter’s diamond model:



**Figure 4:** External factors affecting the farming system (Adapted from (Vandermeulen, Gellynck et al. 2009))

Below are given some examples of external factors in the agricultural context:

- Social factors: demand in farm goods, urbanization, migrations
- Economic factors: access to market, existence of non-farm activities, competition with other farms in the neighborhood ...
- Factors conditions: limitation of land, labor, capital, climate, location, demographics...
- Current strategies: trends in agricultural sector, how regulations apply on a local scale...
- Government: number of free hours of power/day, regulation, antitrust, barriers to entry, taxes and subsidies, investment incentives, employment incentives, macroeconomic policies
- Events: delayed monsoon, drought, inflation ...

## 2.4 Internal factors

We will base our analysis of internal factors constituting the farming system on the five capitals framework described in the Sustainable Livelihood Approach. These capitals are natural, financial, physical, social and human (Carney 1998, Davies 1996, Soussan et al 2000). The ability to pursue different livelihood strategies depends on assets/capitals/livelihood resources people have in their possession (Scoones 1998). Sustainable rural livelihoods are strongly linked to the enhancement of these five capitals (Reddy, Reddy et al. 2004).

According to (Scoones 1998), these five capitals are:

-Natural capital: the natural resources stocks (soil, water, air, genetic resources...) and environmental services (hydrological cycle, pollution sink...) from which resource flows and services useful for livelihoods are derived

Eg: land, water, vegetation, biodiversity

-Economic and financial capital: the capital base (cash, credit/debt, savings, basic infrastructure and production equipment and technologies) which is essential for the pursuit of livelihood strategies; the part of cash that is not used for consumption and social payments.

Eg: financial resources such as savings, access to credit, bank loan, remittances

-Human capital: the skills, knowledge ability to labour and good health and physical capability useful for the successful pursuit of different livelihood strategies.

Eg: skills, knowledge, good health, ability to labour

-Social capital: the social resources (networks, social claims, social relations, affiliations, associations) upon which people rely when pursuing different livelihood strategies requiring coordinated actions. It is also represented by changes in the migration pattern at the household level, as well as women’s participation in self-help groups (Reddy, Reddy et al. 2004).

Eg: networks, groups, trust, social relations

-Physical capital: it is measured in terms of a household’s possession of durable assets (excluding land) such as house, machinery, and livestock.

Eg: infrastructure such as shelter, transport, communication and energy

These capitals are complementary to one another. Natural capital has a crucial role, especially for poor people who depend on natural resources (Reddy, Reddy et al. 2004)

An analysis of assets is a review of what people have (and don’t have). It also considers how assets have changed over time, what changes are predicted, what the causes of changes are and how access and control of assets differ between social groups (Carney 1998).

## 2.5 Driving forces

Global changes will act on the farming system through what will be called “driving forces”.

Driving forces represent the direct action of global changes on the farming system. On the other hand, external factors frame the current environment, versus driving forces that represent the changes happening over time and that will lead the system to evolve. In other words, these driving forces forebode the external factors of the future.

We downscaled global changes in order to understand which of these changes will influence the evolution of the farming system over time. Driving forces identification is a way to show the effects of global changes on a local scale.

These driving forces were identified through literature, experts’ consultation and the results obtained through 2009 and 2010 farmers’ surveys.

Socio-economic driving forces are classified within five categories: economic, social, political, technical and environmental. Then, climatic driving forces have been identified as well.

## 2.5.1 Socio-economic driving forces

- **Economic driving forces**

Five propelling forces have been identified by (Rigg 2006):

- ✓ the erosion of the profitability and returns to small-holder agricultural production;
- ✓ the emergence of new opportunities in the non-farm sector, both local and non-local;
- ✓ environmental degradation;
- ✓ increasing land shortages;
- ✓ cultural and social change.

In Andhra Pradesh, several agricultural growth engines will be developed in the future: rice, poultry, dairy, horticulture, fisheries and agro-industry seeds, oil seeds, cotton, sugarcane, tobacco and maize (Pimbert and Wakeford 2002). High potential areas and high value crops will be developed in priority. In AP, Total Factor Productivity trend for paddy, sorghum and groundnut is increasing over time and is maintained for black gram, moong, sugarcane and cotton (Singh 2004). In KN, Total Factor Productivity trend for sorghum, groundnut is increasing over time, it is maintained for sugarcane and cotton and is decreasing for paddy (Singh 2004).

Vegetable productions still represents 70% of the global production. Livestock farming is increasing as well. The main cultures in India are cereals, fruits, vegetables and oleaginous plants. 50% of the cultivated area is made of rice and wheat. Cereals and legumes are slowly decreasing while plantations (tea, cotton, coffee, rubber and potatoes) are increasing. Livestock farming represents 27% of the agricultural production value and the main products are milk, mutton and poultry (OCDE 2007).

The crop choices are strongly linked with the type of soil in place (Cf Appendix 2 and 3)

The irrigated surface is increasing over time. Inputs consumption increased as well over the last three decades: This is particularly the case for chemicals fertilizers and high-yield seeds (OCDE 2007).

The contribution of India to the global market is increasing. It stands as a net exporter of agricultural products.

Because of the high exportation growth in other sectors than agriculture, the share of agricultural exports decreased by a half between 1995 and 2005 (OCDE 2007).

Investments by private sector will be fostered, especially in irrigation and agro-industry. Exports will be facilitated and restrictions on market will be removed (Pimbert and Wakeford 2002).

Value added tax has been implemented in 2005 in India but basic food products like cereals are not affected by this tax.

Customs duties for importations exist in India. However, there is no income tax concerning the revenues brought by exports.

A new plan (*Vishesh Krishi Upaz Yojana*) has been implemented in 2005 in order to promote the exports of fruits, vegetables, flowers, forest, dairy and poultry products (OCDE 2007).

However, crop market prices remain highly variable and not always generate profit to farmers. Labor force is a problem as well for farmers: wage workers are often too costly and hard to hire. Inflation is happening in India too (Cf Appendix 2 and 3).

Crop insurance has also been implemented. However, it only affects a limited number of crops and varies according to the cultivated area and the type of crop. In 2005, 16 millions of farmers were affiliated to it (OCDE 2007).

Measures have also been implemented in order to facilitate access to credit, particularly by simplifying the proceedings and fostering micro-credit institutions. Debt-reducing measures have been introduced as well.

Farmers are currently diversifying their income sources: non traditional crops (e.g. high value crops), rural non-farm activities, starting of small businesses, migrations to urban areas...(Krishna 2006). The current low access to insurance or credits markets only allows low risks activities and low returns as a consequence (WB 2008).

More and more farmers notice that urbanization is growing very rapidly and about to absorb quantities of rural areas in the next decades (Cf Appendix 2 and 3).

- **Political/Institutional driving forces**

Numerous public institutions intercede as far as agriculture is concerned. Minimal price support was introduced by ECA and affects 24 vegetable products (rice, wheat and sugarcane among others). Measures aiming to develop public/private partnerships and to attract private investments in process industries should soon be implemented and favour rural employment.

Input prices support affects mostly water and electricity (for irrigation) and fertilizers. Banks are also now expected to grant loans to farmers in order to help them buying inputs at lower rates than on the market.

Emphasis will be given to states in which current yields level are below the national average yield. Andhra Pradesh plans to develop high value crops and hybrid varieties. Balanced use of nutrients and water-saving technologies will be fostered (AP: coarse cereals, pulses, oilseeds, cotton crops; KN: coarse cereals, pulses, oilseeds) (Singh 2004).

The establishment of water secure rights to users, privatization of water and introduction of water-saving technologies may also be considered (Singh 2004).

Dry-land technologies will be fostered: maybe removing pro-irrigation biases in public investment and expenditure, as well as credit flows, for technology-based agricultural growth.

Watershed development for raising yields of rainfed crops is planned as well. Access to information will be improved (Singh 2004).

The *Million Wells Scheme* program has been launched in 1988 and extended to borewells in 1998. This program enabled even the poorest to get water thanks to government subsidies (Dupard 2009).

Drinking water is currently a big issue as well, especially for people who don't have access to borewells (e.g. landless people). However the government and numerous NGOs are currently trying to solve this problem by installing public fountains (supplied by borewells) and small tanks (Dupard 2009).

As for the infrastructures' improvement, the government is playing a crucial role as well. It bears the costs of the modernization of irrigation systems, rural roads, electricity set up in rural areas and creation of rural markets. However, electricity supply keeps being of poor quality. In 2005-2006, 121 billion INR (2,7 billion USD) have been invested for the benefit of 6 programs regarding to irrigation (Accelerated Irrigation Benefit Programme), drink water distribution in rural areas, rural roads, rural housing, electricity set up and the connexion with communication networks (OCDE 2007).

The same year, 2 billion INR (45 million USD) have been invested for the promotion of rainwater collection, organic fertilizers and improvement of farming skills in arid and semi-arid areas (OCDE 2007).

These kinds of projects are widely subsidized by international aid.

The Indian Council of Agricultural Research (ICAR) has been founded in order to foster research and development in agriculture. It is mostly financed by Indian authorities and taxing sales.

- **Social driving forces**

A Public Distribution System (PDS) has been implemented as well: basic food products (bought by the government) are distributed to the poorest populations at subsidized prices or are put back on the market in order to stabilize prices. In 2005-2006, 25 million of Indian families received basic food products through the *Mid-day Meal Scheme* (OCDE 2007).

Another program helps one person per family under the poverty line to get work for hundred days. The salary is partly given in the form of food grains.

Household asset position often determines household productivity and livelihood strategies. Education and membership in organizations are particularly important factors (WB 2008).

Economic situation leads farmers to develop alternate activities (other than farming), as we mentioned earlier.

Migrations are becoming more and more frequent. They are several types of migrations: rural-rural, rural-urban (the most common) and circular migrations. Most castes are represented in migration (Haan 1997) but a large proportion of migrants workers belong to lower castes and tribes (In AP, scheduled tribes have a higher rate of migration (Deshingkar 2003)). The main reasons for migrating are poverty, lack of land, increasing number of family members on the same plot of land and income (Haan 1997). Farmers also mention poor monsoon, high prices, less profits, low yields and no work (ref rapport).

Farmers who choose to migrate hope to find jobs with better salaries and often send money back to their family (as a remittance).

Most governments have tried to control rural–urban movement through a combination of rural employment creation programmes, anti-slum drives and restricted entry to urban areas (eg ration cards) (Deshingkar 2006).

- **Technical driving forces**

New biotechnologies will be developed and introduced in food and farming, including high yielding genetically modified crops and livestock (Pimbert and Wakeford 2002).

Some technologies like drip irrigation remain highly subsidized. Agriculture in red-fed areas (Go-AP 1999), dryland agriculture (Go-AP 1999) and GMOs will be fostered. Biofuel programs will be launched and surfaces will be dedicated to biofuel production. Electricity subsidies are essential for irrigation in India and allow farmers to get power quite for free (e.g. in TN where it is free). However, there is still a significant lack of energy in India, and irrigation remains the main consumer.

Finally, access to information will also be improved (e.g. through internet kiosks).

- **Environmental driving forces**

Natural resources are limited in quantity (Guilmoto 2005). Soils are running out of organic matter and uncultivated land and forests are under high pressure.

A solution would be to go green, to bring more bio-based products and develop technological improvement (SriSubramaniam and Subramaniam 2009).

However, the environment still remains pushed into the background by the government and needs to be better taken into account in the legislation.

## **2.5.2 Climatic driving forces**

Climate is changing over time. Farmers perceive these changes through several indicators: the monsoon is delayed (since 2005), the temperature is increasing... They also notice that the rainfall pattern is changing: the number of rainy days per year is decreasing. Finally, extremes of weather are occurring more frequently: The droughts and floods are more severe than previous years.

Conclusion: These driving forces are directly affecting the farming system. As a consequence, farmers have to adapt their way of living by modifying their livelihood strategies.

# **3 Material and Methods**

## **3.1 Available data**

In 2009, a first set of surveys was conducted by J. Guerrin in order to measure farmers' vulnerability. 153 farmers from Gajwel district (Kudaliar watershed, Andhra Pradesh) were interviewed. Although this was about vulnerability, data about farming systems and responses to events (among others) were collected. These data helped us to build

hypotheses in order to build our own farmers’ profiles on Kudaliar watershed as well as relevant livelihood strategies.

Agricensus database was very useful as well because it allowed us to set our own statistics back in a broader context (tehsil, district, state or even national) and to criticize the results we got through the field surveys.

## 3.2 Methodology

The methodology we used to build the following model is based on field surveys and statistics.

We conducted two sets of surveys in April and in June 2010. The survey was based on open, semi-structured interviews and participant observation. 35 surveys were collected in total. This part of the work required the help of a translator in order to get better results. A typical survey includes about 50 questions. The main focus, apart from specific data about household composition and farming system, was perceptions of the environment, access to land, use of non-farm resources, household coping strategies or adaptation mechanisms and importance of non-farm income (among others) (Cf appendix 2 and 3).

The information collected was analysed and organized in the forms of narratives in field reports (cf appendix 2 and 3). Quantifiable data were extracted and entered into a database (cf Table 2).

Insofar as we only interviewed 35 households (21 within South Gundal watershed and 14 within Kudaliar watershed), the statistical analyses we got thanks to these surveys should be interpreted carefully. However, households were interviewed in both watersheds were distributed in all over the area (about one household interviewed per village). Consequently, the results are at least geographically viable (despite not being statistically significant!).

The model was built on the basis of the statistics drawn from the surveys as well as statistics referring to the 2009 Gajwel sample. Thanks to CPA, PFA and DFA analyses, we were able to formulate hypotheses that helped us to frame the model and particularly farmers’ profiles and livelihood strategies. Once these profiles were designed, we associated to each of them a specific livelihood strategy as described in the following section of this report. Then we have described possible evolutions of these strategies over time and particularly in terms of operated area. Indeed, the variation in operated area will help us to identify the farmers who are expected to move from one size category to another.

## 4 Building the model

Indian farmers are classified by Indian administration into 5 categories depending on their operational area size. These categories are: *marginal* (<1ha), *small* (1-2ha), *semi-medium* (2-4ha), *medium* (4-10ha), *large* (more than 10ha). Thanks to the statistical analysis of a 153 farmers’ sample (from Kudaliar watershed in 2009) and the two sets of surveys we conducted, we have been able to build a model that takes into account several farmers’

profiles. These profiles are going to evolve through the model according to their environment and will follow a particular livelihood strategy.  
An outcome of this model is a new distribution of the farmers between the 5 categories.

## 4.1 Survey results

The surveys we conducted took place in South Gundal watershed (Chamrajnagar district, Karnataka, Deccan plateau) and in Kudaliar watershed (Medak district, Andhra Pradesh).

The documents below show the raw data:



Survey results South  
Gundal Karnataka

Table 2: Survey results (South Gundal watershed, Karnataka)



Survey results  
Kudaliar Andhra Pradi

Table 3: Survey results (Kudaliar watershed, Andhra Pradesh)

The following subsection describes the main results we got through the surveys.

### 1. Socio-economic context

#### 1.1 Households characteristics

On average, one typical household concentrates around 5 people. The age of the landowner is about 45 years old and most of the families are Hindus. On average, alphabetisation remains very low.

#### 1.2 Farming system

In India, the individual holding's average size is about 1,17 ha (i.e. “small size” according to official typology). It is a bit less in the districts where we conducted surveys: 1,07 ha in Chamrajnagar (Karnataka) and 1,13 ha in Medak (Andhra Pradesh) (Source Agricensus).

Depending on the watershed, cultivated crops are highly variable. In South Gundal watershed, we found turmeric, sugarcane, coconut, vegetables, sunflowers, bananas, jowar and coconut.

Turmeric is globally increasing in Gundlupet taluk between 1995 and 2002 - especially among marginal holdings. Sugarcane (among all size categories), onions (except for medium farmers), coconut (especially among marginal holdings) are increasing over time as well, unlike bananas and sunflowers that seem to be less and less cultivated among all categories of farmers.

It seems that farmers give more and more priority to short term crops like maize and vegetables (Dupard 2009). The main reason is that they need less water, inputs and labor

force. Moreover, because they grow on a short period, these crops are less risky for the farmers. And finally, these crops don't require too much cash flow (unlike sugarcane for example).

In Kudaliar watershed, there are mostly paddy, cotton, maize and vegetables. Paddy is globally increasing over time in Medak district, especially within marginal and small holdings. However, cotton is slowly decreasing over time.

Finally, maize is highly increasing over time in terms of number of holdings and total cultivated area (in all size categories).

Crops cultivated depend on the type of soil: red soils are poor and don't retain the water. However, black soils (known as “cotton soil”) are sought-after because they are more profitable and prevent the wasting of water. Moreover, in a semi-arid context, black soil can support a kharif crop followed by a rabi crop, contrary to red soil that only supports one kharif crop (Dupard 2009).

Bigger farmers own the best plots of land: those with black soil, located in depressions where water is easier to gather (Dupard 2009).

Most of the farmers own cattle for farm work. Some of the farmers are renting farm equipment (like tractor). Only a few of them have purchased material for their own use.

Moreover, we noticed in Gajwel district the existence of numerous poultry farms (about 50 poultry farms in this district).

In Chamrajnagar district (Karnataka), the net irrigated area in 2000-2001 is about 51 858 ha (i.e. 55 279 holdings out of 180 316).

In Medak district (Andhra Pradesh), the net irrigated area in 2000-2001 is about 146 322 ha (i.e. 202 015 holdings out of 559 639)

Most of the farmers are using borewells for irrigation even if some of them are relying on rain as well (maize and cotton). We noticed that some borewells in South Gundal were drilled far too deeply to be able to find water (because the granite layer was affected by the drilling!): there is no more water at such a depth, but drilling companies keep drilling in order to make more money. Moreover, the particular geology of the hard rock aquifer doesn't help farmers to find a great location for their new borewell and a lot of them can't find water, even if farmers always ask for the help of “traditional geologists” that are supposed to guide them.

Some farmers are using special technologies as well, like drip irrigation.

Inputs consumption increased over the last three decades and particularly chemicals fertilizers and high-yield seeds. 80% of the cereals cultivated belong to high-yield varieties (OCDE 2007).

All farmers are using daily workers, even the smallest holdings (2 to 10 people are often required to take care of the fields, depending on the type of crops). Women or men are employed depending on the work that has to be done. The ratio labor force/acre is highly variable, because some crops require more workers than others (e.g. rice). Moreover, every household employs family labor force and sometimes children when they are not at school.

All the farmers we met were selling their production on market: in nearby villages or bigger cities like Mumbai or Bangalore. Moreover, several factories are buying from the farmers: for example cotton in Kudaliar or sugarcane in South Gundal.

Farming is the main activity for all the households we interviewed. However, some of the farmers are doing extra wage work and running non farm activities in order to make more money at the end of the month. Some of them also diversify in real estate business. There is not so much diversification in Gundlupet area because it remains quite far from the dynamic centres (like Mysore and Bangalore). Consequently, most of the population lives thanks to the agriculture income only (Dupard 2009).

### 1.3 Farm history

Usually, farmers got their farm from their father or grandfather. Some of them chose to change the crops over time in order to diversify their production and to introduce more profitable crops (like sugarcane and vegetables).

## 2. Farming system evolution under the stressors of global changes

### 2.1 Vulnerability to events

When we asked farmers what a bad monsoon was to them, almost all of them mentioned 2008 and 2009. Consequently, farmers seem to have suffered in recent years from bad monsoons and lack of water, especially during the summer season.

Other major problems cited are (all the farmers mentioned all the following events): crop prices that are highly variable (e.g. coconut) and generate no profit; input prices that are too high; crop yields that are not good (mostly because of pests); soil that is not enough rich (some of them are therefore mixing red and black soil); labor problem (too costly and not enough workers available) and inflation (prices keep increasing).

Moreover, it seems that there is a big problem concerning drinking water, especially for farmers that can't access to a private borewell. There are some public fountains in the villages but they are not always working.

The land value is quite variable, depending on the location of the field: closed to the main road or not, in a village, the quality of the soil, irrigation or not... The value in Kudaliar for example begins around 1 lack/acre to 5 lacks/acre (from 8 to 25 lacks in South Gundal watershed). Most of the farmers think that it is not secured to lease out during several years. Most of them agree that it is important to own land (without distinction between good and bad years), even if more farmers think it is more important to own land in bad years.

NB:

1 lack=100 000 Rs= 1 725 euros

### 2.2 Coping strategies

Farmers agree that crop prices are not high enough to generate profit. Consequently, they found solutions in order to adapt: For example in Kudaliar watershed, 10 of them are diversifying their crop varieties, 2 of them are storing some of their production and one of them is operating changes in cropping pattern.

In order to adapt to the increase in input prices, a lot of the farmers we met got loans or credits. The reason is often to be able to drill borewells. However, access to credit is still not well developed in India: In 2003, 21% of the households got a formal credit and 40% an informal one. Other households still don't have access to it (OCDE 2007). Lots of farmers can't borrow money from the banks because their repayment capacity is too poor. Consequently, they borrow from their neighbours or from a bigger landowner. Repayment modalities are various: usually the amount should have been paid back five years later. Moreover, interests can be paid in the form of labor days or part of the crop harvest. Some farmers are sometimes forced to sell a piece of their land in order to pay back their credit (Dupard 2009).

Other major strategies are: use of new crop varieties (less expensive seeds or requiring fewer input quantities) and putting fewer quantities of fertilizers/pesticides.

Moreover, in order to limit prices variations, some farmers harvest their crops (e.g. onions) over several days hoping that prices will go up during that time.

All the farmers are talking about a serious lack of water, especially during the summer season. The strategy most of them chose in order to solve this problem is to drill more and more borewells. Finally, some farmers chose to develop rainfed crops in their farm, even if these crops are still suffering from the lack of rainfalls.

In Kudaliar watershed, in order to adapt to bad yields, 7 farmers got insurance; 11 of them chose to diversify the cropping pattern and 9 of them found another job to make more money. Pests are one of the reasons for getting bad yields: all of the farmers use pesticides in order to diminish the consequences.

On top of that, soil is not very good in the area: one solution is to mix black and red soil in order to get better yields from their fields.

Finding (cheap) labor force is a big problem for most of the farmers. Wage work is less and less paid, and one farmer in Kudaliar watershed was even forced to bring his children back from school to help him with the field work.

Farmers are suffering a lot from inflation as well: most of them operated some cuts down on their expenses and some of them even got loans.

### 2.3 Adaptation capacity

When we asked the farmers about the future of their farm, they told us that it would probably change in coming years: they all plan to buy new equipments and make some investments. However, none of them is planning to stop farming for now.

In Kudaliar watershed, 10 out of 14 interviewees are interested in weather forecasts and therefore influenced by them in the crop management.

Most of the farmers are aware of crop market prices: these farmers use that knowledge to anticipate the next choice of crops they will cultivate.

Concerning farming innovations, all the farmers in Kudaliar watershed know what drip irrigation is and 8 of them seem to know about GMOs. One of them even heard about biofuel technology. All of them plan to use new techniques in the future, especially drip irrigation (8 of them). This contrasts a lot with the answers we got in South Gundal area, where people were not really interested in these technologies, mostly because of the cost they could represent.

Among the interviewees in Kudaliar watershed, only two of them know someone in his family that completed migration in the past. These migrations are short distance, rural-urban migrations (Hyderabad is the final destination for both of them). They all left in order to find work in the city. Consequently, these migrations are intended to be long-term migrations (more than 5 years).

This also contrasts with the surveys conducted in South Gundal area, where the main reason for migration was studies and for a short-term period only. However, literature shows that a seasonal migration is happening towards Ooty tea plantations and various Wayand (Kerala) plantations: tea, coffee, pepper... Daily workers often go to Gundlupet or Mysore. (Dupart 2009). People who don't have a permanent access to water thanks to borewells are more likely to migrate during the dry season, while those who enjoy it can buy new pieces of land thanks to their bigger income (Dupard 2009).

#### 2.4 Global evolution

In Kudaliar watershed, 10 out the 14 farmers think that agriculture is going to change in the village in coming years, mostly because of migration patterns and development of new non-farm activities in the area. We observe that they are far more pessimistic than farmers in South Gundal watershed (only 5 out of 21 farmers talked about changes)...

Some of them told us that monsoon will play a big role in that evolution (if the next monsoons appear to be bad, the future of farming could be jeopardized). Consequently, all the interviewees in Kudaliar watershed think that some farmers will probably stop farming in coming years. The reasons they gave us for that were water problems (11 of them), poor monsoon (10), high prices (2), less profits (1), bad yields (1) and no work (1)... All think that “small” farmers (e.g. marginal and small farmers’ categories) will be the most affected and will leave first. Concerning the possible future of these areas, all agree that bigger farmers will get the newly available land and become bigger and bigger. Some of them will even lease their farmland and start a new business in town. Many of the farmers we interviewed also think that urbanization will permanently absorb these areas in the future and divert them into houses and highways. An increase in cash crops was mentioned as well. The results we obtained in South Gundal watershed were about the same for this set of questions.

## 4.2 Farmers’ profiles identification

### 4.2.1 Economic theory (inspired from(Reddy, Reddy et al. 2004))

Let us consider an initial state:

$$RLS=f(PC ; NC ; SC ; HC ; FC)$$

Where:

RLS : Farmer’s current Rural Livelihood Strategy

PC: Physical capital

NC: Natural capital

SC: Social capital

HC: Human capital

FC: Financial capital

Under the action of global changes (e.g. disturbances), the farming system is going to evolve towards a final state.

This final state can be conceptualized by:

$$\begin{aligned} \text{SRLS} &= f(\rho\text{RLS}) \\ &= f(\rho(\text{PC} ; \text{NC} ; \text{SC} ; \text{HC} ; \text{FC})) \\ &= f(\rho\text{PC}; \rho\text{NC}; \rho\text{SC}; \rho\text{HC}; \rho\text{FC}) \end{aligned}$$

Where :

SRLS : Farmer’s Sustainable Rural Livelihood Strategy

$\rho\text{PC}$ : changes in physical capital

$\rho\text{NC}$ : changes in natural capital (e.g. variation in operated area:  $\Delta < 0$ ,  $\Delta = 0$ ,  $\Delta > 0$ )

$\rho\text{SC}$ : changes in social capital

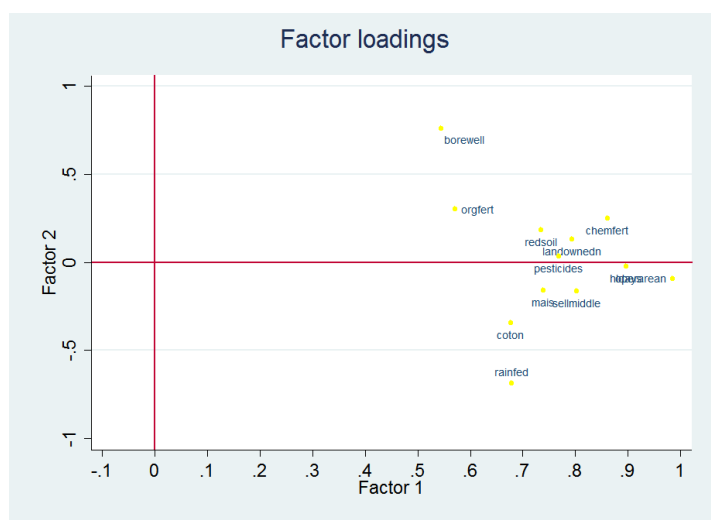
$\rho\text{HC}$ : changes in human capital

$\rho\text{FC}$ : changes in financial capital

## 4.2.2 Statistical analyses

Using R and STATA softwares, we realized some statistic analyses on the 2009 Gajwel sample (153 farmers). Only some variables were selected from the survey results for these analyses (those relating to internal factors). The Gajwel sample is not perfectly representative of Gajwel watershed farmers insofar as marginal and large categories are under represented. However, the sample is useful to test the methodological issues presented earlier. In order to improve representativeness, we finally decide to gather the marginal and small categories and the large and medium ones.

First, we realize a Principal Factor Analysis (PFA) in order to identify the main factors explaining the variance within the sample. Finally, 12 significant variables were selected over the 40 variables included in the model. A Principal Component Analysis (PCA) taking these 12 variables into account was then applied to the sample.



**Figure 5:** Results of Principal Component Analysis (PCA)

The conclusions we drew from the PCA are the following: The first component relates to the operated area and inputs used by farmers, in other words the “production factors”. The second component matches borewell against rainfed irrigation. Finally, the third component matches cotton against maize.

These results first confirm that the farmers’ classification based on their operated area is relevant. Moreover, significant variables that were identified thanks to PFA analysis will partly be used to build the Kudaliar farmers’ profiles, insofar as they describe well the farming system. These variables are: land owned, operated area, types of crops, types of soil (red/black), irrigation system (borewell/rainfed), inputs (pesticides, organic and chemical fertilizers, labor force). We also keep the same variables to build South Gundal farmers’ profiles because we don’t have any statistics on this watershed.

### 4.2.3 Description of farmers’ profiles per category

Before designing the following farmers’ profiles, we realized a DFA (Discriminant Function Analysis) in order to identify variables that could help us to better understand the factors that differentiate the farmers’ categories. However, this analysis was done only on the basis of the 153 Gajwel farmers which is obviously not significant. I finally chose to not use the results of this analysis to build the different farmers’ profile.

As we explained before, the following farmers’ profiles were designed on the basis of the PFA as well as on my perception of relevant internal factors to describe farmers. That is why only 7 out of the 12 factors were used. These factors are: operated area (natural capital), % agricultural income, access to market (financial capital), irrigation system, main crops, cattle (physical capital) and family labor force (social capital). We choose family labor force rather than outside labor force because it is a good indicator of the family devotion to the farming system. In any case, outside labor force would evolve conversely. None of the internal factors belonging to the social capital category were included only because they wouldn’t help to decide between the profiles.

Then, according to the results we obtained through the surveys, we distinguished 15 typical profiles similar to those we found in the course of the field work.

The two tables (one for each watershed, see below) describe the 15 farmers’ profiles identified and distributed into five categories: marginal, small, semi-medium, medium and large. We designed profiles by giving different values to each of the seven internal factors. Each profile is defined by a particular combination of internal factors.



Table  
profiles-strategies

**Table 4:** Profiles and strategies in Kudaliar and South Gundal watersheds

Within each of the five categories, we distinguished 3 different farmers’ profiles. In the marginal category of Kudaliar watershed for example, the variance is mostly explained by

the percentage of agricultural income in the total household income, the irrigation system and the access to crop market.

The first profile (Ma1) is characterized by : <50% of agricultural income, a poor access to the market and an irrigation system based on a borewell. The second profile (Ma2) is characterized by: <25% of agricultural income, a little access to the market and a rainfed-based system. The third profile (Ma3) is characterized by: +50% of agricultural income, a very good access to the market and an irrigation system based on rainfall.

In the small category, the significant variables are the percentage of agricultural income in the total household income, the type of crops and the irrigation system. In the semi-medium group, the variance is mostly explained by the same variables. In the medium category, the significant variables are the percentage of agricultural income in the total household income, the operated area size and the irrigation system. Finally, in the large category, the variance is mostly explained by the operated area size, the percentage of agricultural income in the total household income and the operated area size.

We notice that the operated area size helps to explain the variance only in the bigger size categories (medium and large), where the dispersion is bigger. The family labor force only helps to differentiate the size categories (and not the farmers' profile) because it is mostly function of the operated area size.

In South Gundal watershed, the variance between the size categories is mostly explained by the percentage of agricultural income in the total household income, the type of crops and the access to market. Insofar as every household or so owns at least one borewell, the irrigation system doesn't help to define the profiles. The comments about the operated area size and the family labor force are also valid for South Gundal watershed.

NB: Current work: Using the Sustwater 2005-2006 Gajwel sample and the associated database, we are currently trying to refine the profiles thanks to an Access database. These final profiles will probably be closer to reality than the current ones because the sample is more representative.

*Results coming soon...*

#### **4.2.4 Distribution of the farmers into the different profiles**

Using the Sustwater database and Access queries, we are now able to distribute the farmers into the profiles. For example, by asking the database how many farmers are growing only rice, are using borewells and whose income mostly comes from agriculture (Ma1). Then it is now possible to assess the share of farmers that fit in this category.

### **4.3 Building livelihood strategies**

#### **4.3.1 Current livelihood strategies**

Once the profiles have been defined, a livelihood strategy has to be associated to them. In order to simplify the problem, we only kept 5 different strategies. These strategies are those currently followed by the farmers.

These strategies were designed thanks to our findings in the literature and the interviews we conducted in the course of the field work. The five strategies we kept are the most relevant in the areas we visited; however there are probably many other strategies existing everywhere in the south of India. This analysis is therefore very “context-specific” and should not be generalized.

### **a) Définition of a « livelihood »**

Under the stressors of global changes, Indian farmers are going to adapt. This individual adaptation will be achieved through modifications of their livelihood strategies.

According to Chambers and Conway (1992), “a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means a living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base”.

(Ellis 2000) in his definition of a livelihood has placed more emphasis on the access to assets and activities that is influenced by social relations and institutions.

An important indicator of a livelihood system’s status is its ability to provide individual households with enough income to meet their basic needs (Chimhowu and Hulme 2006).

### **b) Main issue**

According to Scoones (1998), the key question to be asked in any analysis of sustainable livelihood is:

Given a particular context (of policy settings, politics, history, agroecology and socioeconomic conditions), what combination of livelihood resources (different types of “capital”) result in the ability to follow what combination of livelihood strategies with what outcomes? Of particular interest in this framework are the institutional processes (embedded in a matrix of formal and informal institutions and organisations) which mediate the ability to carry out such strategies and achieve or not such outcomes) (IDS 1996).

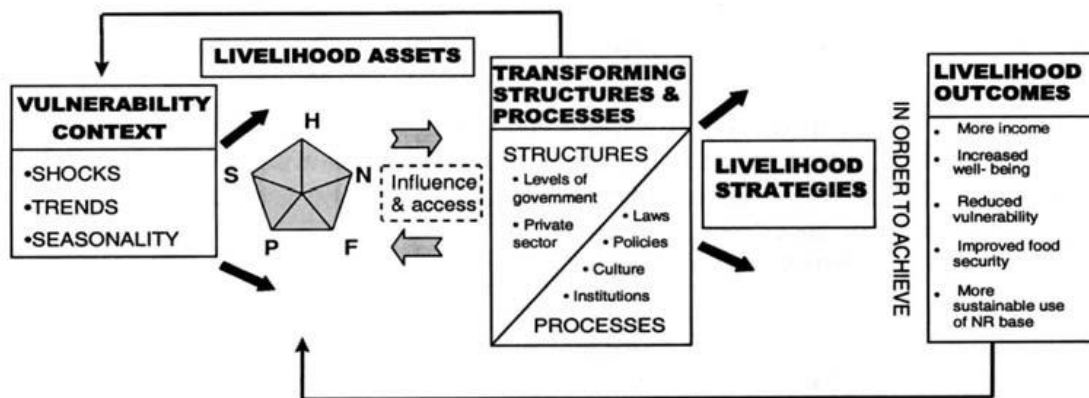


Figure 6: The DFID Sustainable Livelihoods Framework (Carney 1999b)

Key: H (Human capital), N (Natural capital), P (Physical capital), S (Social capital), F (Financial capital).

### c) Building livelihood strategies: methodology

Assessing resilience and the ability to positively adapt or successfully cope requires the analysis of a range of factors, including an evaluation of historical experiences of responses to various shocks and stresses. Different types of shocks and stresses may result in different responses (Payne and Lipton 1994).

Our definition of a livelihood strategy is based on a combination of internal factors (capital/assets approach). The key is to identify what livelihood resources (or combination of capitals) are required for different livelihood strategies combinations (Scoones 1998).

Ex: a market-oriented strategy may combine: access to natural capital (e.g. land, water) with economic capital (e.g. technology, credit). In other situations social capital (e.g. social networks associated with drought or labour sharing arrangements) may be more important.

Socio-economic differences also have a major impact on the composition of livelihood strategies: asset ownership, income levels, gender, age, religion affiliation, cast, social or political status (Scoones 1998).

Access, control and use of assets are also influenced by institutional structures and processes.

It is also important to identify the scale at which the assessment takes place (individual, household, village...) (Scoones 1998). Livelihood trajectories also evolve over time, when local and external conditions change.

Moreover, the choice of a particular livelihood strategy may influence the strategies followed by others, for example by creating new opportunities (e.g. agricultural intensification could foster the creation of processing industries) or on the contrary by diverting resources useful for others to successfully run their own livelihood strategies (like land, water, labour or markets) (Scoones 1998).

Several frameworks have been proposed in the literature for the analysis of livelihoods. First, the Sustainable Livelihood Framework (Carney, 1998, 1999, Scoones, 1998). There are also the Framework for Thinking about Diverse Rural Livelihoods (Ellis 2000) and (Bebbington 1999) Capital and Capabilities Framework.

As for the analysis of internal factors, we chose to base our analysis on the Sustainable Livelihood framework described by Carney (1998, 1999) and Scoones (1998).

#### **d) Livelihood strategies description**

##### **i) Scoones approach (1998)**

According to Scoones (1998), there are 3 main livelihood strategies:

-Either you gain more of your livelihood from agriculture (including livestock rearing, aquaculture, forestry...) through processes of *intensification* (more output per unit area through capital investment or increase in labour inputs) or *extensification* (more land under cultivation)

-Or you *diversify* to a range of off-farm income earning activities (including both paid employment and rural enterprises)

-Or you move away (*migration*) and seek a livelihood, either temporarily or permanently, elsewhere (including income generation and remittances).

-Or more commonly, you pursue a *combination of strategies* together or in sequence.

Other authors distinguished these livelihood strategies as natural resources-based, non natural resources-based (Ellis 2000) and migration (Carney, 1998).

##### **ii) Our approach (Bebbington 1999; Rigg 2006; WB 2008)**

We base the following work on Scoones' theory (1998). However, we padded it thanks to our findings in literature and in the course of the field work. We finally came to identify 5 main livelihood strategies.

A: “*market oriented households*” (most if the income is derived from actively engaging in agricultural markets): more than 50% of agricultural production is sold on (WB 2008). Mostly cash crops are cultivated and access to the market is very good. The labor force varies depending on the farm size but family labor force is more important in smaller farms.

This kind of livelihood requires an access to initial capital (often in very small quantities) to begin trading, an access often mediated through a micro-financial services organization and involvement in networks that facilitate access to market (Bebbington 1999).

B: “*subsistence oriented households*”: people depend on farming for their livelihoods, but use the majority of their produces for home consumption: less than or equal to 50% of agricultural production is sold on market (WB 2008). The access to market is poor or not even existing. The family labor force is predominant et cattle is used for farm work.

C: *“labour-oriented households”*: people derive the larger part of their income from wage work in agriculture or the rural non farm economy, or from non-agricultural self-employment: more than 75% of total income comes from wage or non-farm self-employment (WB 2008). Access to market is not well developed and crops don’t bring in so much money. Family labor force is variable. Cattle is sometimes used for farm work.

Households in prosperous agricultural regions may totally diversify into non-agricultural activities to take advantage of attractive activities. Non-farm activities are becoming central to rural livelihoods. In India during 1971-1999, the share of non-farm incomes in total household income rose from 19% to 48% (Rigg 2006). Those less favored may shift into low value non-agricultural activities to cope with the risks.

To be able to engage in such livelihoods, families need the skills to do the work required and the access to an intermediating agent (like industrialists or traders...) that links the rural families to the market and production chains (Bebbington 1999).

D: *“migration/transfer-oriented households”*: households might choose to leave the rural sector entirely, and depend on transfers from members who have migrated: more than 75% of total income comes from transfers/other non-labour sources (WB 2008). The access to market is poor or not even existing. Crops (if there are any) are cultivated only for home consumption. Remittances are playing a growing role in rural households’ income (Rigg 2006).

Moreover, an increasing number of households have no commitments to farming whatsoever (Rigg 2006).

E: *“diversified households”*: people combine income from farming, off-farm labour, and migration: neither farming, nor migration income source contributes more than 75% of total income (WB 2008). Cash crops (among others) are cultivated and the access to market is well developed. Family labor force is variable. These types of households usually own cattle.

Eg: tiny business, someone sent to the city, non-traditional crops, irrigation, jobs in government, increased job availability in the private sector... (Rigg 2006).

It often is the most successful/sustainable rural livelihood strategy, because people get the skills to enter higher paid labor markets in urban areas and have the social networks to gain access to work opportunities (Bebbington 1999).

## **e) Linking farmers’ profiles with a current livelihood strategy**

Cf Table 4 “Profiles and strategies in Kudaliar and South Gundal watersheds”

Once the farmers’ profiles were defined, a corresponding livelihood strategy had to be linked to each of them. This is one of the trickiest parts of the work, because it is partly subjective. The link was realized by putting into perspective each farmer’s profile and the closest livelihood strategy. This work was done on a logical basis. According to the profile’s characteristics, it is possible to determine a link with a particular livelihood strategy.

For example, in South Gundal watershed, the Ma3 profile is characterized by a high percentage of agricultural income and is cultivating cash crops and high value crops. Moreover, he relies on borewell for irrigation and on family labor force as well - but this can be explained by the fact that the cropped area is very small. Finally, he owns livestock (it

doesn't appear here but he is probably mechanized as well). Consequently, according to the strategies description (cf previous subsection), this profile is likely to follow preferentially a “market-based strategy”.

On the other hand, in Kudaliar watershed, the Ma1 profile is only growing rice that is mostly used for his home consumption: he doesn't rely on market for his survival. Because his farm is very small and because he doesn't earn so much income, the family labor force is needed before all. Finally, he relies a lot on livestock for farm work. Consequently, the strategy the most relevant is probably the “subsistence-oriented strategy”.

Maybe this could be refined in the future by submitting the profiles to some “experts” and by calculating a mean between the strategies they chose for each profile. We didn't do it in the course of this work because this is only a theoretical work which is totally “context-specific” and has no meaning on a bigger scale.

### 4.3.2 Evolution of livelihood strategies over time

#### a) Modification of the operated area size

Livelihood strategies are changing over time insofar as the environment (represented by external factors) is changing as well under the action of driving forces. Cultural and social changes (among others) are implicated in livelihood modifications.

The ability of a livelihood to be able to cope with and recover from stresses and shocks is central to the definition of sustainable livelihoods.

In order to face global changes, farmers will have to adapt their livelihood strategies.

According to the literature (source), there are two ways of doing it:

-1<sup>st</sup> level, coping strategies: temporary adjustments in the face of change

E.g. changes in crop varieties, less inputs...

-2<sup>nd</sup> level, adaptation mechanisms: longer term shifts in livelihood strategies

E.g. land sale, insurance, changes in the mix of activities, end of some activities, accumulation of livelihood resources ...

Consequently, people who are unable to cope or adapt are inevitably vulnerable and unlikely to achieve sustainable livelihoods (Davies 1996).

**The evolution over time of the strategies we built in this study will be based on a combination of both copings and adaptation mechanisms.**

**Moreover, we consider that an evolution within a livelihood strategy is always correlated with a variation in the operated area. This evolution can be positive (increase), negative (decrease) or equal to zero (no change) (cf IV.4).**

## **b) Migration: a crucial issue**

### **i) Definition**

Livelihood strategies that are not sustainable will often lead to migration processes. For example, farmers following the subsistence-oriented strategy and who at some point don't make enough money to survive won't have any other solution than migration.

The internal migration process can be defined as following: movement of people due to work, temporary (for several months or daily commuting) or permanently. Migration can happen over long distances or even in other countries (external migration). This supposedly led to one-way population movements from less-endowed areas to well-endowed prosperous areas through the “push” created by poverty and a lack of work and the “pull” created by better wages in the destination (Lee 1966).

There are two types of internal migration:

1) Rural-rural migration: these movements happen mainly over short distances and usually in places with sharp regional differences in productivity and wages and with a low/moderate level of mechanisation (E.g. AP and TN).

High productivity agricultural areas (“green revolution areas”) continue to be attractive for workers but more migrants are opting for non-farm employment because of better returns.

2) Rural-urban migration: migrants usually cover greater distances and often travel to different states.

Labour-sending areas are typically agriculturally backward and poor and emerging destinations are towns and cities, industrial zones, coastal areas for fish processing and salt panning (e.g. Andhra Pradesh).

Circular migration is a particular form of rural-urban migration.

Ideas of circular and seasonal migrations were first articulated in the 1970s (Nelson 1976; Rao 1994) and defined as “characteristically short-term, repetitive or cyclical in nature, and adjusted to the annual agricultural cycle”.

NB: there is actually a switch from rural-rural to rural-urban migration in areas where agricultural employment is decreasing and industrial jobs are being created (Deshingkar 2006).

### **ii) Migrants' profiles**

Migrations to big urban areas or rich rural areas are often achieved by men and over long distances (sometimes travelling to different states). Women are preferentially migrating over short distances (Guilmoto 2005) and as a consequence of new opportunities in industry and of social norms relating to women's work that are changing (Deshingkar 2006). Consequently, skilled and semi-skilled agricultural labourers will become scarce resources in coming decades.

NB: Rural to urban migrants in India (1991-2001) as a % of urban population: AP: 6,72%; Haryana: 11,45%; Tamil Nadu: 3,34%.

All India: 7,32%

Source: (SriSubramaniam and Subramaniam 2009).

It is not necessary the poorest that migrate but poor have a higher propensity to out-migrate from rural areas. In the migration process, most casts are usually represented. However, Deshingkar and Start (2003) found that scheduled tribes had higher migration rates in Andhra Pradesh and Madhya Pradesh.

Migration rates are high among the most and least educated. Unlike East and South-east Asia, illiterates appear to dominate seasonal labour migration (Deshingkar 2006). Examples include migration from drought-prone areas of Uttar Pradesh, Bihar, Orissa, Andhra Pradesh and Tamil Nadu to the fields of Maharashtra, Gujarat, Punjab and Haryana.

### **iii) *Reasons for migration***

The main reasons for rural-urban migrations are economic, climatic and political distress, finding a job and improving standards of living (Guilmoto 2005),(Cavalier 2006). Considerable projects of land settlements (e.g. dam) could also have consequences on migrations patterns.

Deshingkar (2006) mentioned that the Indian rate of job creation and real wages increases in agriculture have slowed down. The main reasons for that are a worsening land-person ratio, water scarcity, and persistent droughts. About two-third of the arable area in India is arid and drought prone (this is the case in AP and K) and many of these areas show very high rates of seasonal migration. Other phenomenon that favour migration are: income and non-income inequalities (related to tribes, casts, gender and ethnicity), labor-intensive manufacturing, construction and urban services attracting workers (rural-urban migrations) like fish/prawns processing and salt panning all along the coastal areas of AP, and regional inequalities (rural-rural migrations) especially in states like Andhra Pradesh, Tamil Nadu and Rajasthan.

### **iv) *The particular case of circular migration***

Circular migration is a common phenomenon in India: single, generally male migrants go out for work, they maintain close links with their villages of origin, they return when they can or when forced to, and they aspire to return after retirement (Haan 1997). Usually people come to cities when urban wages are high, and then go back when it is less profitable.

At least five factors have contributed to this pattern:

-Availability of cheap transport: even for long distances, the areas are relatively well-connected.

-The conditions in the cities: work in the cities is often not stable, especially because of the shortage of housing: the living conditions are bad.

- The agrarian structure: many of the workers own a small piece of land in their village of origin, and invest part of the income they earn from migration into agricultural production. The link with the land remains very strong and also limits diversification in the town.
- The specific demand for industrial labor: employment is often not permanent (high rate of labor turnover).
- The role of the family: single men migrating leave their women behind and therefore have a good reason to return (Haan 1997).

According to Deshingkar and Anderson (2004), commuting is widespread in AP with 12% of the households on average sending one person to work in a nearby rural location. Indeed, non-farm opportunities are numerous closed to the villages in AP and the communication network is well-developed (roads). Commuting is more important in villages that are better connected to shops, services industries and government establishments (Deshingkar 2004).

Almost all migrants are able to save money and send it as a remittance to their family. This money is usually used for a range of expenses, like food, health, weddings, schooling...

Migration and mobility are currently underestimated by government.

#### **v) *Evolution of migration patterns in the future***

Some data based on the Census of 2001 show that migration is increasing: 30% of the population (or 307 million people) were classified as migrants compared with 27,4% of the population (or 232 million people) out of the total population of 838 million in India in 1991. 44% moved for marriage and only 14,7% for employment.

Insofar as the population of young adults keeps growing, it is likely that migration will continue and even increase over time. Circular migration is going to increase as well, especially in areas where growth is localized in specific areas.

Permanent rural-urban migrations will increase if restrictions to settling down and claiming benefits are removed and if the link with the home village becomes less important.

Governments are trying to control this migration pattern through rural employment programs and indirect policies (like ‘ration card’ that oblige people to get subsidized food in their village of residence). Regular urban clearances also happen.

The DFID-funded Andhra Pradesh Urban services Project has developed effective partnerships between government and NGOs especially in the areas where livelihoods, gender and social development analysis have helped in the identification of vulnerable groups and the development of interventions that can help them.

## **4.4 Consequences in terms of operated area size**

Once each profile was linked with a particular strategy, we associated to each of them one, two or three possible operated area variations that could happen in the future - increase,

decrease or no change - in order to define “sub-strategies” (cf Table 4: Profiles and strategies)

Below is a table with a succinct description of the different sub-strategies:

<b>Current strategy</b>	<b>Future strategy</b>	<b>Comments/examples</b>
<b>A</b> (market oriented)	<b>A.1</b> ( $\Delta=0$ )	-Intensification expected -Specialization -Introduction of high value crops
<b>A</b> (market oriented)	<b>A.2</b> ( $\Delta>0$ )	-Farmer buys land in order to extend the available operated area -Crop diversification
<b>B</b> (subsistence oriented)	<b>B.1</b> ( $\Delta=0$ )	-Survival oriented -Home consumption (no diversification)
<b>B</b> (subsistence oriented)	<b>B.2</b> ( $\Delta<0$ )	-End of farming activity -Migration expected
<b>C</b> (labor oriented)	<b>C.1</b> ( $\Delta=0$ )	-Farmer works outside the farm but keeps a small piece of land for home consumption (as a security) - Development of non-farm activities expected
<b>C</b> (labor oriented)	<b>C.2</b> ( $\Delta<0$ )	-End of farming activity + migration (wage work in agriculture is often underpaid) -Development of non-farm activities expected
<b>D</b> (migration-transfer oriented)	<b>D.1</b> ( $\Delta=0$ )	-Farming maintained (thanks to remittances) -Development of non-farm activities expected
<b>D</b> (migration-transfer oriented)	<b>D.2</b> ( $\Delta<0$ )	- Diminution of farming activity -End of farming activity + migration -Development of non-farm activities expected
<b>E</b> (diversification oriented)	<b>E.1</b> ( $\Delta=0$ )	-Operated area maintained -Crop diversification (high value crops)
<b>E</b> (diversification oriented)	<b>E.2</b> ( $\Delta<0$ )	-Diminution of farming activity -Development of non-farm activities
<b>E</b> (diversification oriented)	<b>E.3</b> ( $\Delta>0$ )	-Farmer buys land in order to extend the available operated area -New crops varieties (high value crops)

**Table 5:** Description of the future livelihood strategies

In order to distribute the farmers into each of the substrategies, we selected three different methods. We will have to choose the most relevant in order to complete the model.

-Method 1: Either we distribute the farmers equally in each substrategy (e.g. 50%-50% or 33%-33%-33%) but it probably doesn't reflect the reality at all.

-Method 2: Either we follow the current trend given by the Agricensus database.

According to the Agricensus database, the trend in India concerning the number of individual holdings between 1995 and 2006 is the following:

	Marginal	Small	Semi-medium	Medium	Large	Total
Andhra Pradesh	+18%	+17%	+4%	-13%	-32%	+14%
Karnataka	+41%	+19%	+7%	-6%	-24%	+23%

**Table 6:** Evolution of the number of individual households between 1995 and 2006 in Andhra Pradesh and in Karnataka states (Source: Agricensus)

We might choose to recreate this trend in the livelihood strategies by adapting the percentages of farmers belonging to each substrategies (and for each watershed) (cf Table 4: Profiles and strategies for the implementation). However, the percentages only stand as a rough estimate of the reality and only point out a global trend.

**Example:**

Let us consider a sample of 120 small farmers in South Gundal, distributed as following:  
 20 S1 distributed into D.1 (i.e. 10 of them) and D.2 (i.e. 10 of them),  
 40 S2 distributed into A.1 (i.e. 16 of them) and A.2 (i.e. 24 of them),  
 60 S3 distributed into C.1 (i.e. 30 of them) and C.2 (i.e. 30 of them).

Once the operated area variation has been applied, we have:

- 56 farmers are still small,
- 40 farmers are becoming marginal,
- 24 farmers are becoming semi-medium.

-**Method 3:** Either we use the vulnerability score we previously got in the project to determine which farmers are more or less vulnerable in each profile and consequently more or less likely to increase/decrease/maintain their operated area.

For example, in the small category:

- Low vulnerability:  $\Delta > 0$
- Medium vulnerability:  $\Delta = 0$
- High vulnerability:  $\Delta < 0$

*This hypothesis is still under study.*

The other main hypotheses are:

- If the operated area is expected to increase, the farmer will leave his current category and go into the next bigger category (e.g. from marginal to small, or from small to semi-medium).
- If the operated area is expected to decrease, the farmer will leave his current category and go into the next smaller category (e.g. from small to marginal, or from large to medium).
- If we consider a marginal farmer whose operational area is supposed to decrease, we consider that he will permanently leave the system (i.e. by migrating to the city).

Finally, another hypothesis might be taken into account in the model as well: According to the literature, the share of employment in agriculture in AP might decrease from 70% to 40-45% over the next 20 years (all size categories taken together) (Go-AP 1999). Whatever hypothesis is finally chosen, we will have to consider this fact as well.

## 5 Conclusion and discussion

### 5.1 Limits and improvements of the model

-First of all, this model is only a theoretical approach of what could happen in reality on a medium scale (10-15 years?). Numerous approximations have been done in order to build it.  
-The model was built on the basis of the surveys we conducted in the course of the field trips. The samples were very small and not significant at all. As a consequence, conclusions that are drawn in this report are valid only in this context (social, economic, geographic and climatic) and should not be applied to another sample. For example, the farmers' profiles in the model stand as a mirror of the sample we studied and will maybe not be relevant in the case of a bigger sample coming from the same watershed. Moreover, these profiles are totally context-specific and are valid only for the watersheds we studied.  
We are currently trying to refine these profiles thanks to the Sustwater database.

-In order to simplify the model, the profiles we designed are quite simplistic (only a few characteristics were selected) and are not exactly reflecting the reality.  
-The model will have to be adjusted to a bigger sample while taking into account the particularities of the context.  
-A limit of this model is that it doesn't take into account the number of new farmers entering each year in the system. This number is specific to each watershed. As a consequence, the model could be improved by adding them and by distributing them between the final categories by applying the upper percentages.  
-Another hypothesis in this model is that only marginal farmers are able to get out of the system. According to the literature and the surveys, they are the most threatened by this phenomenon but it doesn't really reflect the reality.  
-We consider that these evolutions are relevant only for a short period of time (about 10 years?). Indeed, farmers keep evolving over time in terms of operated area size. Consequently, the model could be improved in the future in order to assess the number of farmers belonging to each category on the long run (20 years later, 30 years later). One solution would be to repeat the process several times. For example, a first significant sample could be analyzed to assess the situation in 2020, then the new sample has to be analyzed a second time to assess the situation in 2030, etc.

### 5.2 Implementation of the model (significant sample)

Once the model will have been adjusted to a bigger sample and to a specific location, it will be possible to get an estimation of the farmers' distribution between the categories on the long run.

A CPA will have to be realized in order to identify the significant variables for this particular sample. Then, profiles will have to be designed on the basis of these variables and logic

combination (i.e.: identifying the most typical profiles in the sample). As for Kudaliar and South Gundal watersheds, the profiles we designed could be used on a first basis. Once the farmers will be distributed between the different profiles (thanks to an access database), the model will determine the evolution of the farmers between the categories.

### 5.3 Link with the vulnerability score

Once the sample will be significant (thanks to surveys conducted by the CESS), we will be able to assess how many farmers will move from each category. We will then link a vulnerability score to these new categories.

Thanks to this part of the project, it will be possible to compare between current and future agricultural water users vulnerability and to characterize and map the *winner*s and *loser*s of global changes through a GIS approach, and study the evolution of geographical distribution of the global changes victims. Finally, a cost-benefit analysis will enable to identify the areas where action could be undertaken to mitigate the negative impact of global changes on farmers (BRGM 2008).

### 5.4 Impacts on population and land cover

Predictions tell us that the share of employment in agriculture will decline from its current 70% of the AP population to 40-45% over the next 20 years (Go-AP 1999). Most of these people are going to migrate to the cities in order to find jobs and improve their way of life. Migrants will mostly belong to the marginal and small categories, whose holdings are the least viable. Rural employment and opportunities will have to be developed in order to repress rural depopulation and control urbanization (Dorin and Paillard 2009). Lots of these abandoned areas will be absorbed by the cities. Even the bigger farmers will have part of their businesses located in the city. The land cover is going to change as well: intensification and cash crops will be part of the future.

At the same time, a middle class is emerging: these newly rich people wish to consume more and more. The demand of eggs, meat, fruits, vegetables and fish could treble by 2030 (OCDE 2007).

However, this will happen at the expense of the environment which will still be overexploited in the absence of better regulations (pollution of water tables, soil and groundwater overexploitation among others).

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## 7 Appendix

### Appendix 1: Progress report March 2010



Progress report  
March 2010

### Appendix 2: Progress Report field trip South Gundal (Karnataka) (April 2010)



Progress Report  
South Gundal Karnata

### Appendix 3: Progress Report field trip Kudaliar (Andhra Pradesh) (June 2010)



Progress report  
Kudaliar Andhra Prad

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