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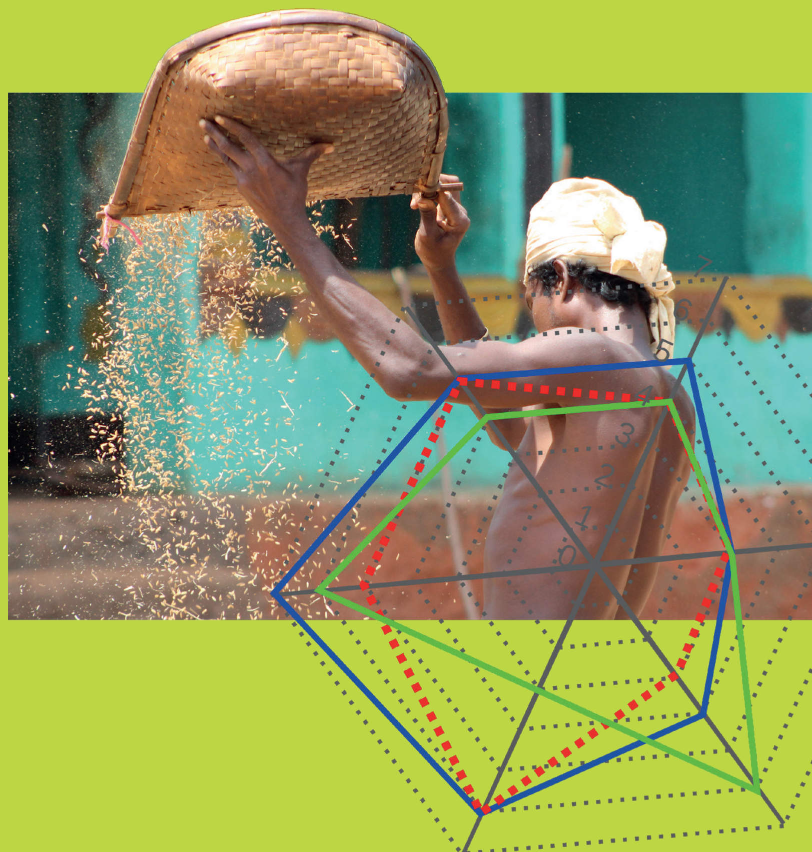
Practices, Productivity and Perception

A Vulnerability Assessment of Rice Farming Households in the Eastern Ghats, India



Fraser Stuart Patterson

Centre for Development Studies (ZELF)
Institute of Geographical Sciences
Freie Universität Berlin

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ZELF

Editor of Berlin Geographical Papers

Prof. Dr. Hermann Kreutzmann

Contact
Centre for Development Studies (ZELF)
Institute of Geographical Sciences
Freie Universität Berlin
Malteserstr. 74-100
D-12249 Berlin

h.kreutzmann@fu-berlin.de

Tel: +49 – 30 – 838 70223
Fax: +49 – 30 – 838 70757

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The basis of this study comes from the results of a questionnaire and I am grateful to every farmer in the twelve villages who took part in it. My thanks are also extended to the other interviewees who patiently took the time to answer my questions.

Abstract

Vulnerability assessments are an increasingly popular tool for evaluating the susceptibility of households, communities, regions and countries to environmental and social change. This study adopts the model of inherent or underlying vulnerability and develops a social-environmental vulnerability index that is applied in a case study of rice farming households in the Eastern Ghats of India. Assessing the vulnerability of farming household sub-groups based on land type and holding size, this study investigates connections between cultivation practices, land size and vulnerability. The study finds that dryland, or rainfed, rice farmers are significantly more vulnerable than farmers cultivating rice on wetland and while small-scale farmers are more productive than large scale farmers, they are also the most vulnerable. The study concludes that while small-scale farmer's productivity can be related to higher application of fertilisers, greater use of high-yielding varieties and more intense use of labour, this higher productivity can be seen as an adaptation strategy to the higher vulnerability to social and environmental change.

Zusammenfassung

Verwundbarkeitsanalysen werden immer häufiger als Methode angewandt, um die Vulnerabilität von Haushalten, Gemeinschaften, Regionen und Ländern gegenüber ökologischen und sozialen Veränderungen zu evaluieren. In dieser Studie wird auf das Konzept der *inherent* oder *underlying* Verwundbarkeit zurückgegriffen und ein sozio-ökologischer Verwundbarkeitsindex erstellt, der in einem Fallbeispiel in den Ostghats von Indien angewendet wird. Die Haushalte wurden in Kategorien nach Bewässerungsverfahren und Größe der Anbaufläche eingeteilt. Anschließend wurde für jede dieser Untergruppen die Vulnerabilität erhoben, um Zusammenhänge zwischen Anbaumethoden, Anbaufläche und Vulnerabilität zu erkennen. Diese Studie kommt zu dem Ergebnis, dass für Bauern und Bäuerinnen, die Regenfeldanbau praktizieren, eine höhere Verwundbarkeit besteht als für Bauern und Bäuerinnen, die Reis auf Feuchtland kultivieren. Trotz einer höheren Produktivität zeigte sich in der statistischen Analyse eine größere Verwundbarkeit der kleinbäuerlichen im Vergleich zur großbäuerlichen Landwirtschaft. Die höhere Produktivität der kleinbäuerlichen Landwirtschaft resultiert aus einer größeren Anwendung von chemischen Düngermitteln, leistungsstärkerem Saatgut und intensiverem Einsatz von Arbeitskraft. Die Anwendung dieser produktivitätssteigernden Methoden kann als Anpassungsstrategie an die höhere Verwundbarkeit gegenüber sozialen und ökologischen Veränderungen verstanden werden.

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List of Abbreviations

ACZ	Agro-Climatic Zone
AEZ	Agro-Ecological Zone
AESR	Agro-Ecological Sub-Region
AR4	Assessment Report 4 (from the IPCC)
AR5	Assessment Report 5 (from the IPCC)
BAP	Budget Allocation Process
DAP	Diammonium Phosphate
GIZ	Deustche Gesellschaft für Internationale Zusammenarbeit
HYV	High-Yielding Variety
IFAD	International Fund for Agricultural Development
INR	Indian Rupee
IPCC	Intergovernmental Panel on Climate Change
IR	Inverse Relationship
IRRI	International Rice Research Institute
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MOP	Muriate of Potash
MV	Modern Varieties
NPK	Nitrogen, Phosphorus, Potassium
PRA	Participatory Rural Appraisal
SDGs	Sustainable Development Goals
SEVI	Social Environmental Vulnerability Index
TAR	Third Assessment Report (from the IPCC)
UNEP	United Nations Environmental Programme
VA	Vulnerability Assessment

List of Hindi / Oriya Terms

Beda	Wetland agricultural land
Kharif	Summer growing season
Rabi	Winter growing season
Saria	Rainfed agricultural land

1 Introduction

On the 25 of September 2015, the 193 countries of the United Nationals General Assembly adopted the 17 Sustainable Development Goals (SDGs). The second of these goals aims to, "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (United Nations, 2015). This goal contains several targets that, as well as ending hunger by 2030, also seek to double agricultural productivity and income of small-scale food producers, ensure sustainable food production systems and implement resilient agricultural practices. Agriculture can also be directly linked to at least nine other goals, such as those related to ending poverty, environmental protection and economic development, and will therefore play a decisive role in whether several of the Sustainable Development Goals are fulfilled or not.

Around 85 percent of the farms in the world can be classified as small-scale and these small-scale farms produce the majority of food in developing countries (Murphy, 2010: 3; Koohafkan, 2011). India is home to the second highest number of small farms in the world and small farm holdings make up 80 percent of all farms in the country (Nagayets, 2005: 357). These small-scale farmers experience diverse challenges, many of which are not only increasing, such as competition for land, rising costs of inputs such as fuel and fertiliser, and increasing impacts from climate change, but they are also becoming more difficult to predict (IFAD and UNEP, 2013: 9). While the SDGs are a powerful tool for directing the attention of the world's media, as well as policy and funding, they do not state *how* small farmers should be supported to help achieve these goals.

In the 20th century and especially during the Green Revolution, much literature and policy focused on the productivity of farmers and sought ways to improve this using technical means. In recent years there has been increasing attention paid to a wider understanding of agriculture and viewing farms as social-environmental systems. Using vulnerability assessments as a tool, the focus of this research has been to determine different ways these systems can be supported. Much of this literature has focused on one specific hazard or risk, with climate change gaining much attention, however, recent attempts have been made to assess *inherent* or *underlying* vulnerability of social-environmental systems to account for these different challenges (see Allen, 2003). However, these assessments have not yet been fully explored regarding farming systems.

1.1 Aim and Structure of this Study

This study seeks to determine the agricultural practices and productivity of different sub-groups of farmers based on land size and land type and use this as a basis for assessing vulnerability of these groups. The different factors that influence productivity and vulnerability will be determined, so that the driving factors contributing to vulnerability can be compared between the different sub-groups. Viewing farms as a social-environmental system, both environmental and social aspects of rice cultivation will be considered. Using the concept of *inherent* vulnerability, this study can be relevant in advancing this concept in practice and identifying ways to reduce vulnerability to a variety of hazards and changes in both social and environmental spheres. The overarching research aim of this study is therefore to establish to what extent *inherent* vulnerability differs between small, medium and large-scale farming households and what are the causes of these differences.

In order to conduct and present the analysis necessary to answer this research aim, this study has been divided into several chapters. In the next chapter, relevant literature on the subject of small-scale farmers and vulnerability analyses is explored and opportunities that exist for further research are identified. This chapter forms the theoretical basis on the study and three research questions based on this literature are presented. In chapter three the methods used to collect and analyse data to answer the research questions are outlined. As the majority of the research in this thesis is connected to a case study, in chapter four the study area is then presented, including the history of rice cultivation, the impacts of the green revolution and the conditions for small-scale agriculture in the region. The empirical results of the fieldwork are then analysed in chapter five before being discussed within the wider literature and aims of this thesis in chapter six. Finally, the implications of this study and its findings will be summarised.

2 Conceptual Framework

2.1 The Global Importance of Small-Scale Farming

There is no universally accepted definition for a small farm. The classification of a farm holding as small may be based on number of workers, capital invested or the size of the land under cultivation (IFAD and UNEP, 2013: 10). Land size is the most commonly used indicator and multilateral organisations such as the World Bank, among others, have adopted a 2 hectare (ha) threshold as a size-based definition of smallholder agriculture (World Bank, 2003). However, national and regional indicators can vary from an average of 0.5 to 10 ha and up to 500 ha is considered a smallholding in Australia (Maass Wolfenson, 2013: 15).

The definition of a smallholder farmer is not limited to land size. Dixon et al. (2004) argue that small holder farming differs from other groups in their allocation of resources to food, cash crops, livestock and off-farm activities, their use of external inputs and hired labour, the proportion of food crops which are sold, and their household expenditure pattern. Murphy (2010: 3) uses an alternative definition of smallholder farmers and characterises them as a marginalised group in terms of geography, assets, resources, markets, information, technology, capital, and non-land assets. It is argued that due to the diversity of definitions that exist, smallholder farms must then be defined at a regional or country level (Maass Wolfenson, 2013: 15).

Despite this lack of a definitive definition for smallholder farmers at a global level, there appears to be unanimous agreement on their positive contribution to global development, economic development and environmental protection. Based on the two-hectare threshold, it is estimated that there are 450 million small-scale farms worldwide supporting a population of 2.2 billion people (Singh, 2009 cited in Murphy, 2010: 3). Small-scale farms therefore make up roughly 85% of the world's farms (Murphy, 2010: 3). The majority of these small-farms are located in Asia (87 percent), followed by 8 percent in Africa, 4 percent in Europe and 1 percent in the Americas (Nagayets, 2005: 356). Almost half of the world's small farms can be found in China (189 million), where small farms account for 98 percent of all agricultural holdings in the country, followed by India with the second highest number (ibid).

While the average farm size in North America and Western Europe has been rising in the past 30 years, in Africa and Asia the number of smallholder farms is increasing despite economic growth (Nagayets, 2005: 361). In the DR Congo, the average size of landholdings shrank from 1.5 ha in 1970 to 0.5 ha in 1990 and the number of small farms in the country doubled during this time (ibid). In Asia, China saw its average farm size decrease from 0.56 ha in 1980 to 0.4 ha in 1999 (Fan and Chan-Kang, 2003: 136). Finally, Chand et al. (2011: 7) explain that in India, the total number of operational farm holdings increased from 71.01 million to 128.89 million between 1970-71 and 2005-06 and the average size of these holdings decreased from 2.28 ha to 1.21 ha. This led to the number of small and marginal holdings doubling in the same period, resulting in smallholders cultivating 42% of the land yet constituting 83% of total land holdings (ibid). Chand et al (2011: 7) attribute this to the growth of the rural population at the time, as both the number of land holdings and rural population increased during this period at exactly the same rate (1.76 percent).

Smallholders, therefore, produce the majority of food in developing countries and in many ways their contribution to global food security is growing (Koohafkan, 2011). They can, therefore, play an important role in economic development and poverty reduction. This has been shown in several studies on growth in the agriculture sector and poverty reduction. Cervantes-Godoy and Dewbre (2010: 16) show in their study of 25 countries that over half of the reductions in poverty in the countries they selected can be attributed to a growth in agricultural income. Christiaensen et al. (2011: 248) find that growth in agriculture is significantly more effective in reducing poverty for the poorest people as a 1% increase in agricultural per capita GDP reduces the total $1 a day poverty gap by five times more than a 1% in GDP per capita in any other sector. Furthermore, Irz et al. (2001: 462) found evidence that an increase in yield by one third might reduce the numbers of poverty by a quarter or more by generating employment, stimulating the rural economy through linkages and reducing the real cost of food. Irz et al. (2001: 449) therefore question if any other comparable development efforts are likely to have a greater impact on reducing poverty than promoting an increase in agricultural production.

2.2 Small is Beautiful

In 1962, Indian economist Amartya Sen published his seminal paper based on research conducted in six regions in India stating that agricultural productivity has an inverse relationship with size of land holding, meaning productivity per acre decreases as the size of the land holding increases (Sen, 1962). Sen attributes higher productivity of smallholdings to greater inputs and labour per acre (ibid: 246). However, he does not conclude that small farms are in themselves more productive. Instead he argues that the system of farming has a greater influence, specifically whether it is wage based or family based and a large cooperative farm operated with family labour would be expected to be as productive as a small farm also dependent on family labour (Sen, 1962: 247). The debate, however, continues and interest in the issue of farm size and productivity has intensified and become the focus of global inquiry, with Heltberg (1998: 1807) stating, "the inverse relationship between farm size and output is one of the most important and hotly discussed *stylised facts* of rural development."

A great volume of literature regarding this inverse relationship (IR) has been published without a consensus being reached. Fan and Chan-Kang (2003: 135) state that in Asia, an area that has received much attention on the subject, the debate of farm size and productivity has come full circle. In the 1960s, small farms were regarded as more efficient due to their use of resources, especially family labour. However, in the 1970s and 1980s during a period on increasing industrialisation often referred to as the Green Revolution, small farms were regarded as a major obstacle, especially as modern inputs and machinery could reduce labour constraints on farms during peak seasons. The circle reached completion in the 1990s with the mantra 'small is beautiful', when agriculture diversified into high-value commodities such as cash crops, livestock and horticulture, for which small-farms were better suited (Fan and Chan-Kang, 2003: 135). This view gained further support as the environmental hangover of the green revolution was being felt, caused by input intensive practices of large farms leading to extensive land degradation.

A considerable number of studies have been conducted into the IR hypothesis, which support its existence (see Binswanger et al. (1995) and Eastwood et al. (2010) for extensive reviews of the literature and empirical evidence involved in this debate). IR has been described by Bhalla and Roy (1988: 55) as, “a fact that has endured the test of time and space”, and this can be seen in a much referenced study of 15 countries by Cornia (1985), which found that in 12 of the 15 countries in Africa, Asia and South America, a strong negative relationship was established between farm size on one side and factor inputs and yields per hectare on the other. The author attributes the higher yields from small farms to greater inputs and a more intensive use of the land, and makes a strong case for land redistribution in favour of smaller holdings (Cornia, 1985: 532). Summarising the results of a variety of studies on IR, Fan and Chan-Kang (2003: 141) state that the evidence supporting the IR claim is greater application of inputs, more intensive use of land and greater technical efficiency and use of resources.

Alternatively, the IR hypothesis has been accused of being a statistical artefact for multiple reasons. Bhalla and Roy (1988: 71) argue that when land quality variables are considered, the IR weakens or in many cases disappears. Others have stated that it is caused by insufficient or flawed data, especially regarding land size or yields (Lamb, 2003). It is also asserted that the IR is limited to regions where low levels of technology in agriculture are being used, as in areas where higher levels of agricultural technology are available, this will be adopted to a greater extend by large farmers, which would increase their productivity (Deolalikar, 1981: 278).
Carletto et al. (2013) address a substantial part of the IR debate in the African context of their study, namely that IR is a statistical artefact that stems from insufficient data. Comparing self-reported land size from a household survey with GPS plot measurements in Uganda, they find empirical validity of the IR hypothesis is strengthened, not weakened, by the improved measurements. This is supported by a recent study into small-scale farmers in India by Chand et al. (2011: 10) as their findings support IR and reveal that fertiliser use, irrigation, crop intensity and adoption of technology such as HYV decline with increased farm size. Therefore, they attribute this to the higher productivity of small farmers. Despite this, the authors conclude that small farmers continue to struggle more to generate income and sustain their livelihoods compared to large farmers. They postulate that it is not possible to generate enough income to keep a family farm out of poverty on holdings under 0.8 ha (Chand et al. 2011: 11).

While the debate surrounding the inverse relationship and its influencing factors continues at a global level, it is clear that small farms and smallholders in the global south are facing increasing challenges from multifarious sources. Hazell (2005: 95-96) summarises several of these challenges, including increasing rural populations that lead to further subdivision of small farms to a point that they are too small to be efficient and can no longer support the livelihoods of the farmers or provide their subsistence needs. This can force farmers into unsustainable farming practices that may further worsen their condition long term. Market chains are changing and there is increasing demand for quality and food safety, often with supermarkets controlling access to these markets directly. While this can be advantageous for those integrated in these markets, those who are not are pushed further to the periphery. Thirdly, protectionist agricultural policies make it more difficult for unsubsidised farms not receiving subsidies to compete, not only in the international market but in facing increasing competition from subsidised agricultural imports in their own countries. Finally, Hazell (2005: 96) argues that increasing prevalence of HIV and AIDS in rural regions of many countries is reducing the number of productive family farm workers who can cultivate plots and decreasing the knowledge transfer of sustainable practices onto other generations of farmers.

A joint report on smallholder farmers by IFAD and UNEP (2013: 9) further explain that many of the problems for small-scale farmers originate at a global level, are increasing and are becoming more difficult to predict. These issues include increasing competition for land and water, rising cost of inputs such as fuel and fertiliser and the impacts of climate change. In the report it is suggested that smallholders are more vulnerable to these challenges as they are more directly dependent on ecosystem services and have less capacity to adapt to changing contexts, compared with larger farmers with more resources. Furthermore, it is argued that smallholders are often neglected in the debates concerning the future of agriculture and are ignored by policy-makers at numerous levels.

2.3 Farming as a Human-Environmental System

Ruthenberg (1980: 2) argues that farms can be viewed as systems because they involve several activities closely related by the common use of the farm's resources, such as labour, land and capital, by risk distribution and by joint use of the farms management capacity. Shaner et al. (1982: 16) advance this definition as follows:

> [A] farming system is a unique and reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to the physical, biological and socio-economic environments and in accordance with the household's goals, preferences and resources. These factors combine to influence output and production methods. The farming system is part of a larger system, i.e. the community, and can be divided into sub-systems e.g. cropping systems.

Ruthenberg (1980: 2) explains that the sub-set of systems that agriculture is based on can be both biological, political and social, and therefore farming must be seen as a hybrid system. This hybrid system is a major decision point for agricultural development as both an ecosystem and independent unit of economic activity (ibid).

Turner et al. (2003: 8080) argue that the concept of vulnerability and vulnerability assessments are a useful way to analyse human-environmental systems. They can provide improved understanding of the vulnerability of people, places and ecosystems to environmental change from a local to a global level. Increasing emphasis is being placed on vulnerability research, which marks a focus on the examination of a system being stressed and its ability to respond (Luers et al. 2003). These assessments have been applied in a variety of contexts and human-environmental systems on a variety of scales.

In a case study of wheat farming households in the Yaqui valley in Mexico, Luers et al. (2003) assess the vulnerability of wheat yields to climate variability and change, and market fluctuations. The authors describe the advantages of such an approach as follows:

> By focusing on the mechanisms that facilitate or constrain a system's ability to cope, adapt or recover from various disturbing forces, vulnerability assessments aim to not only identify which systems are most at risk but also to understand why (Leurs et al. 2003: 255).

While it is argued that vulnerability research has produced insightful results in social and global change sciences, the development of measures to assess vulnerability has been complicated by its lack of consensus on the exact meaning of the term (Luers et al. 2003: 255). The development of the term vulnerability, particularly regarding social-environmental systems relevant for this study, its practical application, its limitations and the critiques made against it are outlined below.

2.4 The Developing Concept of Vulnerability

The Oxford Dictionary of English (2015) defines vulnerability as, inter alia, "exposed to the risk of being attacked or harmed, either physically or emotionally." It is a term that is familiar in everyday language with most people having a working understanding of what it means to feel vulnerable, look vulnerable or act vulnerable without the need for further clarification (O'Brien, 2004: 2). However, therein lies the danger that when used within a scientific capacity, different scientists may think they have a mutual understanding of the term but in actual fact they are working under different conceptualizations (ibid).

2.4.1 Pinning down Vulnerability

"In its most basic sense, vulnerability conveys the idea of susceptibility to damage or harm, but much debate remains around how to characterize vulnerability in theory and practice" (Eakin and Luers, 2006: 366). A reason for these different conceptual understandings is that each interpretation is influenced by different academic fields and schools of thought. The growing body of literature on the concept of vulnerability uses a variety of terms, such as: vulnerability, sensitivity, resilience, adaptive capacity, risk, hazard, coping range and adaptation baseline (Brooks, 2003: 2). These terms are then used by a wide variety of schools of thought and academic disciplines, including economics, anthropology, natural sciences, psychology and engineering. In recent years, several attempts have been made by researchers from different academic fields to draw together and retrace the various theoretical lineages of vulnerability (see Atlang, Siegel and Jorgensen, 2001; Adger, 2006; Eakin and Luers, 2006). Eakin and Luers (2006: 367) argue that the concept of vulnerability of social-ecological systems can be traced back through three overarching intellectual lineages.

The first of these fields is the risk-hazard approach, which uses a biophysical threat as a basis for analysis to ascertain to what we are vulnerable, what consequences might be expected and where and when those impacts may occur (Eakin and Luers, 2006: 369). The concept of vulnerability has been credited as being one of the most important additions to hazards research in the past three decades (Mustafa et al. 2011: 62).

The second field in which the vulnerability of human-environmental systems is prominent is political ecology and political economy. The work of Amartya Sen has played an important role in the development of this field of thought. In his work *Poverty and Famine,* Sen (1981) develops a concept of entitlement and capability to explain severe food crises and vulnerability to famine. Sen (1981: 2) argues that to understand starvation you must first understand the structure of ownership as well as a network of entitlement relations such as trade, production, labour, inheritance and exchange entitlement. Starvation, he argues, is often a failure of entitlements, the social and economic means of obtaining food, and not absolute food availability (Sen, 1981: 7). This approach, while diminishing the role of ecological and physical risk, brought social differentiation to the fore as a cause and outcome of vulnerability (Adger, 2006: 271).

Eakin and Luers (2006: 370) argue that Sen's work contributed greatly to political-economy perspectives on vulnerability and provides a "theoretical bridge" to broaden research on poverty alleviation and food security. Sen's concept of entitlements and capabilities was the foundation of further work by Watts and Bohle (1993), who perceived hunger and famine to take place in a multi-layered and multidimensional social space of vulnerability that spread across local, regional and national scales, as well as temporally along short-term and long-term baselines. Figure 1 shows Watt and Bohle's conceptualisation of the space of vulnerability, which is delineated by political economy, entitlements and empowerment.

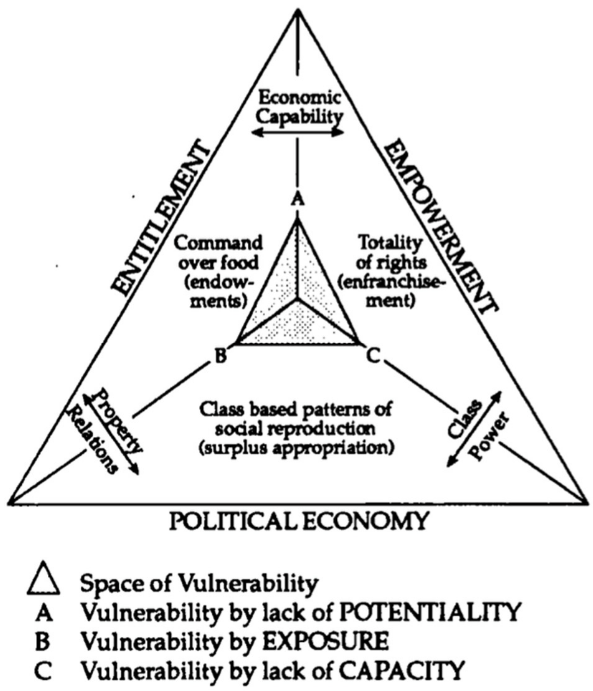


Figure 1. Model of the causal structure of vulnerability (Watts and Bohle, 1993: 53).

Watts and Bohle (1993) argue that at the intersection of these causal powers are three concepts central to their explanation of the space of famine and hunger, namely: economic capability, property relations and class power. These concepts are drawn from the three elements of exposure, capacity and potentiality which are based on Chambers' definition of vulnerability as:

> Exposure to contingencies and stress, and difficulty in coping with them. Vulnerability has thus two sides: an external side of risks, shocks, and stress to which an individual or household is subject; and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss (Chambers, 1989: 33).

A key element of these approaches to vulnerability is that rather than an outcome, vulnerability is described as a state or condition that is dynamic with a variety of influences (Eakin and Luers, 2006: 370).

While it is argued that the entitlement approach to vulnerability underestimates ecological or physical risk (Adger, 2006: 271), the natural sciences have also contributed to the development of the vulnerability concept. C. S. Holling's concept of resilience of natural systems, published in his 1973 article titled *Resilience and Stability of Ecological Systems* has also contributed to the development of the contemporary concept of vulnerability (Eakin and Luers, 2006: 371). Holding defines resilience as, "the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973: 17). His theory was a departure from assessing natural systems by levels of equilibrium and instead by stability and resilience (Holling, 1973: 2). Resilience was more clearly defined than vulnerability at the time and the use of the term to refer to social systems and their ability to 'bounce back' from severe stress increased through the late 1970s and early 1980s (Timmermann, 1981: 19).

Since the 1980s, this concept of resilience has been increasingly used to analyse human-environmental interactions, leading to the "Resilience Alliance" being formed in 1999 (Janssen at al. 2006: 241). In contrast to political-ecology approaches to vulnerability, resilience approaches have often focused on the effects of social and environmental changes across an expansive geographical space, and place anthropological activity within a wider system of species where humans are only one of the driving forces and species affected by change (Eakin and Luers, 2006: 371). It is argued that this concept has played an important role in the development of vulnerability:

> [Ecological resilience] has contributed to a productive exchange of ideas about assessing and understanding vulnerability not only in relation to global environmental change, but also more broadly in relation to a variety of stresses and shocks acting on and within coupled human-environment systems (Eakin and Luers, 2006: 371).

2.4.2 Vulnerability Prospers - Climate Change and the IPCC

Beginning in the 1990s, an increasing awareness of climate change motivated many scholars to begin focusing on the impacts of environmental change. This led to an increase in academic literature on the concept of vulnerability of environments and populations (Janssen et al. 2006: 241). This increase in the use of the concept of vulnerability in the literature can be attributed, at least in part, to the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC) (O'Brien et al. 2004: 1).

The IPCC was founded in 1988 to establish and report on the state of knowledge related to climate change, both its environmental and socioeconomic impacts (IPCC, n.d.). The first IPCC report was released in 1990 and since then four further reports have been published, increasingly focussing on sustainable development policies, mitigation and adaptation to climate change, as well as vulnerability. The term vulnerability first became prominent in its Second Assessment Report (SAR) (IPCC, 1996). This coincides with an increase in the use of the term in literature, as shown in the study by Janssen et al. (2006). Due to this focus, vulnerability has become an intrinsic part of the climate change lexicon. The concept of vulnerability attracted much interest as it is a flexible concept that can be adapted to different situations and perspectives, such as regional analysis, ecosystems and social groups (O'Brien, 2004: 1).

The same definition of vulnerability was used in the Third Assessment Report (TAR) and Fourth Assessment Report (AR4) (IPCC, 2001; IPCC, 2008). In this definition the three key elements of vulnerability are exposure, sensitivity and adaptive capacity, relating to the definition as given by many authors referenced in this chapter (Watts and Bohle, 1993; Kelly and Adger, 2000). However, in the most recent report released in 2013-14, Assessment Report 5 (AR5), the definition of vulnerability changes:

> The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2014: 5).

While previously an interplay of the attributes exposure, adaptive capacity and sensitivity had resulted in vulnerability, now vulnerability includes the elements of sensitivity and adaptive capacity. This is a marked difference in the definitions of exposure and vulnerability between the two reports and a shift to viewing vulnerability as something inherent in a system. However, the definitions given in AR5 have be criticized for inconsistencies and ambiguities in the framework regarding how these terms should be applied in practice (GIZ, 2015: 33). This framework can be seen in Figure 2.

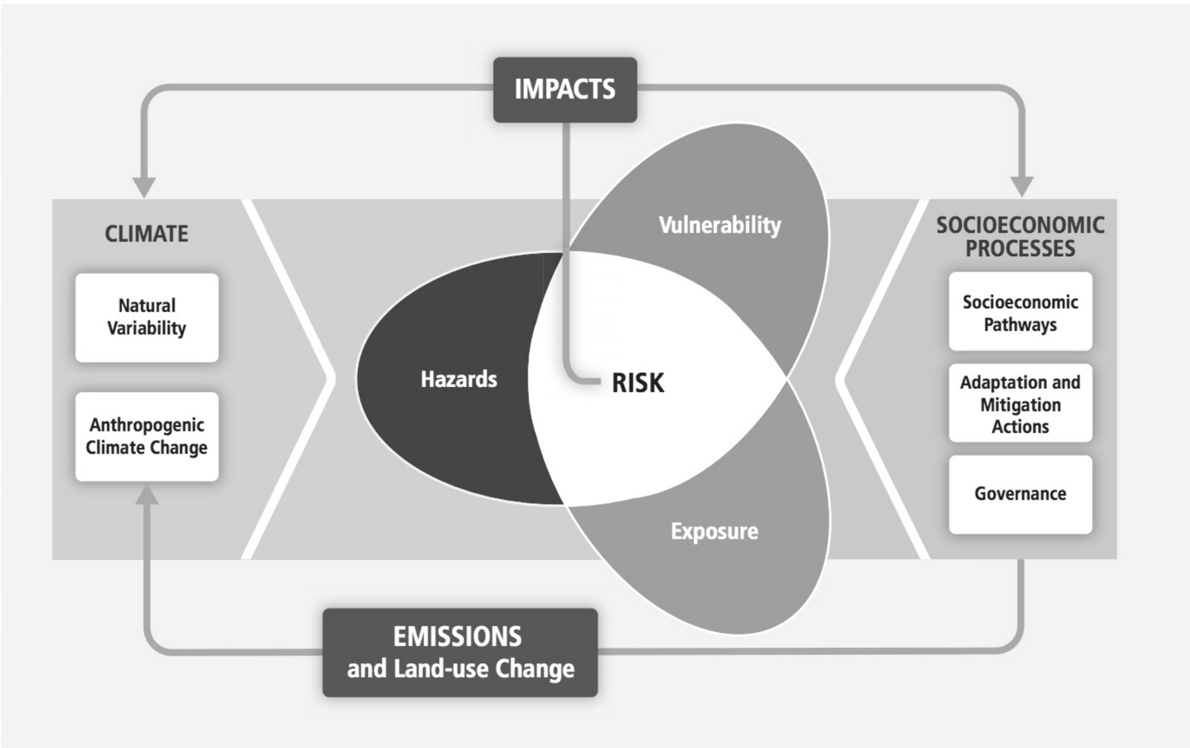


Figure 2. Core elements of WGII AR5 (IPCC, 2014: 3).

2.4.3 Inherent and Underlying Vulnerability

Kelly and Adger (2000: 328) explain that vulnerability is a derivative of the Late Latin word *vulnerabilis*, a term used by the Romans to describe that state of an injured soldier on the battlefield. Following this logic, the authors argue vulnerability refers to prior damage (the existing wound) and not to future stress (or further attack) (ibid). Kelly and Adger (2000: 328) therefore conclude that vulnerability of an individual or social group is determined primarily by their current state and their capacity to respond to a hazard, rather than by what may happen in the future.

The concept of vulnerability in geography has developed from many fields of academic research and has resulted in a profusion of definitions. Although many of these meanings focus on the vulnerability to *something*, the influence of political ecology and political economy has led to a greater concentration on the diverse pressures and hazards that a system can face. This is reflected in the increasing focus on the inner dynamics of a system and how this contributes to vulnerability. The study of these dynamics, usually split into sensitivity and adaptive capacity and independent of exposure, usually refers to *inherent* or *underlying* vulnerability.

Allen (2003: 170) uses the latter of these definitions and explains, “underlying vulnerability is experienced as a contextual weakness or susceptibility underpinning daily life.” This view regards vulnerability as a *lived* reality, therefore it exists within systems independently of external hazards (Brooks, 2003: 4). This can also be referred to as social vulnerability but in studies that concern themselves with the vulnerability of non-human systems, for which the term social is not appropriate, then the term inherent vulnerability may be used (Brooks, 2003: 4). This concept of inherent vulnerability has recently been implemented by Sharma et al. (2015) in their investigation into the inherent vulnerability of forests using an indicator based method. The focus on inherent vulnerability allows information to be gathered on how to build the resistance of the forest to yet unknown future stresses.

Underlying vulnerability is closely tied to environmental and societal changes and processes, which are influenced at a local level by factors with a broad impact and origin (Allen, 2003: 171). Regarding this definition of vulnerability, community based analysis is useful for conceptualising the dynamics and complexity of vulnerability, as by tying it to natural events other facets of vulnerability and connections between them are ignored. Therefore, the application of underlying vulnerability analysis is particularly useful for local level analysis, as Allen (2003: 182) argues:

> From a community member perspective, livelihoods, not hazard events, are the primary source of vulnerability. Local manifestations of vulnerability are linked to such factors as land tenure patterns that limit access to land; processes of environmental degradation; lack of livelihood opportunities in the area; rising prices of agricultural inputs and basic commodities; and falling

> market values of local produce. Different manifestations of vulnerability are too closely interlinked in the lives of most community members to separate neatly vulnerability to flooding or storm surge, from vulnerability to food shortage, or underemployment.

The history of these theoretical lineages is important as it influences how vulnerability is perceived and applied in practice. Kelly and Adger (2000: 326) group the divergent perceptions of vulnerability and vulnerability assessments into three main categories: the end point, the focal point or the starting point of an appraisal. Vulnerability is often considered the endpoint in a sequence of analysis into climate change that begins with projections of future emissions, impacts and adaption options. The adverse consequences that remain after this adaptation process are defined as vulnerability. This method is often used in the IPCC's goal of summarising the net impacts of climate change.

The second concept of vulnerability as the focal point of analysis is often seen in food insecurity and famine literature, such as the work of Watts and Bohle (1993). By defining vulnerability as a space, Watts and Bohle (1993: 45) conceptualize vulnerability based on the three elements of exposure, adaptive capacity and potentiality. Here, vulnerability is an overarching conceptual framework, a focal point of analysis.

Finally, vulnerability can be used as a starting point for impact analysis. This comes from a focus on the social dimension of vulnerability, where the biophysical component (exposure) is left outside this framework. Sensitivity and adaptive capacity of people are assessed and vulnerability is a starting point of impact analysis (Kelly and Adger, 2000: 327).

Janssen et al. (2006) in a bibliometrics analysis of the knowledge domains of vulnerability, resilience and adaption, propose that concepts surrounding resilience have developed within a different knowledge domain than vulnerability and adaptation. However, since 1995 there has been a marked increase in cross citation between the fields and a trend of increasing overlap between the domains. This, combined with a major increase in the number of published papers on all three fields, suggest that an integration of the different knowledge clusters into an overarching knowledge domain is imminent (Janssen et al. 2006: 250).

2.4.4 Rendering the World Unsafe: Critique of Vulnerability in Theory and Practice

The rise of the term vulnerability and its use in vulnerability assessments is accompanied by critique of the term in both theory and its use in practice. The main criticisms against vulnerability concentrate firstly on the concept itself, the discourse through which it was created and the power relations involved in this discourse; and secondly on the negative implications it can have when applied in practice in vulnerability assessments.

In the field of disaster management, Bankoff (2004: 29) acknowledges that the concept of vulnerability does provide a radical critique of prevailing technocratic approaches and allows experts to look at what renders communities unsafe, such as entitlement and empowerment over basic necessities. However, he argues that inadequate attention has been given to the historical roots of the discursive framework within which hazards, and therefore vulnerability, are presented and the influence of cultural values on how certain regions of the world are viewed and imagined (Bankoff, 2001: 20). Bankoff (2001: 28) argues that the concept of vulnerability developed within a space of western language and knowledge and is used to identify regions of the world as "vulnerable" and therefore unsafe, following a lineage of other terms that have served the interests of more powerful elites.

> 'Tropicality', 'development' and 'vulnerability' form part of one and the same essentialising and generalising cultural discourse: one that denigrates large regions of world as dangerous — disease-ridden, poverty-stricken and disaster-prone; one that depicts the inhabitants of these regions as inferior — untutored, incapable, victims; and that it reposes in Western medicine, investment and preventive systems the expertise required to remedy these ills (Bankoff, 2001: 29).

Vulnerability, by its very meaning, concentrates on the idea of societies or people as weak and passive instead of their strengths and capacities. However, Hewitt (1997: 167) argues that those who are defined as vulnerable have huge capacities and skills, yet their problems stem from the underlying social constructions in which they live as opposed to their inherent qualities.

This dominance in the discourse can therefore lead to what Stephan (2004: 99) argues is the *regionalisation* and *homogenisation* of vulnerability, where it forms part of the global process that polarises North and South in terms of ideological, economic and political tensions. This further deepens the divide between 'poor' and 'rich' countries and national interests take president over sub-national and local ones. This results in local versions of vulnerability assessments being ignored in favour of global, technological and scientific assessments, which are more influenced by national and international discourses (Stephan, 2004: 99).

Delica-Willison and Willison (2004) argue that these misconceptions can be further advanced by the use of the term itself. 'Vulnerability' is normally discussed by western experts, the 'non-vulnerable' people, who then decide who is vulnerable (ibid: 150). However, for those labelled vulnerable, or living in vulnerable areas, the term can be rather abstract and they would use other words to describe their situation, such as 'weakness', 'problems', 'constraints' but also 'risk' and 'risk avoiding strategies' (Heijmans, 2004:120; Delica-Willison and Willison, 2004:150).

While many international organisations claim that vulnerability is a greater problem for the poor, or that the poor are the most vulnerable (Heijmans, 2004: 116), this can lead to the incorrect assumption that those living in poverty are automatically vulnerable and vice versa. It is argued that poverty is determined by historical processes that deprive people of access to resources, while vulnerability is determined by historical processes that deprive people of the means of coping with hazards and change (Bankoff, 2004: 25).

On a practical level, the parameters for vulnerability assessments are often also defined by foreign experts and not by the vulnerable people or communities themselves. However, vulnerability is often viewed very differently by the experts and those affected and Delica-Willson and Willson (2004: 145) argue that the factors that lead a community to feel vulnerable are different from what an outside observer might expect. This non-consideration of the views of the poor has led to interventions that increase the vulnerability of the target groups (ibid).

An example given by Delica-Willson and Willson (2004: 154) is a population in Delhi, India, which has built its homes along the bank of a river levee but is often threatened by rising flood waters, which force inhabitants to evacuate or even lose their houses. A team working for the Indian government defined the group as ‘highly vulnerable’ and identified a ‘less vulnerable’ location for the people to move to where they would be given land for free. However, when they informed the community of the opportunity, they had no intention of moving to the land that the experts considered less vulnerable and more valuable. Many had lived in the area for over 20 years, worked nearby, had children who went to a local school and had a social network of neighbours and friends. The greatest threats they perceived were not the flood waters but the threat of being evicted and losing their livelihood. It was this fear that made them feel vulnerable, not the fear of floods.

A non-consideration of the views of vulnerable groups can result in actions that increase their vulnerability and Heijmans (2004: 120) states that this is why when conducting vulnerability assessments (VA) individual perception is key. Using outside criteria, two households with similar economic circumstances may be labelled equally vulnerable but might perceive risk differently and therefore take different risk-avoiding strategies that ultimately affect how vulnerable they are (ibid). Therefore, vulnerability reduction must be carried out by the vulnerable people themselves and greater attention should be paid to non-western knowledge and local practices (Bankoff, 2001:28; Delica-Willison and Willison, 2004:155). While VAs have contributed to a reorientation to focus on proactive strategies, especially in the field of disaster management, they have often concentrated on the who and where of vulnerability, and Delica-Willison and Willison (2004: 155) argue that in future more attention should be given to why people are in this condition, such as limited access to income earning opportunities, credit, education, health services and markets.

Finally, as shown in this chapter, vulnerability has a variety of definitions and frameworks dependent on what field and by what actor it is being used. This can hinder the transfer of vulnerability from theory into practice, yet allows for the complex realities of vulnerable populations around the world to be considered (Frerks and Bender, 2004:196). These complex situations should be kept in mind when conducting vulnerability assessments as knowledge based interventions can simplify complex situations and strengthen existing homogenising assumptions about the culture, history and capacity of the populations involved in the study (Frerks and Bender, 2004:201-202).

It is clear, therefore, that no one fixed definition for vulnerability exists and it is referred to differently in theory and practice depending on the actors involved. The history of the concept's development and present day application can be criticised for a number of reasons, such as the lack of participation by those who are being assessed, its ability to homogenise whole areas as vulnerable and its focus on weaknesses instead of strengths. However, these criticisms do not render the term useless as participatory strategies are being developed and its theoretical framework along with its practical application continue to be enhanced by further research.

2.5 Vulnerability Defined in this Study

This review of the literature has shown the different definitions, contexts and language that is used to describe vulnerability and the complex nature of the term. Within the framework of this study, the definition of vulnerability is based on the most recent IPCC report, AR5, which focuses on the components of sensitivity and adaptive capacity. Vulnerability is taken as the focal point of analysis and the study seeks to advance the concept of *inherent* vulnerability in practice by using it as a framework for an assessment of rice cultivation of farming households in the Eastern Ghats of India. This study incorporates the concept of farms as systems embedded in social and environmental spheres, which are therefore influenced by a variety of factors. Therefore, using inherent vulnerability is appropriate due to the variety of social and environmental challenges farming systems can experience at one time, as previously discussed, and does not value certain challenges or risks above others.

Given the extensive literature regarding farm size and productivity, this study seeks to explore if patterns also exist between farm size and vulnerability, and if so what are the influencing factors causes these differences. Acknowledging the critical literature regarding perspective, this study understands vulnerability to be subjective and a 'lived reality'. It therefore applies participatory methods, with the households being assessed providing weights and influencing which indicators are selected. This study seeks to further explore this issue by completing a second vulnerability assessment using the opinions of local experts, allowing for comparison between these two groups.

Using this theoretical framework, the issues stated above shall be explored on the basis of the following three research question:

- Do practices and productivity differ between farmer sub-groups based on land size and type?
- What is the inherent vulnerability of different farmer sub-groups in the study area and how do farming practices contribute to this?
- How is vulnerability perceived by these farmer sub-groups and local experts?

3 Methodological Approach

3.1 Data Collection

The empirical data for this study was collected during three field visits to the study area, each lasting from ten days to five weeks, between April and August 2015. The field work consisted of one structured questionnaire carried out with rice farmers in the study area, focus groups, expert interviews and field walks.

An eight step approach adapted from Schröter et al. (2005) was followed for the data collection for the household vulnerability assessment. Firstly, the study area was defined and then information was collected during initial field visits by conducting semi-structured interviews with farmers and experts from local agricultural organisations and NGOs. This was supplemented by extensive literature-based research. This allowed farmer subgroups to be identified based on land type and farm size.

Due to the latent nature of vulnerability, an indicator-based method was used to assess household vulnerability in this study. Indicators are parameters which provide information about specific states or conditions that are not directly measureable (Meyer, 2011 in GIZ, 2014). The unit or system of analysis in this study is the social-environmental farming system of rice cultivation. To evaluate the vulnerability of this farming systems of the sub-groups identified, five dimensions were determined as influencing household paddy cultivation based on the initial data collection phase, namely: cultivation practice and productivity; household income and assets; access to inputs and labour; access to information; and access to services and infrastructure. A total of 19 indicators were then selected to be used to analyse these factors, based on results of preliminary interviews and literature research.

Indicator selection was based on the following criteria: valid and relevant to the factor being assessed; reliable and credible to allow data acquisition in the future; a precise meaning of what the indicator is measuring; clear in its direction to vulnerability so that an increased value has an unambiguously positive for negative relation to vulnerability; the data is accessible; and it is appropriate for the temporal and spatial resolution of the assessment being conducted (GIZ, 2014: 78). These indicators covered the elements of inherent vulnerability; political, social, economic and environmental factors, as stated by Allen (2003: 173) and shown in Figure 3, as well as belonging to one of the elements of vulnerability, namely sensitivity and adaptive capacity. Furthermore, indicators were chosen that were applicable to all households in the sample to allow for comparison. The data gathered for these indicators formed the basis of the vulnerability assessment. A detailed list of the indicators and their justification is shown in Table 1.

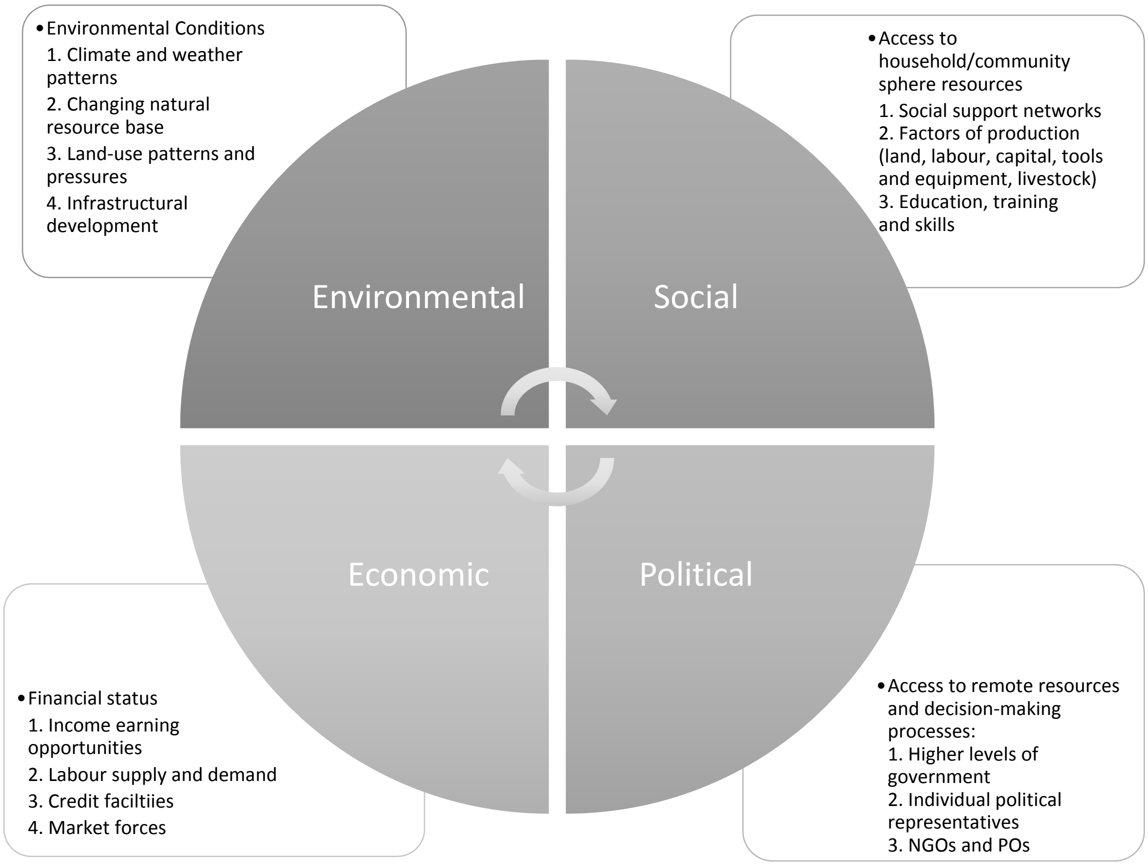


Figure 3. Four elements of inherent vulnerability (Allan, 2003: 173).

The data for these indicators were collected using a structured questionnaire on farming practices. A total of 95 farming households were surveyed in twelve villages across three study sites. A stratified random sampling technique was used to select participants of the household survey. The sample was stratified by area under cultivation and land type for rice cultivation. As explained previously, different definitions of farm size classifications exist globally.

Dimensions	Indicator	Measurable	Relationship to vulnerability	Rationale / Justification
Cultivation Practice and Productivity	Paddy Yield	Yield (kg)/acre (3 year average)	↓	Shows the productivity of the farmer's cultivation practices.
	Crop loss in paddy	Percentage of total crop lost (3 yr average)	↑	Reduces yield, reducing return on investment and income for HH.
	Meeting HH rice subsistence needs	Amount of rice bought (kg) in year (3 yr average)	↑	Rice is a main crop in family household diet and indicates whether basic subsistence needs being met from cultivation.
	Diversity of rice varieties	Number of rice varieties grown in past 3 years	↓	Shows ability to change to different rice varieties when necessary and better for biodiversity of region, potentially reducing pests.
	Irrigated area under paddy	Percentage of paddy land irrigated	↓	Irrigated plots can be cultivated year-round increasing productivity and are less vulnerable to erratic rainfall patterns.
Household Income and Assets	Total area under paddy	acres	↓	Smaller plots can limit the total yield gained from cultivation.
	Land ownership	Percentage of paddy land being cultivated that is owned	↓	Greater security for household if land being cultivated is owned solely by the farmer and not leased or unofficially cultivated.
	Income diversity	Percentage of household income gained from sources other than paddy crop	↓	Reduces the dependency of the household on one agricultural crop.
	Skilled labourers in household	Number of household members	↓	Skilled labourers have the potential to earn more money and are less susceptible to labour market fluctuations.
Access to Inputs and Labour	Fertiliser use	Average use for past 3 years (kg/ac)	↓	Sufficient use of fertiliser improves rice crop yields.
	Manure application	Average use for past 3 years (kg/ac)	↓	Organic inputs are essential for healthy crop production.
	Availability of household labour	Number of HH members working on paddy plots	↓	Influences productivity of plots, especially during peak times, and the farmers ability to deal with change.
	Cost of Labour and Equipment Hire	3 year average labour and equipment (cost per acre)	↑	Higher labour costs show higher dependency and greater vulnerability to labour shortages.
Access to information	Number of information sources in household	Number out of 5 (internet, newspaper, radio, TV, mobile phone)	↓	Farmers can gain access to agricultural information important for cultivation from newspapers, television, internet or mobile phones.
	Contact with NGO and government institutions	Have you received any agricultural training from an institution (yes / no)	↓	NGOs and government organisations can provide useful agricultural information and training.
	Literacy of household	% of household who can literate	↓	Household literacy allows farmers greater access to agricultural information.
Access to Services and Infrastructure	Access to loans	Does household have access to loans (yes/no)	↓	Allows farmers to invest in agricultural production.
	Access to markets	Time taken to reach nearest market in minutes	↑	This allows farmers to sell produce, if excess available, and increase income or gain access to agricultural inputs.
	Electrification	Household connected to electricity (yes/no)	↓	Can be used for pumping water for irrigation, other mechanisation and increases adaptive capacity.

Table 1. Indicators used for inherent vulnerability assessment. *S = Sensitivity , **AC = Adaptive Capacity

The International Fund for Agricultural Development (IFAD) defines small-scale farmers as those cultivating two hectares or less of land and this definition encompasses 85 percent of the world's farms (Båge, 2008). Murphy (2010: 3) argues that in any rural context there exists smaller and larger farms and this definition differs at local and national contexts. At a national level, India uses the following division of land holdings: marginal (below 1 ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-10 ha), large (10ha and above). According to the Agricultural Census Division of India (2011), in the state of Andhra Pradesh only 0.27 percent of land holdings fall into the large farmer category, while 86.09% fall into the marginal and small categories. This is similar for Odisha, in which one of the study sites is located, with 0.12 percent and 91.85 percent respectively (Agricultural Census Division India, 2011). Therefore, definitions at state-level can differ, with a 10 acre (4.05ha) farm being considered large in Kerala but in other states considered small or medium (Husain, 2008). Local agricultural offices and agricultural NGOs in the study area therefore used the categories of small and marginal farmers: 0 – 2.5 acres (0 – 1.01 ha), medium farmers: 2 – 10 acres (1.01ha - 4.05ha) and large farmers: 10 acres and above (>4.05 ha) and these are the classifications for the sub-groups that will be used in this study. As acres (1 acre = 0.4ha, 1ha = 2.47 acre) were used by local farmers this unit of measurement is used throughout this study when referring to survey data and the analysis of results. The fieldwork was conducted in three study sites. The sub-groups were split into wetland and dryland paddy farmers in the two study sites of Paderu and Semiliguda, where wetland and dryland farming was present, to ensure both types of farming were included. In the third study site of Addateegla only dryland farming was practiced. 17 large farmers, 27 medium farmers and 51 small and marginal farming households were surveyed in total. This sampling strategy reflected the proportion of farms by land size in the study area. Based on data available this was calculated to be small and marginal farmers (50%), medium farmers (40%) and large farmers (10%) (Agricultural Census Division India, 2011). The sample size selection for this study is shown in Table 2.

Farmer Group / Study Site	Large-Scale Farmer		Medium-Scale Farmer		Small-Scale Farmer		Total
	Wetland	Dryland	Wetland	Dryland	Wetland	Dryland	
Paderu	6	2	6	7	13	8	42
Semiliguda	3	2	6	4	12	9	36
Addateegla	0	4	0	4	0	9	17
Total	9	9	12	15	25	26	95

Table 2 Sample size and selection of farmers.

Weights for the indicators of the vulnerability index were later collected, both from farmers and local experts, using Participatory Rural Appraisal (PRA) and Budget Allocation Process (BAP), following guidelines from the OECD (2008: 96). One information sheet for each of the 5 factors was created showing pictures that represented the individual indicators and annotated in the local language. Participants were given tokens that they could allocate to the different pictures / indicators depending on how important they judged the variable in contributing to vulnerability of their rice cultivation. A total of nine focus groups were conducted with farmers across the study area, one per size subgroup in each of the three study sites. The size of the focus groups varied from three to nine participants with a gender balance of 45 percent women, 55 percent men. Farmers weighted the indicators for their size group and experts weighted the indicators based on their knowledge of all farmers in the respective study area.

The weights applied to indicators in vulnerability assessments have a significant influence on the results of the calculations. While a variety of weighting techniques exist, all are based to certain extent on value judgements and can therefore be seen as subjective (GIZ, 2004: 126). The farmers themselves were chosen to weigh the indicators for their sub-groups as the study recognises their agency as capable actors and the value of their contributions based on local knowledge and experience, both important regarding the local level focus on the studies (Allen, 2003: 175). These focus groups also provided an opportunity to gain further qualitative data on farmers' perspectives on the vulnerability of their cultivation practices.

This method of collecting weights was then repeated with 4 experts from local NGOs and government agricultural organizations to allow any differences in perspectives between the experts and the farmers to be identified for later analysis. Semi-structured interviews were also conducted with these experts to gain information on how institutions support rice farmers in the study area.

3.2 Data Analysis

The data from the questionnaires were then collated into a database and the data for each indicator were normalized between 0 and 1 using the Min-Max method based on its functional relationship to vulnerability. Normalization is required before any aggregation can take place as the indicator data was in different units. All the indicators have either a positive or negative functional relations with vulnerability. A positive relationship to vulnerability means the higher the value of the indicator, for example, crop loss, the greater the vulnerability. These indicators were normalized using Equation 1. Those indicators with a negative functional relationship, for example, household literacy, were normalized using Equation 2.

$$\chi_{i,0\ to\ 1} = \frac{\chi_i - \chi_{Min}}{\chi_{Max} - \chi_{Min}}$$

Equation 1. Min-Max formula used for normalising metric data with a positive functional relationship to vulnerability.

$$\chi_{i,0\ to\ 1} = \frac{\chi_{Max} - \chi_i}{\chi_{Max} - \chi_{Min}}$$

Equation 2. Min-Max formula used for normalising metric data with a negative functional relationship to vulnerability.

Where: X_i represents the individual data point to be transformed, X_{Min} the lowest value for that indicator, X_{Max}, the highest value for that indicator, and $X_{i,\ 0\ to\ 1}$ the normalized data point within the range of 0 to 1.

An average of the weights given in the focus groups for each farmer subgroup and for all expert weights was taken for each indicator. Each normalised indicator value was multiplied by its respective weight and then the appropriate indicator values were aggregated using Equation 3 to provide a total aggregated score for each of the five factors as well as a sensitivity score, an adaptive capacity score and a total aggregated vulnerability score for each farmer.

$$CI = \frac{I_1 \times w_1 + I_2 \times w_2 + \ldots I_n \times w_n}{\Sigma_n^1 w}$$

Equation 3. Weighted arithmetic aggregation of individual indicator values

Where: *CI* is the composite indicator, *I* is the normalised indicator value and *W* is the weight assigned to that indicator.

These individual scores could then be further aggregated using the same process to create scores for the farmer subgroups based on size and land type (small, medium and large and dryland and wetland). This process was then completed again for all categories using the weights given during the expert interviews. These calculations produced vulnerability scores for each of the farmer sub-groups that could be compared to analyse how vulnerability differed between the groups. Furthermore, individual indicator values could be assessed to identify the 'drivers' of the vulnerability score; the factors which had a little or a great influence on the score could be identified and finally the weighted values from the differed groups could be used to compare different perceptions of vulnerability within the sample groups.

A Social-Environmental Vulnerability Index (SEVI) could be synthesised as a composite of all vulnerability indicators. The value of the SEVI is a dimensionless score between 0 and 1 and provides a quantitative perception on the status of inherent vulnerability within the farming systems studied (Sharma, 2015: 577). Due to the dimensionless nature of the SEVI values, they have no significance in themselves, however, the value of the composite index and its component indicator values can be interpreted and used as a basis for further analysis.

3.3 Methodological Challenges

Overall, the methodology applied in the study was appropriate to investigate the research questions of this study. However, several issues arose during the fieldwork and analysis stages for this study.

Firstly, as part of the questionnaire to gain data for the SEVI, quantitative answers from respondents were required regarding land size, yield, and costs and quantity of inputs. In some cases, it was difficult for respondents to give exact values or quantities regarding these questions. The researcher endeavoured to reduce inconsistencies by using local measurement units, such as bags of grain for yield, head loads or cart loads of manure for input that were then converted to metric values. Where possible, land size was corroborated with records from local NGOs that had completed surveys with interview respondents.

Secondly, regarding the indicators selected as part of the SEVI, certain improvements could be made based on critical evaluation post-analysis. The indicator measuring access to electricity was given a low weighting by all sub-groups and proved to have less than 1 percent influence on vulnerability in all cases. This was due to low levels of agricultural mechanisation in the study area and no farmers were reliant on electricity for their agricultural activities, such as for powering pumps for irrigation.

During the final fieldwork stages it became clear that social relations within the community had a great influence on vulnerability of the rice farming systems. While this was partly covered by labour costs, as farmers that participated in labour sharing at a community level had lower or no labour costs for their harvest, it could prove interesting to include social cohesion or community support related indicators in the assessment. In the original version of the vulnerability assessment framework of this study, pesticide use was included as an indicator of vulnerability. The majority of farmers were found to have used chemical pesticide at some point in the last three years and the most common pesticide applied was Endosulfan. Many studies have shown that Endosulfan can have severe negative impacts on both human health and the environment (Abhilash and Singh, 2009), and a global phase-out by 2012 was agreed under the Stockholm Convention in 2011 (Hogue, 2011). Certain exceptions were made however, and the chemical will continue to be produced and widely available in India until 2017. It was therefore not possible to determine a clear functional relationship with pesticide use and vulnerability as first expected and this indicator was removed from the vulnerability assessment. The weights that had been applied to these indicators were then removed and equally divided among the other indicators in the category.

Finally, the total sample size for both the vulnerability index and the focus groups for collecting weights is a key limitation of the study. A total of 95 respondents provided data for the questionnaire. The number of respondents was also limited due to the local infrastructure and mountainous geography of much of the study area, which was compounded by time restraints that are associated with a study conducted as part of the fulfilment of a Master's Degree. To increase the statistical robustness of the analysis, more questionnaire responses should be collected.

4 Study Area: The Eastern Ghats of Andhra Pradesh and Odisha

The area chosen for the study lies towards the eastern coast of India in the Eastern Ghats mountains. The Eastern Ghats covers an expansive area of India's Eastern coast and for this study 12 villages were selected that are located within a 10km radius of one of the three small towns of Paderu, Semiliguda and Addateegla, which are referred to as the three research sites in this study. The three sites are situated in the sub-districts of Addateegla, Paderu and Hukumpeta, and Semiliguda. Sub-districts are interchangeably referred to as *mandals, taluks, tehsils* or *blocks,* depending on the state. The three research sites fall within the three adjoining districts of East Godavari (Addateegla), Visakhapatnam (Paderu) and Koraput (Semiliguda) in the two states of Andhra Pradesh and Odisha. A list of villages included in the study can be seen in Table 3.

India is a heterogeneity of landforms and climatic conditions that greatly influence the land use and agriculture of different regions of the country. The country is divided into 20 agro-ecological zones (AEZ) and 60 agro-ecological sub-regions (AESR) based on soil, physiography, length of growing period and bioclimate, which provide an overview of the different environmental and meteorological conditions of different areas (Gajbhiye and Mandal, 2000: 4). All three study sites fall within AEZ 12, the Eastern Ghats hot sub-humid eco-region. The sites of Semiliguda and Addateegla belong to AESR 12.1 and Paderu to AESR 12.2. Both AESRs have a hot, moist, sub-humid climate, loamy red and lateritic soils and a growing period of 180 to 210 days a year (Gajbhiye and Mandal, 2000: 4). The country is also further divided into 15 agro-climatic zones.

The study area falls into ACZ 7, with mean monthly temperatures in July between 25-35 degrees and January between 15 and 25 degrees and a mean annual rainfall of 750mm to 1500mm. The agriculture in the region in mainly rain-fed and the main crops grown are rice, maize, millets and grams (Husain, 2008). The elevation of the study area varies from around 180m in the low land areas around Addateegla to around 1400m in the hill regions of Paderu and Semiliguda.

Within the study area the greatest ethnic group is scheduled tribes, who represent an average of 73.3 percent of the population across the 4 sub-districts (Indian census, 2011). This is significantly more than at the national level, as according to the Indian Census (2011) 8.6 percent of the total population in India belong to scheduled tribes. This includes 705 ethnic groups that are registered as scheduled tribes under the schedules castes and tribes (prevention of Atrocities) act 1989 by the Indian government (Ministry of Tribal Affairs, 2013).

Village	Sub-district	District	State
Bilaiguda	Semiliguda	Koraput	Odisha
Jhaliaguda	Semiliguda	Koraput	Odisha
Kandamguda	Semiliguda	Koraput	Odisha
Kondhpungar	Semiliguda	Koraput	Odisha
Parjapungar	Semiliguda	Koraput	Odisha
Kondamamidi	Paderu	Visakhapatnam	Andhra Pradesh
Kothapalle	Paderu	Visakhapatnam	Andhra Pradesh
Mottojoru	Hukumpeta	Vishakhapatnam	Andhra Pradesh
Nakkalaputtu	Hukumpeta	Vishakhapatnam	Andhra Pradesh
Rangapalle	Hukumpeta	Vishakhapatnam	Andhra Pradesh
Sannayasammapalem	Hukumpeta	Vishakhapatnam	Andhra Pradesh
Tungamadugula	Addateegla	East Godavari	Andhra Pradesh

Table 3 Sample villages included in the study.

This act was put in place to counteract the discrimination suffered by certain castes and tribal groups in Indian society and to increase their legal protection, create preferential quotes for their inclusion in public services, representational bodies and educational institutions and allow for greater contribution to development through the targeting of resources and distribution of benefits (National Human Rights Commission, 2002). As of 2005, 47.3 percent of the population of

Scheduled Tribes live below the national poverty line, compared to 28.3 percent of the general population in India, showing that inequality still exists between social groups (Perspective Planning Division, 2005).

The state of Odisha is one of poorest in India with 32.59 percent of the population living below the national poverty line, according to figures from 2011-2012 (Perspective Planning Division, 2016). Andhra Pradesh fares better with 9.20 percent, which lies significantly higher than the national average (ibid). The Human Development Index shows a similar picture with Odisha lying below the national average with 0.362 compared to Andhra Pradesh at 0.473, which sits above the national average of 0.467 (Government of India, 2011). Rice is the major crop of both Odisha and Andhra Pradesh and the staple food of almost the entire population of both states, which means its production and productivity is vital to the economy (Das, 2012: 1; Cheralu, 2011: 2). Rice farming, similar to the majority of agricultural cultivation in the study area, focuses around two growing seasons, namely *kharif* and *rabi. Kharif*, the growing season that relies on the monsoon rains, usually begins around May and can last until the harvest period in December or January.

The second growing period, *rabi,* usually lasts from January until May. *Kharif* is the main growing season for paddy and it can be grown on both wetland and rainfed land while *rabi* can only be grown on wetland or land with an irrigation source. The different cultivation patterns in the study area are summarised in Boxes 1 to 3 based on data collected from 193 farmers across three sub-districts within the study area as part of a study by Esteeves and Patterson (2015). The cultivation period is dependent on the variety of rice with some traditional varieties requiring more time than HYV. According to the 2010-2011 Agricultural Census of India, around 60 percent of rice in the country is irrigated (Agricultural Census Division India, 2011). This is compares to around 34 percent irrigated and 66 percent unirrigated within the study area[1] (ibid).

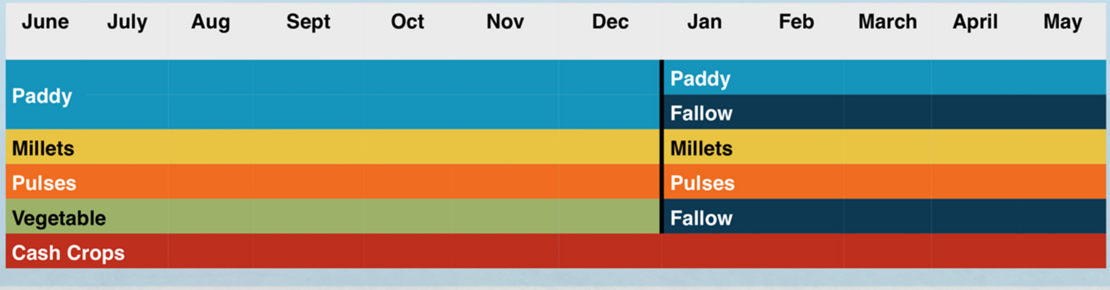
Rice can be grown in a variety of ecosystems and climatic conditions. Within the study area, rice cultivation can be classified into irrigated ecosystems with bunded upland, medium land and lowland grown in both *kharif* and *rabi*, and rainfed ecosystems with upland, medium land, and low land with shallow, semi-deep and deep water (Das, 2012: 3).

[1] Based on sub-district data taken from the Agricultural Census 2010-2011 for the four sub-districts in the study area.

Box 1. Cropping patterns and land use in Paderu sub-district

Crops Cultivated and Cropping Calendar

Cereals	Pulses	Cash Crops	Vegetables
Paddy, Millets, Maize	Kidney Bean, Horse Gram, Red Gram	Oilseed, Sugarcane, Coffee, Ginger, Turmeric, Pepper, Broomstick	Eggplant, Carrot, Tomato, Pumpkin

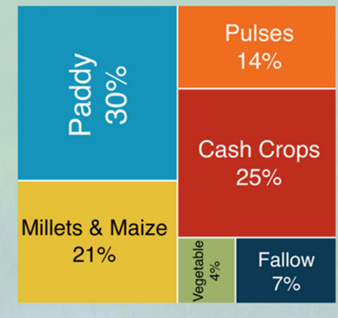


Rice is grown by almost all farmers in *kharif* in Paderu. The majority of these are traditional tall varieties, which changes to short high-yielding varieties in *rabi*. Wetland plots can be cultivated with paddy again in the *rabi* season while dryland paddy is left fallow or cultivated with horse gram.

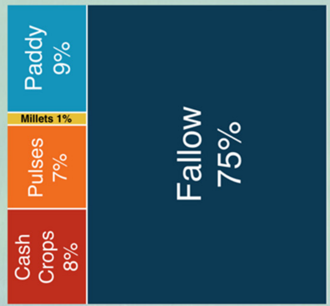
96%
Farmers growing paddy in Kharif

54%
Farmers growing paddy in Rabi

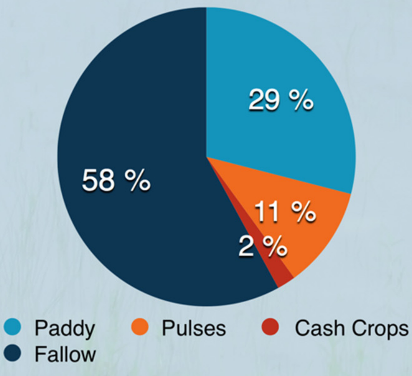
Area under Crop Type in Kharif (%)



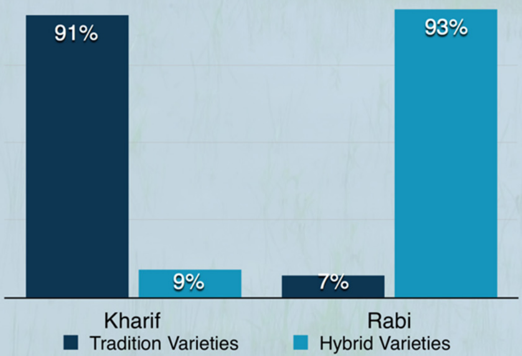
Area under Crop Type in Rabi (%)



Crops Grown on Paddy Plots in Rabi



Rice Varieties Grown in Kharif and Rabi

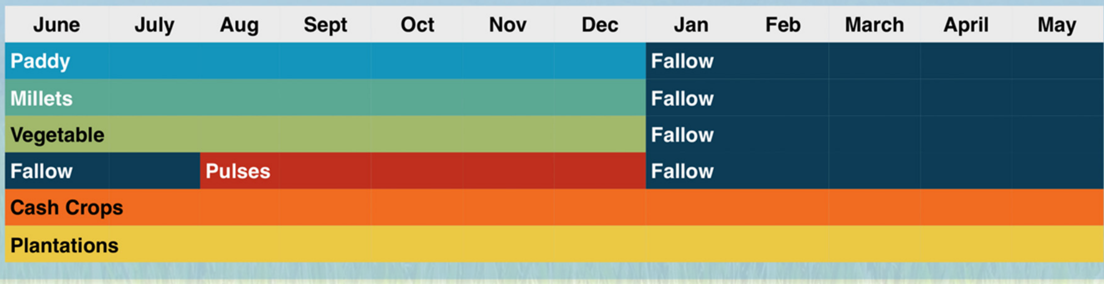


Data source: Esteeves and Patterson (2015); Design: author

Box 2. Cropping patterns and land use in Addateegla sub-district

Crops Cultivated and Cropping Calendar

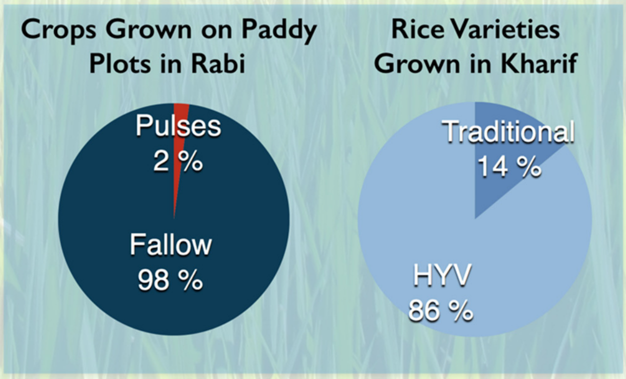
Cereals	Pulses	Cash Crops	Vegetables	Plantation
Paddy, Millets, Maize	Black Gram, Horse Gram, Cow Pea, Red Gram, Kidney Bean	Cotton, Oilseed, Tobacco, Tapioca	Eggplant	Casuarina, Cashew, Mango, Palm Oil

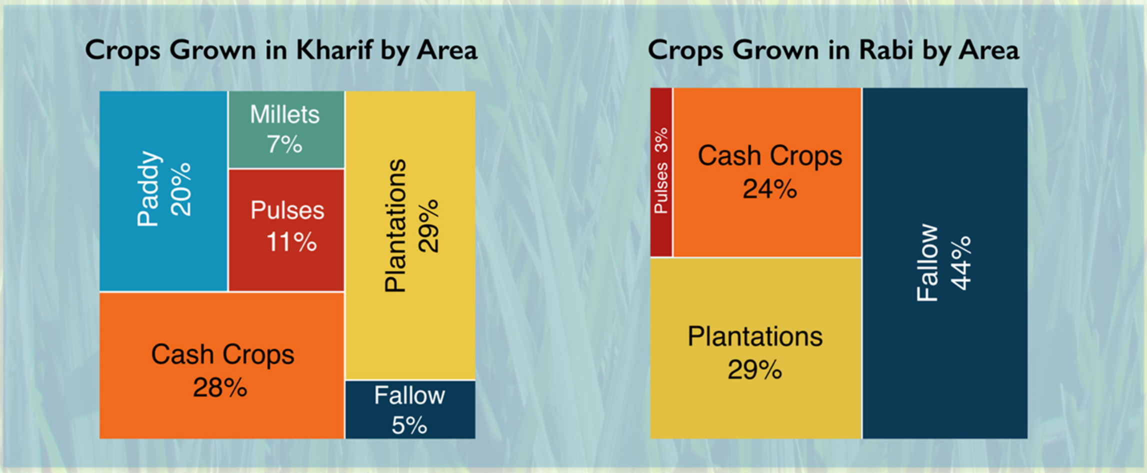


The crop calendar shows the different crops grown by farmers in the study site throughout the year. Paddy is grown in a nursery then transplanted into the main field when it is around 30 days old. Paddy is the most common crop cultivated by farmers, however cash crops cover more farm area. The region is in the low lands of the Ghats mountains and rice is grown on rainfed lands. Therefore it is only grown in the *kharif* season and 98% of the paddy fields are left fallow in *rabi.*

68%

Farmers growing paddy in Kharif



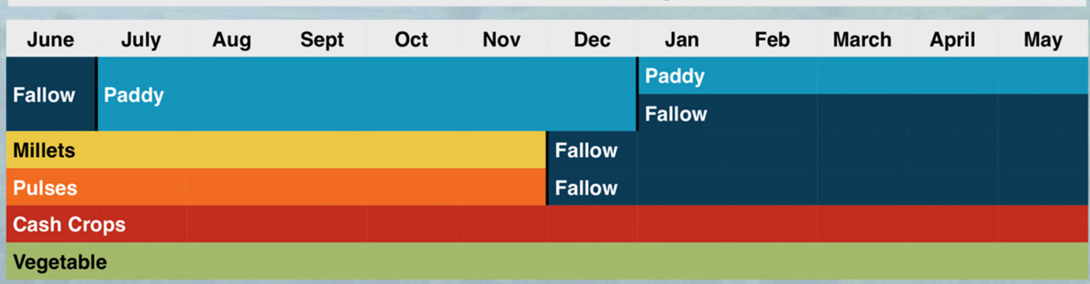


Data Source: Esteeves and Patterson (2015); Design: Author

Box 3. Cropping patterns and land use in Semiliguda sub-district

Crops Cultivated and Cropping Calendar

Cereals	Pulses	Cash Crops	Vegetables
Paddy, Sorghum, Little MIllet, Finger Millet, Pearl Millet, Foxtail Millet	Flat Beans, French Beans, Black Gram, Cow Pea, Pigeon Pea, Horse Gram, Green Gram	Sesame, Flax / Linseed, Jute, Turmeric, Ginger, Groundnut, Niger	Cabbage, Carrot, Pumpkin, Sweet Potato, Cucumber, Tomato, Coriander, Potato, Chilli, Gourd, Cauliflower

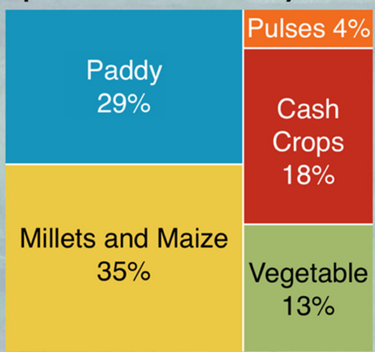


The cropping patterns in Semliguda are diverse with extensive use of intercropping. Paddy is grown on both drylands known as *saria* and terraced wetlands with a perennial streams known as *beda* plots. *Beda* plots are often small in size but can be cultivated in the *rabi* season whereas *saria* plots are rainfed and left fallow. In *kharif*, traditional rice varieties with a medium (130-150 days) to long cultivation period (170-210) days are grown. High yielding varieties with a short duration are grown in lowland areas.

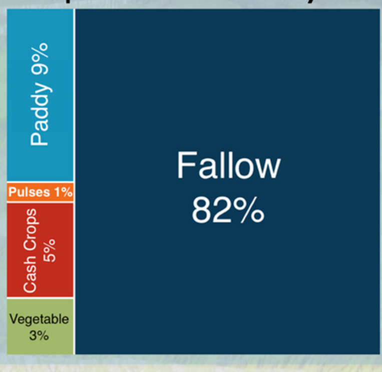
98%
Farmers growing paddy in Kharif

52%
Farmers growing paddy in Rabi

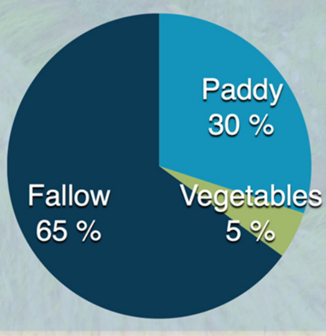
Crops Grown in Kharif by Area



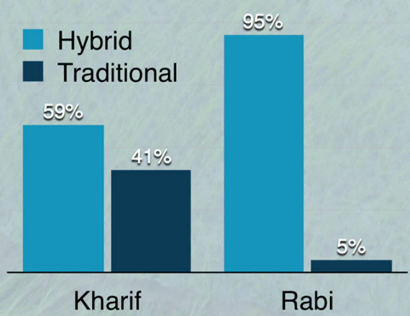
Crops Grown in Rabi by Area



Crops Grown on Paddy Plots in Rabi



Rice Varieties in Kharif and Rabi



Data Source: Esteeves and Patterson (2015); Design: Author

The variety of rice cultivated is usually dependent on the ecosystem as well as the preference of the farmer. The factors that can reduce yields are also different between wetland and dryland paddy. Yields from irrigated land are particularly affected by cyclones, flooding, weeds, submergence of the crop at key stages, and pests. Rainfed paddy is particularly sensitive to drought, delayed rains at the beginning of the season and intermittent dry spells during cultivation. Throughout the study area, seedlings are grown first in nurseries and are then transplanted into main fields after 20 to 40 days. However, if the first rains are delayed this can lead to seedlings being transplanted later in dryland plots and this in turn reduces yields. The different land types can be seen in Box 4.

4.2 Green Revolution in India and its Impacts on Rice Cultivation

The advances in plant breading, improved agronomy and the development of inorganic fertiliser and pesticides led most industrial countries to sustained food surpluses by the second half of the 20th century. However, these innovations were slow in reaching developing countries. Hazell (2010: 67) explains that while the colonial government in India had concentrated on improving the cultivation of tropical export crops, they invested little in local food production systems. This neglect, combined with a rapidly increasing population, led to widespread hunger and malnutrition and a growing dependence on food aid, not only in India but across Asia and Africa in the 1960s. In India this was further exacerbated by several droughts in the mid 1960s. During the 1950s, a concentrated effort was made by scientists to develop HYV or modern varieties (MV) of crops for developing countries due to a fear that certain crops, including rice, had reached their cultivation frontier and these countries would soon suffer from massive famine and starvation (Estudillo and Otsuka, 2013: 17). For the decade prior to 1965, growth in rice production in south Asia had been fuelled by an expansion of the area under cultivation, an expansion that was thought to have reached its limits at the time (ibid).

This changed in 1966 when the International Rice Research institute (IRRI) introduced IR8, the first HYV of rice to the Asian market, which had certain notable qualities such as being short-statured, stiff-strawed, fertiliser responsive and non-photoperiod sensitive, features that all help to support greater yields (Estudillo and Otsuka, 2013: 18) These MVs were further improved to incorporate certain features such as short growth duration, multiple disease and insect resistance, superior grain quality and increased tolerance for poor quality soils. The use of these seeds, along with other modern agricultural practices such as chemical fertiliser, irrigation facilities and improved farm implements came to be known as the Green Revolution (Singh, 2000: 97). In India prior to this time, an increase in crop production was usually attained through an expansion of the cultivation area. However, through the intensification of production caused by the introduction of these new technologies, food grain yields increased to a point that India became self-sufficient (ibid).

Box 4. Land types found in the study area (source: author).

Upland wetland paddy plots near Paderu. Plots contain newly transplanted *kharif* crop and nursery is still visible in two plots

Midland wetland paddy plots near Semiliguda with *rabi* crop being harvested

Lowland wetland paddy plots near Semiliguda.

Midland dryland plot and nursery near Semiliguda

The global Green Revolution is known to have been driven by advancements in technology such as irrigation, improved seeds, fertilisers and pesticides that together dramatically increased crop production. However, this revolution was greatly supported in India at a policy level, for example, by subsidising fertiliser, power and water since the 1960s to help sustain the increasing crop cultivation (Hazell 2010: 72). The Government of India made agricultural development a main focus after independence. Prime Minister Nehru invested 30 percent of the government's budget on agriculture and irrigation, which led to great improvements in rural infrastructure, agricultural research and fertiliser plants. This was accompanied by significant land reforms targeted at improving the conditions for agricultural workers. Between 1970 and 1995 the irrigated area in

India increased from 18.4 percent to 31.8 percent, while within the same period the average fertiliser use increased from 13.7 kg/ha to 81.9 kg/ha (ibid). The Indian government continues to make agriculture and paddy farming a priority and has embarked on various rice development schemes, such as the Special Rice Development Programme and the National Food Security Mission to promote hybrid rice (GRiPS, 2013: 112). Furthermore, the government began to subsidise inputs such as fertiliser, electricity, seeds and machinery as well as operating a system of domestic price support, procurement and distribution for rice (ibid).

It is argued that these factors led to an increase in cereal production in India by 47 percent in the periods 1952/1953-1964/1965 and 1967/1968 -1977/1978 and that this has left India in a much stronger position to ensure national food provision (Pinstrup-Andersen and Hazell, 1985: 5). The Green Revolution and its effects have also been attributed to a reduction in people suffering from chronic hunger, from 262 million in 1979-81 to 231 million in 2003-05, despite rapid population growth (Spielman and Pandya-Lorch, 2010: 2).

During this period there was also a dramatic shift in the cropping systems in India. While in 1965-66 the main crops by cropping area in *kharif* were *Bajra* (pearl millet) (46%), rice (12%) and sorghum / jowar (12%) this had changed by 1995-96 to rice being the main crop (34%) other crop types reduced (Singh, 2000: 98). In the winter cropping reason of *rabi,* wheat had greatly increased within the same time period from 43 percent to 64 percent at the expense of other crops, such as chickpea (ibid). The seed varieties also changed during this time. In the state of Odisha, high-yielding varieties increased from 12.7 percent of the area under rice in *kharif* in 1976-77 to 77.0 percent by 2008-09 and HYV varieties now make up 82 percent of all rice produced in the country (Das, 2012: 10; GRiPS, 2013: 113).

Given the complex underlying causes of poverty and the diversity of livelihoods it is difficult to determine and measure how the Green Revolution has impacted on poverty in India. However, Hazell (2010: 77) presents several ways which the Green Revolution could have benefitted farmers: helping to increase their production, increasing the quantity and quality of their subsistence production, increasing their cash income through the sale of surplus products, increasing new employment opportunities and reduced food prices.

The onset of the green revolution provided a tremendous boost for the economy by bringing sharp increases in incomes, production and productivity for all classes of agriculturists. However, the boost was short-lived – with productivity declining over a period of time, income dipping due to increased costs of production but a near freeze in minimum support prices, and with large numbers rendered unemployed due to mechanisation of agricultural operations and lack of alternative employment opportunities (Gill and Singh, 2006: 2767). Near stagnation in the agricultural sector and non-descript development of the other sectors of the economy saw the beginning of a crisis which has reached unprecedented gravity, to the extent that cultivators were forced to take their own lives rather than live a life of extreme poverty, mounting debt burden and the agony of not being able to pay back the debts (ibid).

4.3 The Violence of the Green Revolution

The contributions of the Green Revolution to poverty reduction are contested, as it can be argued that policies favoured large farmers who have better access to credit, seeds, fertiliser and irrigation. Shiva (1991: 11) contends that within her case study area of Punjab, a much referenced state showcasing the advantages of the green revolution, that here the green revolution has led to ecological destruction and civil unrest due to degraded soil, increase incidence of pest and farmer debt.

Firstly, Shiva (1991: 68) argues that the gains, especially of cereals, is grossly overestimated and flawed as it compares traditional farming based on mixed-cropping patterns with mono-cropping patterns promoted during the green revolution. While she accepts that the cereal crops of rice and wheat did increase during this period, this was at the expense of other more nutritious food crops such as Bajra (pearl millet), Ragi (finger millet) and Jowar (sorghum).

Furthermore, while in indigenous farming practices, inputs such as seeds, organic fertilizer and pest control all came from the farm, the practices promoted during the green revolution tied yields to expensive external inputs such as HYV seeds, chemical fertilizer, chemical pesticides and extensive irrigation infrastructure (Shiva, 1991: 72). She therefore argues that the seeds being used are not 'high-yielding varieties' but rather 'high-responsive varieties' as yields are only achieved with these external inputs, otherwise the yields are lower than indigenous seed varieties (ibid).

In 1986 riots in Punjab left 598 people dead; in 1987 this increased to 1544 and in 1988 it reached 3000 (Shiva, 1991: 19). She places the source of the conflict not on religious tensions, which are often stated, but instead on discontent within the farming community at the state's failed agricultural policy (Shiva, 1991: 19). Within the study area of the states Andhra Pradesh and Odisha, connections have also been suggested to exist between the failure of the Green Revolution to improve the situation for small-scale farmers and the rise of armed conflict and revolt in the form of the Naxalite movement (Cleaver, 1972: 185; Banerjee, 1980: 12). The Naxalite movement began in 1967 as an armed uprising in the village of Naxalbari which quickly spread into a national Maoist political movement (Dasgupta, 1974). Landless labourers belonging to scheduled castes and tribes made up the majority of the movement, whose demands started with key land reforms and land rights and quickly developed into a wider political movement, mobilising landless labourers and tribal populations by overthrowing the government through armed revolution and replacing it with a classless and casteless society (Singh, 1995; Mukhopadhyay and Banik, 2015: 2). Banerjee (1980: 10) argues that this movement was a direct consequence of the failure of two government strategies to improve the economic situation for rural small-holders and agricultural labourers, namely: land reform and the new agricultural strategy that later came to be known as the Green Revolution. While the policies connected with the Green Revolution increased food production, it also increased land prices as new elites were attracted to buying farmland as agriculture became more profitable. This led to an increase in rents for those smallholders that leased land with some farmers having to give up 70 percent of their crop to landlords (ibid).

In a study by Cleaver (1972) into the rice growing regions of Andhra Pradesh during this period, it was found that the majority of farmers were cultivating rice on land around two to three acres. Although small doses of fertilizer led to an increase in yields, the financial gains were not significant enough to invest in land development and with increasing prices it only helped small-scale farmers stabilise their livelihoods surrounded by rising costs. However, those who rented land saw their situation deteriorate. It was in this atmosphere of deteriorating conditions for small holders, while opportunities increased for elites in society, that the flames of the Naxalite movement in the study area were fuelled.

The movement continues today and the study area falls within the ‘red corridor’, a region expanding across Andhra Pradesh, Odisha and other states in Eastern India with high tribal populations. A study by Mukhopadhyay and Banik (2015) into the development situation within the so-called red corridor includes the three districts in which the three sites of this study are situated. Mukhopadhyay and Banik (2015: 9) find that the red corridor region is substantially more impoverished based on seven indictors of access to health, education, finance and communication as well as nature of work participation, living standards (house type) and poverty head count ratio. The authors argue that the inequalities within rural communities that the Government endorsed Green Revolution and land reform sought to alleviate are still very much persistent in the region today (Mukhopadhyay and Banik, 2015: 24).

4.4 Justification of Study Area

The chosen study area in the Eastern Ghats is an appropriate location to conduct fieldwork to answer the research questions of this study for several reasons. The study area allows for the inherent vulnerability of different farmer sub-groups to be assessed and compared. A variety of farm sizes can be found in the region, allowing farmers to be split into small, medium and large farm groups. There are also different land types present, both dryland, which relies on monsoon rains, and wetland, which is supplied by perennial streams. Therefore, differences in practices and vulnerability of farmers cultivating on these land types can also be investigated.

Throughout the study area, rice is the main crop cultivated and is also the staple food in the diets of the population. It is therefore a suitable crop to select and assess the vulnerability of the social-environmental system that supports its cultivation and comparisons can be made between all the different farmers in the region. The majority of the literature on the inverse relationship has focussed on cereal production and the Agricultural Census of India provides data on cereal and rice production, allowing the results of this study to be compared at a state and national level as well as with related literature.

As this study focuses on the inherent vulnerability of agricultural production, it is important that the three study sites are all situated within the same AEZ and ACZ. As this is the case, the ecological and agricultural conditions across the study area can be considered comparable, although local conditions will vary in some respects.

There is a high tribal population in the study site and the different tribal communities are often grouped under the term scheduled tribes. This group is considered on of special importance by the Indian Government and a range of policy measures are in place to support them. While policy targeted towards this group tends to treat the different communities as a homogenous group, this study can explore differences between communities at a local level.

Furthermore, the ongoing unrest within the region has been attributed to failed agricultural policies, particularly those regarding the Green Revolution. By collecting data on the practices of farmers as part of the vulnerability study, the extent to which Green Revolution technologies have been adopted can be investigated and differences in vulnerability can be explored.

5 Empirical Results

5.1 Characteristics of the Social-Environmental System of Rice Cultivation

Interviews were conducted with a total of 95 farming households as part of this study with a combined cultivated area of 481.42 acres of which 217.64 acres (45%) is under rice cultivation. The average total land holding and area under rice cultivation for the different farmer sub-groups is shown in Table 4. Almost all rice was cultivated on land owned by the farmers themselves (96%), four farmers cultivated rice on land they had leased (total 8.5 acres), and one farmer cultivated rice on land that was neither owned nor leased.

	Large Farmers (>10 acres)	Medium farmers (2.5 - 10 acres)	Small Farmers (<2.5 acres)
Average total land holding (acres)	16.83	5.40	1.54
Average land holding cultivated with rice	5.64	2.43	0.98
Average land holding under wetland paddy (acres)	2.49	0.82	0.31
Average land holding under dryland paddy (acres)	3.89	1.69	0.66

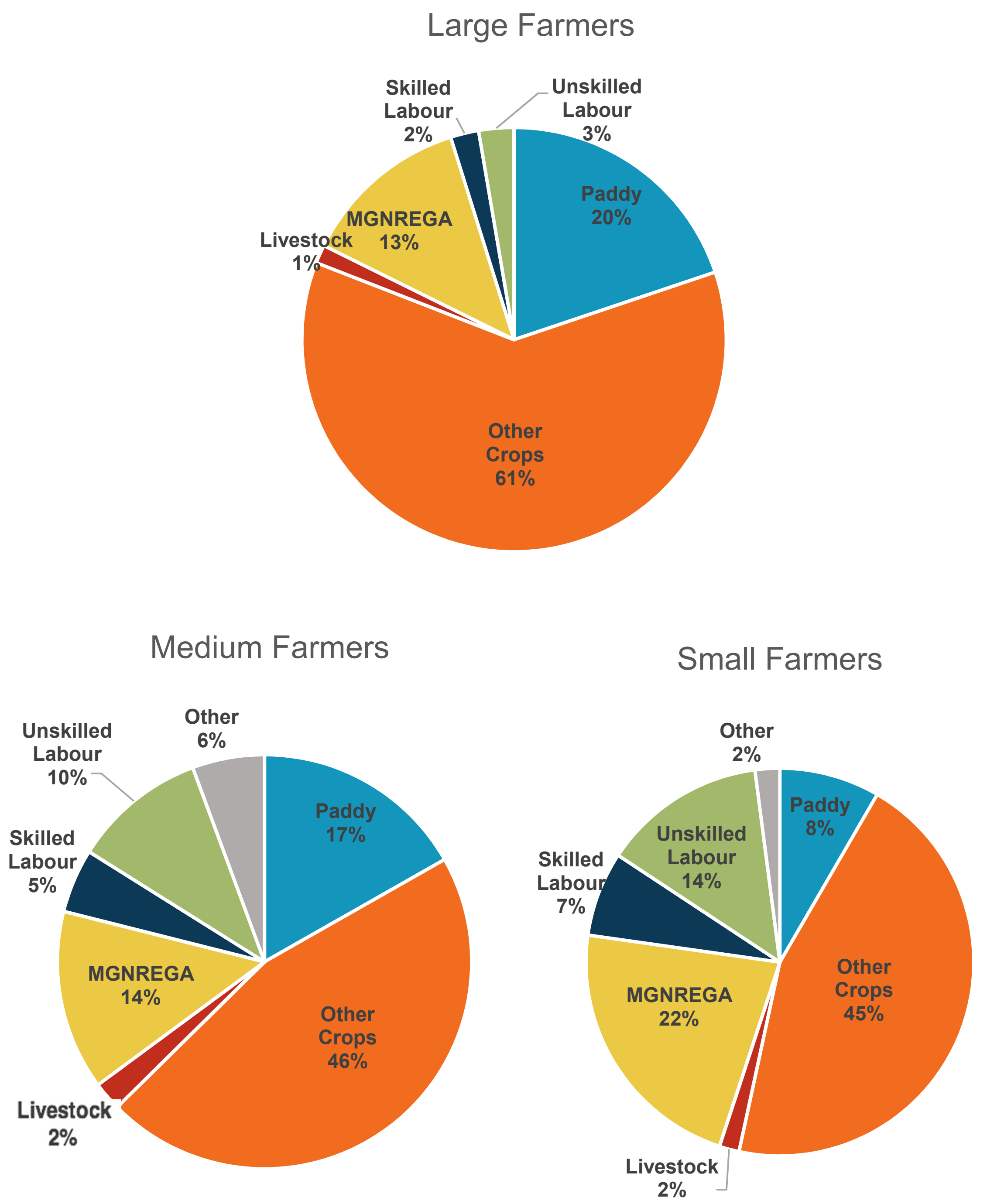
Table 4. Average land area cultivated with paddy by farmer size and land type.

5.1.1 Income Diversification

Within the sub-groups of this study, the extent to which the cultivation of rice contributed to household income differed. For large farmers, rice cultivation made up 20 percent of their total annual household income, this reduced to 17 percent for medium farmers and 8% for small-scale farmers. Income from agricultural products made up a total of 81 percent of the household income for the large-scale farming households interviewed, while this was 63 percent for medium farmers and 53 percent for small farmers. Small-scale farmers had a greater diversification of their income sources and were more reliant on unskilled labour or daily labour created through the Mahatma Gandhi National Rural Employment Guarantee Act[2] (MGNREGA). Animal husbandry and livestock contributed the least to income of households, followed by skilled labour, which was low due to lack of employment and training opportunities in the study area. None of the households interviewed reported any income gained from migrating for work or from family members who had moved away in search of work. Sources of income are shown for each sub-group in Box 5.

[2] MGNREGA is a labour law created by the Indian Government in 2005 that guarantees 100 days of wage employment in a financial year to every rural household whose adult members volunteer to do unskilled manual labour. It was launched in 200 districts in 2006 and by 2008 it was expanded to include all districts in the country (Department of Rural Development, 2008).

Box 5. Income diversification of farmers by land size sub-group.



5.1.2 Access to Information and Services

The extent to which farming households had access to different information sources and services can be seen in Table 5. The most common sources of information and communication in the study area were mobile telephone and television, with large farmers having greater access to both compared to medium and small farmers. Large farmers were also found to be slightly closer to markets in both average distance and average time taken to reach them. However, more medium and small farmers had received agricultural training from local government agricultural offices and NGOs. Most of this training was specific to rice cultivation such as Strategic Rice Intensification (SRI), new transplantation technics, organic pesticide training as well as general sustainable agriculture practices.

	Large Farmers	Medium Farmers	Small Farmers
Households owning mobile phone (%)	100	61	59
Households owning radio (%)	0	0	2
Households owning TV (%)	86	42	41
Households with access to newspapers (%)	14	6	6
Households with access to internet (%)	0	3	0
Households who received agricultural training (%)	14	23	25
Households with access to loans (%)	36	52	41
Average distance to market (km)	5,4	5,5	6,2
Average time taken to reach market (minutes)	30	44	36
Households with electricity (%)	100	87	92

Table 5. Access of households to information sources, infrastructure and services.

5.1.3 Paddy Cultivation and Productivity

According to the questionnaire results, a total of 18 different varieties of rice were grown by farmers in the study area. This number is expected to be greater, however, as some interview respondents reported their rice varieties as 'local' or 'traditional' as certain traditional local varieties of rice did not have a common name between all farmers. Traditional varieties made up 58 percent of paddy grown on wetland and 56 percent on dryland during the *kharif* season and 30 percent during the *rabi* season. The other rice varieties were hybrid or high yielding varieties (HYV). The cultivation of hybrid and HYV of rice in *kharif* had the highest adoption rate by small farmers with 49.0 percent of rice cultivated, compared to 41.2 percent of large farmers and 29.6 percent of medium farmers. The most popular variety grown in *rabi* was the HYV Khondagiri.

The average yield (kg/acre) in the study area for land cultivated in *kharif* was 740 kg/ac. This lies between the average *kharif* rice yield for the two states of Odisha (629kg/ac) and Andhra Pradesh

(1349 kg/ac) and slightly below the national average for India of 810 kg/ac (Das, 2012: 2; Cheralu, 2011: 5). However, there were significant differences between the sub-groups of farmers included in this study. There was a 51 percent difference between the yields gained by wetland farmers than those gained by dryland farmers for the *kharif* season based on a three-year average from 2012 to 2014. Medium farmers had the highest productivity in *kharif* for wetland paddy with average yields of 1049 kg/ac and a total average of 816 kg/ac for all medium farmers. Small farmers had the highest average yield for dryland cultivation at 679 kg/ac and a total average of 791 kg/ac. Large farmers had the lowest average yield for both wetland and dryland and a total average of 464kg/ac.

	Large-Scale Farmer	Medium-Scale Farmer	Small-Scale Farmer
Total Average Yield (kg/ac)	464	816	791
Average Wetland Yield (kg / ac)	556	1049	908
Average Dryland Yield (kg / ac)	361	630	679

Table 6. Average yields (kg/ac) for farmer sub-groups in the *kharif* season based on three-year average (2012 – 2014).

The inverse relationship between farm size and productivity, measured in yield (kg) per acre, of the rice crop was also tested for the farming households in the study area (n=95). A correlation of -0.19 (ρ = .068), a relationship of marginal significance, was found to exist between farm size and productivity, shown in Figure 5. This suggests that an inverse relationship exists between the farms in the study area, albeit a weak one.

Despite large farming households producing significantly lower yields per acre than the other sub-groups, 41 percent of large farming households reported meeting their household subsistence needs for rice from their own cultivation, compared to 28 percent of medium farmers and 21 percent of small farmers. Households that grew enough for their own needs reported that they kept surpluses as an insurance mechanism for problems with future harvests. The average amount of rice bought by households is 240kg a year which falls below the monthly allowance of 35kg that they can buy subsidised from Indian Government stores. Several of the households that grew enough rice for their household requirements reported that they still bought their full allowance of rice from these subsidised stores, either 35 kg a month or 20 kg a month depending on their economic status, as an insurance measure against future crop failures or loss.

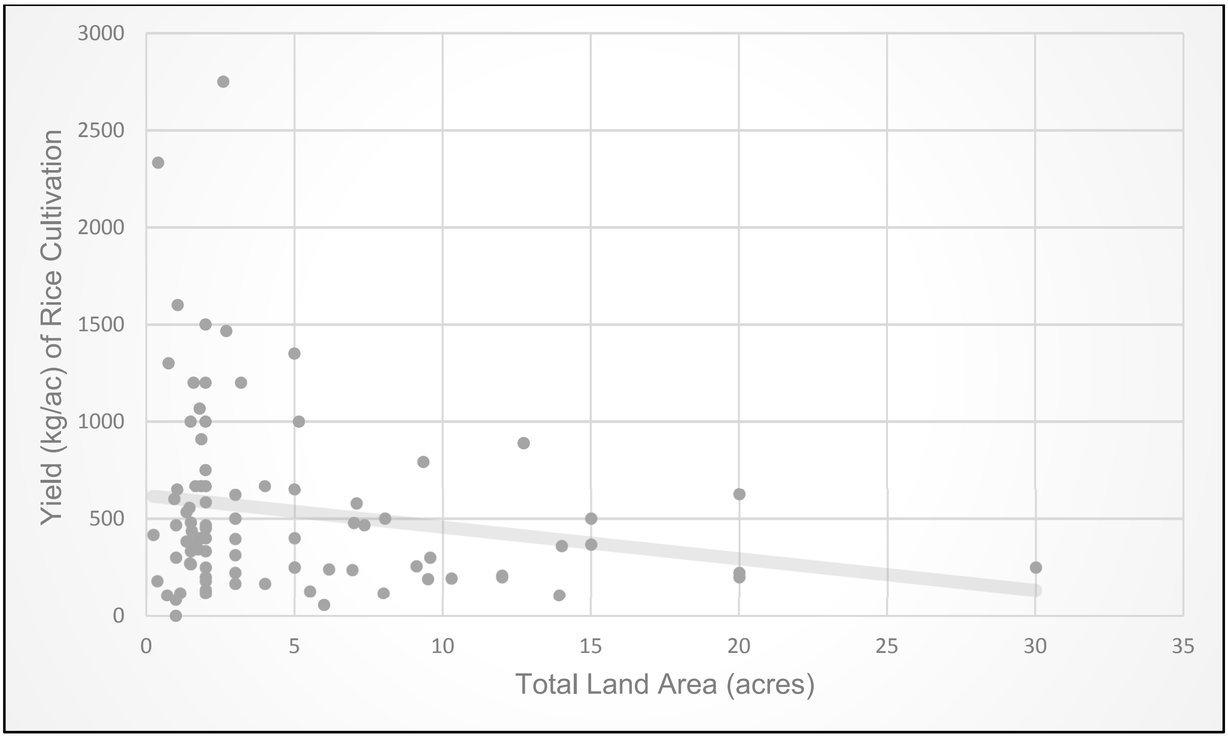


Figure 4. Correlation between total farm size and rice yield of all farming household respondents

Crop loss was prevalent in the study area and 81 percent of respondent households reported to have suffered crop loss from their paddy plots during the past three years. The majority of this was due to cyclone Hudhud that affected Eastern India in October 2014, where its point of landfall was the city of Visakhapatnam near the study area. Several farmers lost their entire rice crop and had to depend on their stores and buy extra rice.

5.1.4 Agricultural Inputs

The agricultural inputs considered in this study are chemical fertiliser, organic manure, pesticides, irrigation and labour. 75.8 percent of farmers included in this study were using chemical fertiliser over the past three years in their *kharif* rice crop cultivation. The different fertilisers being applied was measured in kg/ac and was then divided down to its components of nitrogen (N), phosphorus (P) and potassium (K). The most common fertilisers and their NPK values used in the study area are: Urea (46:0:0), Diammonium Phosphate (DAP) (18:46:0), N:P:K Complex (20:20:0) and Muriate of Potash (MOP) (0:0:60). Table 7. shows the different inputs being used by the farmer sub-groups in this study.

This study found an inverse relationship between land size and fertiliser application for the farmers included in the survey. Small farmers had the highest application rates of 49.6 kg/ac, followed by medium farmers (33.9 kg/ac) and large farmers (27.0 kg/ac). Dryland farmers applied on average

43.4 percent more fertiliser than wetland farmers. Regional Agricultural Research Stations provide recommended crop-wise NPK fertiliser application rates for agro-ecological zones in India. The research station in Chintapalli is closest to the study site and provides recommended NPK quantities for rice cultivation in kharif in the High-Altitude Tribal Zone, the agro-climatic region in which the majority of the study area falls, as 32:24:20 per acre (Regional Agricultural Research Station, 2014).

	Small Farmer			Medium Farmer			Large Farmer		
	Wet-land	Dry-land	Total	Wet-land	Dry-land	Total	Wet-land	Dry-land	Total
Average total fertiliser application (kg/ac)	33,7	62,6	49,6	32,0	35,3	33,9	19,5	34,5	27,0
Nitrogen application (kg/ac)	9.6	17.6	14.0	9.7	11.1	10.5	6.8	12.5	9.6
Phosphorus application (kg/ac)	9.5	16.0	13.3	9.5	8.6	9.0	5.8	8.8	7.3
Potassium (K) application (kg/ac)	0.0	0.0	0.0	0.0	0.3	0.2	0.9	0.0	0.4
Manure application Kharif (kg/ac)	587	150	183	703	446	560	502	196	358
Percentage farmers applying pesticide (%)	11.8	33.3	41.2	18.5	37.0	55.6	55.6	66.7	64.7
Labour cost in Kharif (INR)	10553	6678	8893	6544	4873	5615	5518	1862	3831

Table 7. Inputs by farmer sub-groups in the study area.

No farmers included in this study reached all three requirements in rice cultivation in *kharif* based on a three-year average of application. 10.5 percent of farmers fulfilled the nitrogen requirement, 14.7 percent fulfilled their phosphorus requirement and no farmers fulfilled the potassium requirement.

Small-scale farmers had the greatest application of N and P per acre, however had no application of K, and the highest application was by large-scale farmers with an average of 0.4 kg/ac, significantly lower than the recommended dosage of 20 kg / ac. A different trend can be observed with organic fertiliser as application was highest among wetland farmers, with medium-scale farmers having the highest application, followed by large-scale farmers and small-scale farmers. Chemical pesticides were used by 50.5 percent of all farmers in the study. Chemical pesticide use was most common among large farmers with 64 percent reporting to have used it in the last 3 years, followed by medium farmers with 55.6 percent and small farmers with 41.2 percent.

In Paderu- Hukumpeta and Addateegla, 78.6 percent and 88.2 percent of farmers were using chemical pesticides for paddy cultivation, however, in Semiliguda no farmers, independent of land size or type, used chemical pesticides on their rice crop. This was the only region where farmers applied organic fertiliser, made from local products and materials, or adopted other pest reduction measures such as trap crops.

5.1.5 Labour

Labour costs for each farmer were calculated based on three-year average of total labour costs for *kharif* paddy cultivation per acre, which allowed all farmers to be compared. There were nine stages in paddy cultivation where labour costs were considered, namely: nursery planting, nursery input, tillage of main field, transplantation to main field, manure application, fertiliser application, pesticide application, weeding and harvesting. Paddy cultivation is a labour intensive practice, partly due to the small plots on which it is grown and mechanisation was only evident in land preparation, albeit for the minority of farmers. Farmers plough their fields as part of land preparation one to five times before transplantation. The most popular method of land preparation for any of these events was with a bull drawn plough and power tiller or tractor was used only by 7 percent of farmers in any of those ploughing event

Based on available household labour, small farmers had the highest labour-land ratio for rice cultivation with one labourer to 0.40 acres of land, followed by medium farmers with 1 to 0.87 acres and large farmers with 1 to 1.68 acres. As would be expected, large farmers therefore had the highest total labour costs for *kharif* rice cultivation, followed by medium farmers and small farmers. However, when this is divided down to labour cost per acre, an inverse relationship between labour cost and farm size emerge. Small farmers had the highest average labour costs at 8893 INR per acre, followed by medium farmers (5615INR/ac) and large farmers (3831 INR/ac).

The high price for small-scale farmers per acre may not represent the actual amount paid out as often the area under rice cultivation was less than an acre, with the average area being cultivated under rice by small farmers was 0.98 acres, which would lead to labour costs calculated per acre to be higher than what was paid in reality.

The paddy plots of medium farmer households had an average size of 1.26 acres and large farmers 3.19 acres. It is important to note that labour costs were not uniform across the study area and differences in labour practices were observed. While in the Paderu and Addateegla villages all farmers had labour expenditure, in Semiliguda 64 percent of farmers had no labour costs. This was due to labour sharing and community transplanting and harvesting work, where all farmers help and work on each other’s plots during the most labour intensive times. Only four large farmers and one medium farmer (13.9%) reported having a shortage of labour during key stages of their rice cultivation compared with 20 percent of farmers in the other two study sites.

5.2 Empirical Results of the Vulnerability Assessment

The socio-ecological vulnerability index (SEVI) of rice farming households within the study area is calculated for all households using weights given by experts and then for the three sub-groups using values given by the small, medium and large-scale farmer sub-groups. Within each of the four groups, vulnerability has been calculated for wetland and dryland farmers also. The SEVI values are between 0 and 1 and each household has been assigned a five point ranking system of 1 to 5, and described as very low, low, medium, high and very high.

The SEVI provides a quantified status of the inherent vulnerability of rice farmers in the study area, however, the values themselves have no standalone significance and the practical value of the SEVI is in the analysis of the individual indicators, the causes of vulnerability they represent.

5.2.1 Socio-Ecological Vulnerability for All Farmers Using Expert Weights

For all farmers in the study area (n=95) the social-environmental vulnerability index was calculated using expert weights. This study found the average SEVI value for all farmers in the study area to be 0.51 (medium vulnerability). 46 percent of farmers had a low vulnerability, 52 percent medium vulnerability and 2 percent high vulnerability. No farmers had a SEVI ranking of very low or very high. Wetland farmers (n = 46) have an average SEVI value of 0.484 (low vulnerability) while dryland farmers have an average SEVI value of 0.527 (moderate vulnerability).

Figure 6 shows the values for the five factors that were used to calculate the aggregated vulnerability value. Household income and assets contributed greatest to the inherent vulnerability of farmers (37%) followed by cultivation practice and productivity (19%), access to information and access to services and infrastructure both contributed equally (15%) and finally access to inputs and labour (14%).

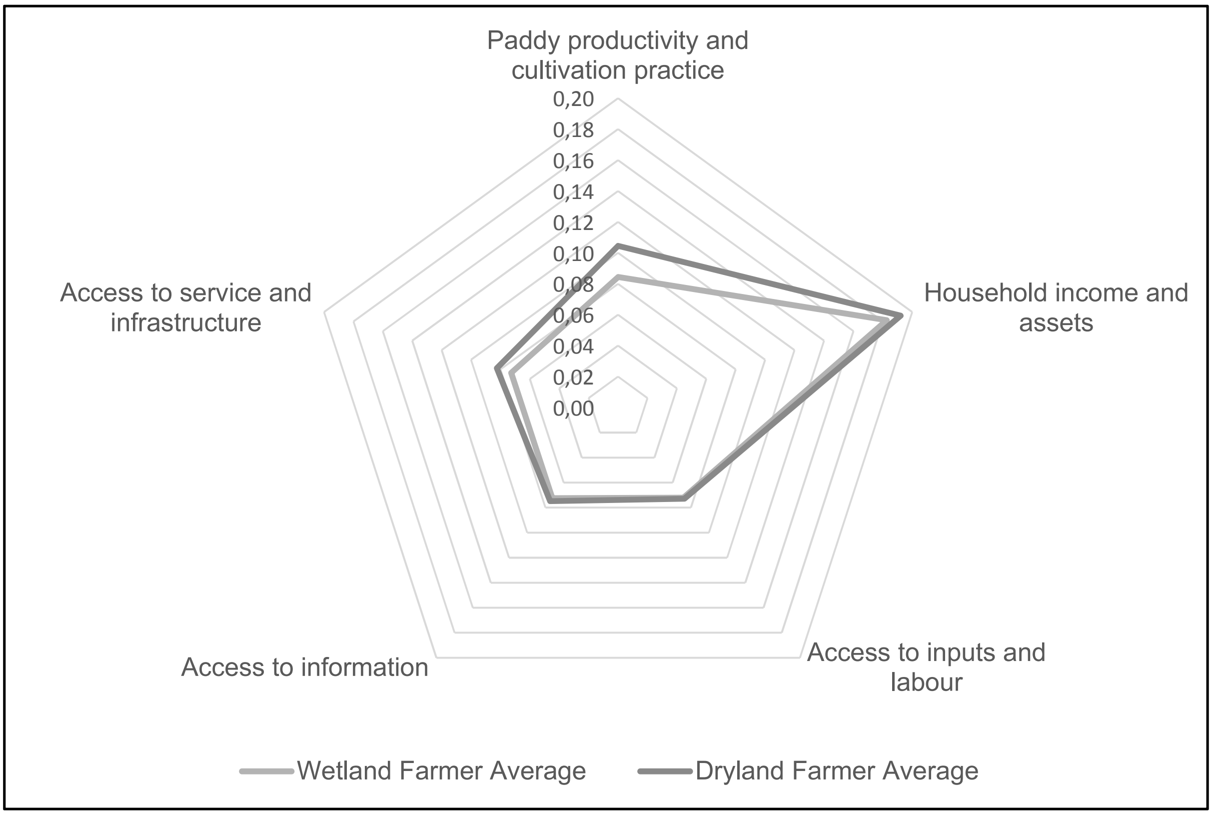


Figure 5. Socio-ecological vulnerability profile of wetland and dryland farmers based on expert weights

5.2.2 Drivers of Vulnerability

The individual indicators that contributed most to the vulnerability and contributed to half of the vulnerability value in this study (50.9%) were total area under paddy (25.1%), access to loans (11.6%), number of skilled labourers in household (7.6%) and irrigated area under paddy (6.6%). This was in part due to the high weighting given by experts for land size and access to loans and the low measured value for skilled labourers and irrigated area under paddy.

Land ownership (0.5%) and household electrification (0.5%) made a negligible contribution to vulnerability. This was mainly due to high levels of ownership of the lands being cultivated, as only four farmers cultivated on rented lands and this rented land made up a low percentage of their total land cultivated. Only eight households had no access to electricity in their home and this was given a low weighting by experts as contributing to vulnerability, as no farmers reported using electricity in their farm cultivation, such as for pumps for irrigation or any other machinery.

Dimension	Indicator	SEVI Value	% of SEVI
Cultivation Practice and Productivity	Paddy yield (kg/acre)	0.022	4.3
	Crop loss (3 year average)	0.010	1.9
	Meeting HH subsistence needs	0.013	2.6
	Diversity of rice varieties	0.017	3.3
	Irrigated area under paddy	0.034	6.6
Household Income and Assets	Total area under paddy	0.127	25.1
	Land ownership	0.003	0.5
	Income diversity	0.019	3.8
	No. skilled labourers in household	0.039	7.6
Access to inputs and labour	Fertiliser application	0.012	2.4
	Manure application	0.026	5.2
	Availability HH labour	0.022	4.3
	Cost of labour	0.012	2.4
Access to Information	No. information sources in household	0.027	5.4
	Contact with NGOs and government institutions	0.030	5.9
	HH literacy	0.017	3.3
Access to Services and Infrastructure	Access to loans	0.059	11.6
	Access to markets	0.017	3.3
	Electrification	0.003	0.5
Total		0.506	100.0

Table 8. Individual indicator SEVI values and percentages.

5.2.3 Vulnerability of Small, Medium and Large-Scale Farming Households

The SEVI was also calculated for three sub-groups of farmers based on land size. Small scale (<2.5 acres), medium-scale (between 2 and 10 acres) and large-scale (>10 acres). The SEVI was calculated separately for the three sub-group using different weights collected from the respective sub-group during focus groups. A summary of the results can be seen in Figure 7 and Figure 8.

5.2.4 Small-Scale Farmer Vulnerability

Small-Scale farmers are all those with a total of <2.5 acres of land (<1.01 ha). In this assessment, the social-ecological vulnerability value for small-scale rice farmers was 0.527, ranking 3 on the vulnerability scale (moderate vulnerability). A difference exists between small-scale wetland and dryland farmers, scoring 0.482 (low vulnerability) and 0.571 (moderate vulnerability) respectively. Of the total small-scale farmers included in the analysis (n=51), 62.7 percent ranked moderately vulnerable, 35.3 percent ranked low and 2 percent ranked very low on the vulnerability index.

The aggregated vulnerability score is based on the five factors identified and explained in the previous chapter. The factor that contributed most to inherent vulnerability in this farmer group access to inputs and labour (35.4%) followed by, cultivation practice and productivity (22.2%); access to information (17.2%); household income and assets (15.5%%) and finally access to services and infrastructure (9.6%). Of the 19 indicators included in the assessment, 4 contributed to half (50.1%) of the SEVI value and are referred to as the *drivers* of vulnerability: manure application (19.2%), number of household members working on plots (12.5%), contact with institutions (9.4%) and number of skilled workers in the household (9.0%).

Regarding the two components of vulnerability, sensitivity and adaptive capacity, small farmers had a sensitivity score of 0.219 (41.5%) and adaptive capacity score of 0.308 (58.5%), indicating that vulnerability is more influenced by a lack of adaptive capacity. Dryland farmers were found to be more both sensitive and have a greater lack of adaptive capacity compared to wetland farmers.

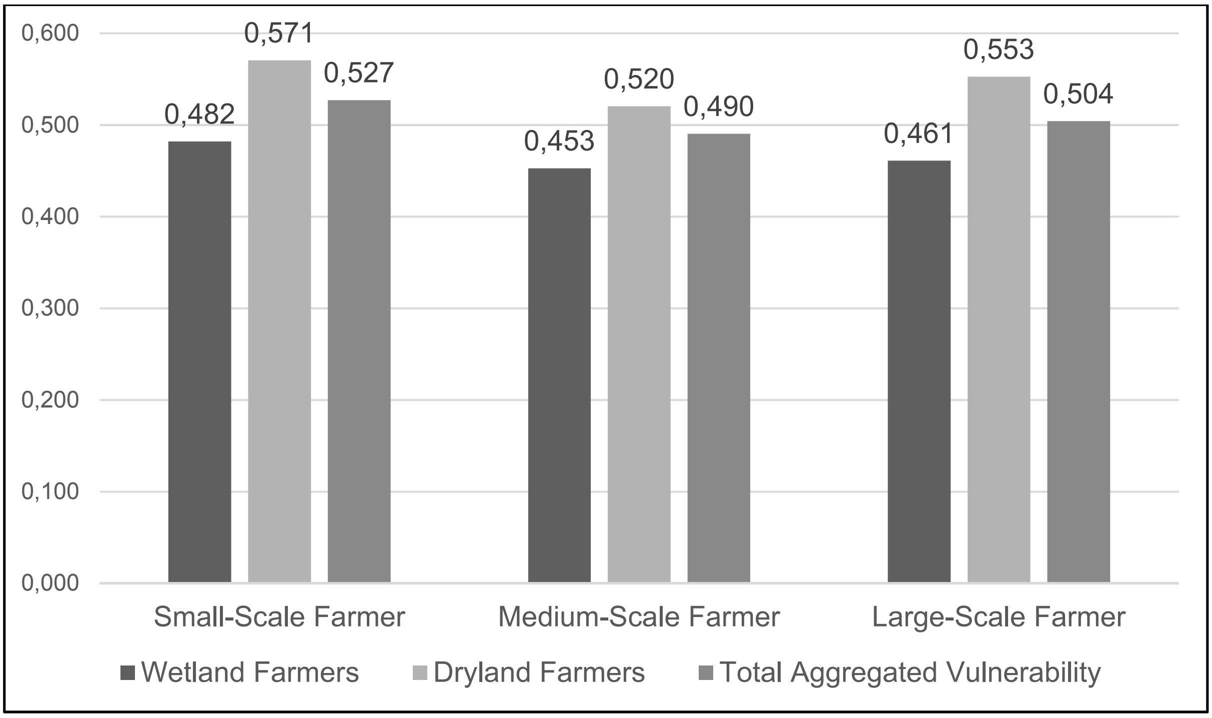


Figure 6. Aggregated SEVI values for all sub-groups.

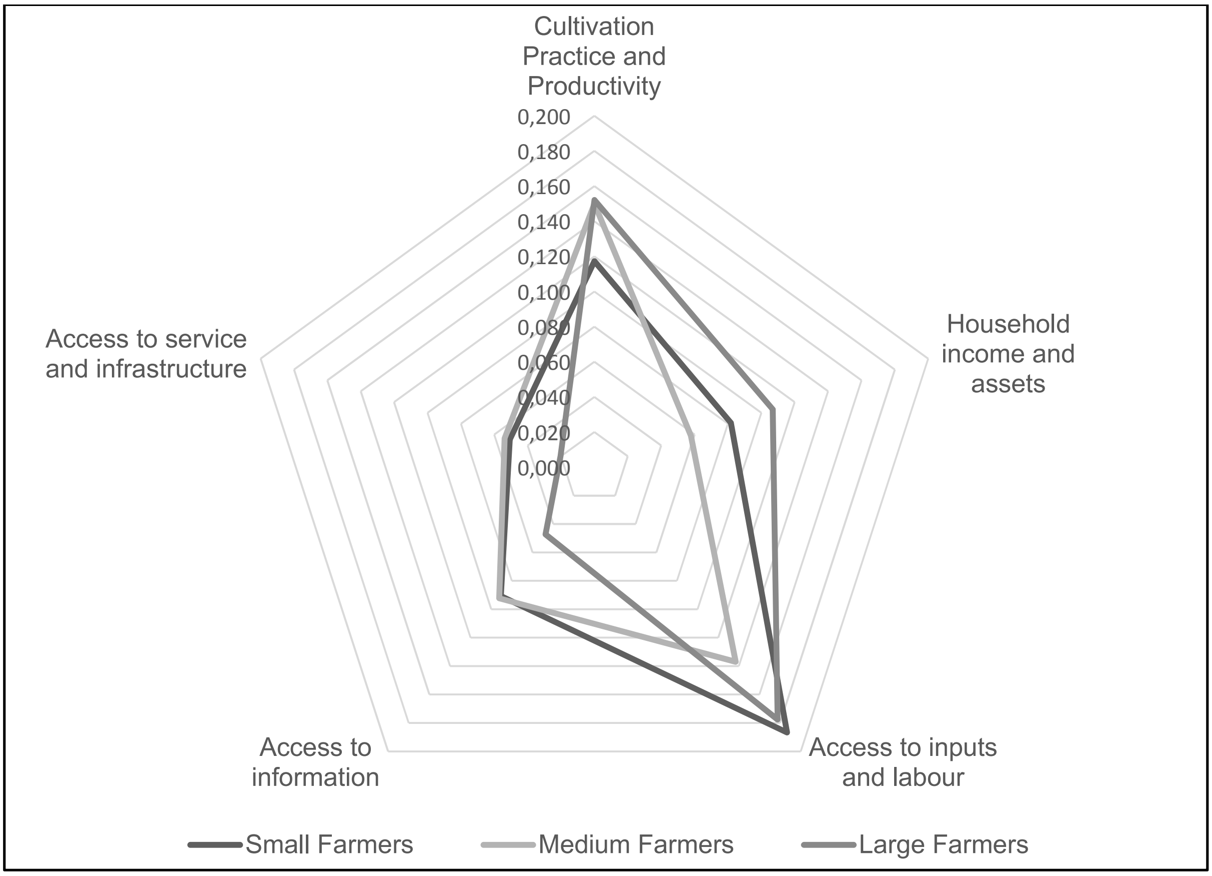


Figure 7. The five factor components that make up SEVI scores.

5.2.5 Medium-Scale Farmer Vulnerability

Medium farmers were found to have an aggregated vulnerability of 0.490, which has a ranking of 2 (low vulnerability). Wetland farmers in this group had a vulnerability score of 0.453 (low vulnerability) and dryland farmers had a vulnerability score of 0.520 (medium vulnerability). Of all medium-scale farmers included in the assessment (n=27), 55.6 percent farmers had a score of 2 (low vulnerability) and the remaining 44.4 percent had a score of 3 (medium vulnerability). Of the five factors that made up the vulnerability assessment, cultivation practice and productivity (30.6%) contributed the most to vulnerability, followed access to inputs and labour (27.9%), access to information (18.8%), household income and assets (11.8%) and access to services and infrastructure (11.0%). The following five individual indicators made up half (50.2%) of the SEVI value: paddy yield (12.9%), manure application (12.2%), number of information sources in household (9.8%), area under paddy cultivation (8.1%) and available household labour (7.2%). All medium-scale farmers were found to have similar scores for sensitivity and adaptive capacity, with a sensitivity component value of 0.238 (48.6%) adaptive capacity of 0.252 (51.4%). This differed between land types with dryland farmers having both a higher sensitivity and lower adaptive capacity than wetland farmers.

5.2.6 Large-Scale Farmer Vulnerability

The total aggregated vulnerability for large-scale farmers was 0.504 (moderate vulnerability). Large-scale wetland farmers had a low vulnerability score (0.461) and dryland farmers had a moderate score (0.553). Of the total large-scale farmers included in the assessment (n=17), nine farmers had a moderate vulnerability rating and the remaining eight had a score of 2 (low).

Factors	Indicator	Small Farmer	Medium Farmer	Large Farmer
Cultivation Practice and Productivity	Paddy yield	4.1	12.9	5.0
	Crop loss	2.2	4.5	2.3
	Meeting HH subsistence needs	3.2	5.1	7.1
	Diversity of rice varieties	5.6	6.0	3.5
	Irrigated area under paddy	7.2	2.1	12.3
Household Income and Assets	Total area under paddy	4.7	8.1	18.5
	Land ownership	0.0	0.6	0.7
	Income diversity	1.7	2.1	2.0
	No. skilled labourers in household	9.0	1.0	0.0
Access to Inputs and Labour	Fertiliser application	0.9	3.1	9.5
	Manure application	19.2	12.2	4.5
	Availability HH labour	12.5	7.2	15.4
	Cost of labour	2.8	5.4	5.9
Access to Information	No. information sources in household	5.3	9.8	5.4
	Contact with NGOs and government institutions	9.4	5.4	1.9
	HH literacy	2.4	3.6	2.1
Access to Services and Infrastructure	Access to loans	6.4	4.0	2.6
	Access to markets	3.0	6.6	1.5
	Electrification	0.1	0.3	0.0
Total		100.0%	100.0%	100.0%

Table 9. Contribution (%) of individual indicators to SEVI for all three farmer sub-groups.

Access to inputs and labour (35.2%) was the most significant contributor to vulnerability followed by cultivation practice and productivity (30.2%), household income and assets (21.2%), access to information (9.4%) and access to services and infrastructure (4.0%). The individual indicators that acted as drivers of vulnerability in this group were area under paddy (18.5%), number of household members working on plots (15.4%), irrigated area under paddy (12.3%) and fertiliser application (9.5%). The aggregated vulnerability score for this group could be divided into sensitivity (59.7%) with wetland farmers having a lower score for sensitivity than dryland farmers. Adaptive capacity contributed less to the aggregated vulnerability (40.4%) and dryland farmers had a higher adaptive capacity than wetland farmers.

6 Interpretation of Results

6.1 Is Small Beautiful?

The results of the household questionnaire show key differences between the farming practices of small, medium and large farmers. The small farmers in the study were shown to have greater income diversity, relying on agriculture, skilled and unskilled labour and daily labour provided through the MGNREGA scheme. Small and medium farmers were shown to be the most productive, according to this study, with medium farmers having the highest productivity for wetland and small farmers having the highest productivity for dryland. Large farmers had the lowest productivity for both land types.

In studies on this inverse relationship between farm size and productivity, greater inputs including labour are often stated as being the cause of the higher productivity of small farmers (Fan and Chan-Kang, 2005: 141). One argument, that was first proposed by Sen (1962) and has since been supported by several other studies, is that small farms use more family labour, which is more efficient than hired labour used by large farms. In the study area the labour to land ratio based on household labour and area under rice cultivation was highest for small farmers with 1 household labourer to every 0.40 acres, followed by medium farmers with 1 to 0.87 acres and finally large farmers with 1 to 1.68 acres. This is one element of labour use that could go some way in explaining the higher productivity of small and medium farms.

The existence of a dual labour market, where smaller farmers have lower labour transaction costs than large farms and therefore can use more labour, is another common explanation for the inverse relationship (see Fan and Chan-Kang, 2005; Bhalla and Roy, 1988). Paddy cultivation is particularly labour intensive and the only evidence of mechanisation was the use of tractors and power tillers for ploughing paddy plots, however this was only used by seven farmers, two of which were classified large, one medium and four small. This meant that hired labour was required by all farmers at key stages during the growing season and large farmers had significantly higher overall labour costs per household compared to small farmers. However, when compared by land size, small farmers had on average a much higher labour expenditure per acre at 8893 INR compared to medium farmers (5615 INR) and large farmers (3831 INR). The price for agricultural labour was the same throughout the study area at 100 INR a day per person and therefore the higher price paid by small farmers per acre indicates a more intense use of hired labour.

Furthermore, Feder (1985: 311) argues that farm labour will be more efficient when subjected to higher amounts of supervision and that household members, as well as being more motivated, will also perform this supervisory role. Therefore, he argues that households with a higher household labour to land ratio will have more efficient hired labour resulting in higher productivity. In the study area, small farmers benefit from this synergy as they had the highest amounts of household and hired labour per acre, closely followed by medium farmers.

It is worth noting that while these are average labour patterns, they are not universal across the study area. In the five villages near Semiliguda; Jhaliaguda, Parjapungar, Kondhpungar, Bilaiguda and Kadamguda, farmers cultivated rice on the basis of a shared labour system. For the important periods of the paddy cultivation, the whole village would work as a team moving round plots and completing labour intensive work such as transplantation, weeding or harvesting, until all the farmers' plots had been worked. This was a practice that was used exclusively by small and medium farmers as the large farmers included in the survey of this area did not participate in this shared labour, but instead hired agricultural labourers on a daily basis similar to farmers in the other research sites.

In all five villages, farmers reported that during the harvest period they begin harvesting one plot together and work round all the plots in the village until the harvest is completed. When the harvest is completed on the first farmer's plot, the farmer pays all those that helped with a share of his rice harvest. As they move round the plots of each farmer, the first farmer would then be repaid the rice he has given out by helping on other plots. This works to ensure that labour is fairly shared by all members of the community. This use of rice instead of money was found in all villages included in the study in Semiliguda sub-district, which contributes greatly to the reduced labour costs reported in the questionnaire. Sen (1966: 247) explains:

> It is not size as such, which is incidental, hut [sic] the system of farming. viz. whether it is wage-based or family based. For example, if a large cooperative farm operates on a non-wage family labour basis, there is nothing in our observations to indicate that it will have a lower output per acre.

When the productivity of farmers is compared across the three research sites, households in the five villages in Semiliguda are the most productive with a yield of 710 kg/ac, which is 27.5 percent greater than in Paderu with an average yield of 557 kg/ac and a 74.1 percent increase compared to the average yield of 408 kg/ac in Addateegla. All farmers that participated in the labour sharing scheme reported that they had not experienced any labour shortages in the last three years, while the four large farmers and one medium farmer that did not participate in labour sharing all experienced shortages in labour during key periods in the cultivation calendar such as transplantation and harvesting. This can have a particularly negative effect on yields when it results in delayed transplantation of seedlings from the nursery into the main field and delayed or insufficient weeding (Das, 2012: 24). Labour shortages were also experienced by 20 percent of farmers in the other two study sites and this can affect the productivity of cultivation.

It is argued that in the post Green Revolution period, agriculture is more science based and family labour is less important in influencing productivity, and factors such as fertiliser and improved seeds have a greater impact (Deolalikar, 1989; Fan and Chan-Kang, 2005: 141). Both fertiliser and improved seeds were shown to be widespread in the study area with 76 percent of farmers using fertiliser. High-yielding or hybrid varieties of rice were grown by 43 percent of farmers in *kharif* and 70 percent of farmers that cultivated rice in *rabi*. Chemical pesticide was also used by around half of the farmers in the study area (50.5%). In was expected that as these technologies became increasingly available in India, they would be adopted by large farmers with more access to capital, which would lead to these farms being more productive compared to smallholders (Deolalikar, 1989; Ghose 1979; Hanumantha, 1975). In the research area of this study, the opposite has been shown to be the case as small farmers were applying greater amounts of fertiliser per acre compared to medium and large farmers and were the closest to reaching the recommended NPK quantities for the agro-ecological zone. For modern varieties of rice, adoption again was greatest amongst small farmers, followed by large and then medium farmers. An exception in this trend was shown with chemical pesticide, with use being highest among large farmers.

Differences in input use could also been seen across the study sites. Of the farmer respondents in the Paderu study site, only 2 out of the 42 respondents reported using HYV of rice in their *kharif* crop. Farmers stated that they were aware of other rice varieties available but chose to cultivate their traditional varieties of rice because they felt they understood these varieties and their required better than new varieties. Furthermore, as the majority of their cultivation was for subsistence needs, they preferred the taste of their local varieties and felt that they were better quality and preferred to grow them even if they produced less than modern varieties. In the Addateegla research site, the split between farmers growing HYV and traditional varieties was almost equal (53% hybrid, 47% traditional), while in the villages in Semiliguda 69 percent of farmers were using HYV varieties in *kharif* and 31 percent were using local. The local government Agricultural Officer reported that in recent years there had been a great increase in the use of hybrid seed varieties, which were often being strongly promoted and advertised by seed companies. The companies would come to villages and distribute free seed for farmers to try and encourage them to buy the same seeds the following year.

The Agricultural Officer (AO) reported that hybrid varieties were especially popular in lowland villages near Semiliguda, which has a market where the seeds are sold, while villages further away in upland areas had less contact to markets and were still cultivating rice using traditional methods. This is corroborated with data from this study, as in the village of Parjapungar, which is located around 10km from Semiliguda in an upland location, all farmers in the village were using local varieties. Farmers reported that it took them between one and two hours to reach Semiliguda, their next market. In the lowland village of Kadamguda, only 3km away from Semiliguda, 75% of farmers were using hybrid seeds. The AO further stated that the increase use of hybrid and HYV in some villages has led to a loss of indigenous knowledge between generations of farmers and younger farmers are no longer aware of cultivation practices for traditional varieties and are solely reliant on hybrid varieties. Farmers using hybrid varieties are more dependent on markets as they must buy new seeds for every cultivation period and they require more fertiliser. The AO estimated that around five to ten new hybrid seed varieties appear on the market in Semiliguda every year and this can lead to confusion around what seeds are best for which conditions and what inputs are required to get the maximum yield. This lack of knowledge was not a problem among farmers growing traditional varieties.

Despite the higher use of HYV and hybrid varieties, none of the household respondents in the villages in Semiliguda reported using chemical pesticides for any for their cultivation. The reasons stated for this were that farmers thought chemical pesticide was poisonous for the soil or it wasn’t needed as they had sufficient alternative methods for preventing and coping with pest attack. These alternative methods are diverse. One strategy is using organic pesticide, which is made from crushed neem leaves mixed with cow dung, cow urine and curd and left to ferment for 10 to 12 days before being filtered to a solution and used on the fields. Further strategies involved conducting religious ceremonies and placing fishtail palm leaves around the plots, which are believed to protect the plots. The use of organic pesticide was supported by local NGOs who providing training in the research site on its production and use. The application of chemical fertiliser was also lower in this region. 37.8 percent of farmers used no chemical fertiliser on their crop, while this was 18.6 percent in Paderu and all farmers reported using chemical fertiliser in Addateegla. However, to compensate for this, the use of farmyard manure was greater in Semiliguda than the other two research sites.

These results support the findings in other studies such as Cornia (1985) who attributes a strong negative correlation between farm size and productivity in 12 countries to higher factor inputs such as fertiliser and intensive land use of small farms. In a nationwide study in India, Chand et al. (2011: 8) reach similar conclusions and attribute the higher productivity of smaller farms to higher doses of inputs, making more intensive use of the land and the widespread adoption of new technology. Furthermore, the authors predict that future changes in the labour market and the increased demand for labour will further increase the advantage of small holders. Despite the advantages that small holders have in India in terms of productivity, this does not mean that their livelihoods are secure and often fail to generate enough income to keep the household out of poverty, especially those plots that are under 0.8 ha (0.98 acres) (Chand et al. 2011: 11).

6.2 Who is the most vulnerable?

6.2.1 Differences between Dryland and Wetland Farmers

In all study areas, farmers cultivating rice on rainfed or dryland were found to have the highest SEVI score, classified as moderate vulnerability, while wetland farmers had a low vulnerability in both the vulnerability assessment using expert weights and the sub-group assessments with weights provided by farmers themselves. A key driver of this higher vulnerability score for dryland farmers was the lack of irrigation, which can influence vulnerability for several reasons. Without an irrigation source, rice can only be cultivated in the monsoon season of *kharif*, which lasts on average from around the second week in May until the third week in November. No dryland farmers included in this study cultivated anything on their paddy plots in the *rabi* season from December to April and so they remained fallow, compared to 74.9 percent of wetland farmers who cultivated rice in both seasons. This results in a much lower annual yield for dryland farmers.

In the *kharif* season, cultivation is entirely dependent on the monsoon rains. If these begin later than expected or are erratic at key stages of the growing season this can have a great impact on the yields produced. Rice seedlings are grown in nurseries at the beginning of the season and can only be transplanted into the main field when the first rains begin. If these are delayed, this can affect yields as seedlings transplanted past a certain age have been shown to produce lower yields (Das, 2012). Dryland farmers did not report to have any coping mechanism for when this occurs. No farmers reported planting alternative drought resistant crops such as grams or millets when rains failed and the only coping mechanism reported was buying more subsidised rice from government shops. Farmers stated that alternative strategies are limited as agriculture is the main source of employment in the study region and when rains are delayed or fail there is little demand for agricultural labourers, further reducing livelihood opportunities of the farmers affected.

Average *kharif* yields of dryland farmers were on average 33 percent lower than those of wetland and meeting household subsistence needs was therefore a key driver of vulnerability for this group. This was especially the case for large farmers, who purchased on average 320 kg of rice annually compared to 126 kg of large wetland farmers. A reason for this higher figure is that large farming households also had on average the most household members of the sub-groups. It can therefore be concluded that irrigation is a key factor in influencing vulnerability of all households, regardless of land size.

6.2.2 Differences in Vulnerability Based on Land Size

Medium farmers were shown to be the most productive in this study and they were also found to be the least vulnerable based on the SEVI using farmer weights. Small farmers were found to be the most vulnerable, despite their high productivity and large farmers lie between these two groups, despite having the lowest productivity. This shows the importance of a variety of factors in defining the vulnerability of farmers beyond productivity.

The vulnerability dimension *access to inputs and labour* contributed most to the vulnerability of all farmers and the individual indicator, *number of household members working on plots* was a driver of vulnerability for all farmers. This was due to both the high weighting given by all farming groups and the limited number of household members available. As rice cultivation is labour intensive, the greater the number of household members working on the plots reduces the dependence on hired labour and the potential for shortages during peak times of the season. This contributed most to the vulnerability of large farmers, who had the lowest household labour to land ratio and were therefore more reliant on hired labour for their rice cultivation.

Regarding other inputs, a difference existed between which inputs contributed to vulnerability of the different groups. A lack of fertiliser was a driver of vulnerability among large farmers and organic fertiliser, such as farm yard manure, was a driver of vulnerability among small and medium farmers. This was in part due to the high weighting given by the respective farming groups and the lack of availability. Small and medium farmers had a higher application of chemical fertiliser compared to large farmers and they considered the levels they applied to be appropriate for their cultivation. For large farmers, they considered chemical fertiliser as one of the most important inputs they used and 70.6 percent of large farmers reported more fertiliser would be applied if they could afford it.

A key constraint for the use of farmyard manure for small and medium farmers is owning cattle. While only one large farmer bought manure, all other large farmers owned cattle and this supplied their use of manure for rice cultivation. Only three small farmers purchased manure and 54.9 percent of small farmers owned cattle and used manure from them. The remaining small scale farmers had no access to manure as the majority of farmers did not sell it, yet there was a high acceptance among this group that farmyard manure was important for rice cultivation and improved yields. This was also reported as a key motivation for using more chemical fertiliser.

The difference between the farm size sub-groups are clearly shown in their difference in the two components of vulnerability, namely sensitivity and adaptive capacity. Small farmers were found to have a low sensitivity to change or disruption in their social-environmental farming system, which was coupled with a lower adaptive capacity. Medium farmers had more of an even split between sensitivity and adaptive capacity and large farmers were found to have a greater sensitivity which was coupled with greater adaptive capacity.

Large farmers had higher sensitivity to change compared to small farmers due to the lower rice yields, greater crop loss, less percentage of area irrigated and falling further below the recommended fertiliser levels compared to small farmers. Due to the greater areas being cultivated by large farmers and their greater dependence on hired labour, they are unable to cultivate as intensely as small farmers. However, large farmers were shown to be better equipped to deal with change resulting from their higher adaptive capacity. The adaptive advantages of large farmers were based on their greater diversity of rice varieties being cultivated, which shows a greater ability to change variety and adapt to changing environmental conditions. They also had a greater number of skilled labourers in their household, who can earn a greater income than the unskilled labour that small farm households relied on. Large farming households also had greater access to information through higher literacy rates and more access to information sources such as television and mobile phones. Finally, large farmers had better access to infrastructure and services such as markets, both in time and distance, which allows them to buy and sell products easier as well as having better access to loans. This allows them more opportunities to adapt to changes and to invest in new cultivation methods.

6.2.3 Expert vs Farmer: Difference in Perspectives

Significant differences can be seen between the results of the vulnerability assessment using weights given by experts and those given by farmers. For the two assessments the same data was used and only the weights applied to the indicators changed. The SEVI results based on farmer weights found medium farmers to have the lowest SEVI score and therefore lowest vulnerability, followed by large farmers and then small farmers. Using the expert weights, however, the opposite was shown to be the case, with small farmers having the lowest score (0.501) followed by large farmers (0.508) and then medium farmers (0.515). The key to these different scores are the weights applied that resulted in different drivers of vulnerability for the two assessments.

Using farmer weights, the main drivers of vulnerability were manure application, number of household members working on plots, total area under rice cultivation, percentage of land under irrigation and yield per unit land. Area under rice cultivation and percentage land irrigated were also found to be drivers in the expert study, however, other drivers included access to loans, number of skilled workers in the household and contact with government institutions and NGOs. Access to loans was given a low weighting by all farmer groups as they reported this was not a solution to their most pressing challenges. The indicator *number of skilled labourers in household* only contributed to the vulnerability of small holders due to the weight they had given it, however this was not viewed as a priority for medium and large farmers. Finally, contact to governmental institutions and NGOs was weighted highly by experts but was shown to be viewed as of little importance to large and medium farmers and moderate importance to small farmers. Out of the sub-groups, small farmers reported having the most contact with government organisations and NGOs, with 27.5 percent of farmers having received agricultural training from such an institution, which could explain why smallholders weighted this higher than other groups. The experts who provided the weights mostly came from agricultural organisations working in the research area, such as government agricultural offices and NGOs, therefore it is unsurprising that they weighted the importance of agricultural extension work and support highly.

Experts, therefore, favoured more service and technical solutions and reducing vulnerability of households by increasing adaptive capacity, such as through loans, skilled work and training. The strategy involves reducing vulnerability through new and innovative approaches. Farmers' perception of vulnerability more focused on issues of sensitivity for improving their cultivation and reducing their vulnerability, such as increased organic manure, labour, irrigation and land with the clear goal of improving yields. Therefore, farmers focussed on strategies *reducing* risk, while the strategies championed by experts, such as loans, were seen by farmers as potentially *increasing* risk.

Delica-Willson and Willson (2004: 154) argue the factors that lead a community to feel vulnerable can be different from what an outside observer or 'expert' might expect. Therefore, they argue for the greater inclusion of the views of the poor into vulnerability assessments to prevent interventions that may not be appropriate or may actually lead to an increase in vulnerability. The difference in results between the two vulnerability assessments conducted in the study area show the importance of individual perception and how it can have a significant impact on the results of such assessments. Vulnerability assessment are usually conducted to influence decisions on points of intervention and the differing results of this study would suggest that different conclusions regarding intervention strategies would be drawn. The results of this study would therefore support demands calling for greater participation of individuals and communities in vulnerability assessments, at least those conducted at a local or regional level.

6.2.4 Productivity and Vulnerability: Are they Related?

Productivity is often used as an indicator to assess the wellbeing of agriculture in a region or country, for example as part of the World Development Indicators (World Bank, 2016). Productivity and yield has also been used as an indicator to assess the vulnerability of agricultural systems, with higher yields indicating lower vulnerability (see Luers et al. 2003). This was the rational for including yield per acre as an indicator in the SEVI for this study, with an inverse relationship to vulnerability. However, despite small farmers having higher productivity compared to large farmers, small farmers also have higher vulnerability, based on the SEVI using farmer weights.

The reason for the higher productivity of small farms in this study can be attributed to both qualitative and quantitative factors that agree with factors already presented in other studies. However, considerably less attention has been paid to the reasons for these differences. Chattopadhyay and Rudra (1976: 144) argue that it is important to distinguish between factors that allow small farmers to more intensively cultivate their land and the factors driving them to do so. This statement is further supported by Dryer (1997: 113) as he argues that there is a need to go beyond farm size and examine the underlying relations and forces of production. Both studies come to the conclusion that the inverse relationship is a phenomenon, not of relative efficiency, but rather of distress (Chattopadhyay and Rudra, 1976: 144; Dyer, 1997: 123). Chattopadhyay and Rudra (1976: 144) describe this succinctly as follows:

> Among the factors that drive a small farmer to more intensive effort the most important one, of course, is his need for survival. There is a certain basic minimum of consumption that a poor peasant family has to have without which it will be simply wiped out. It is only understandable that such a poor peasant family, depending on a small piece of land, submerged in a vast population of surplus labour in the countryside, and thus not having any alternative sources of employment and income, would try to produce the maximum output on his piece of land. He would not only ignore any marginal productivity calculations insofar as family labour is concerned, he would employ hired labour whenever necessary to supplement family labour, and in doing that would pay no heed to marginal productivities. He would also try to apply non-labour and non-monetised inputs with maximum intensity, once again by using labour without any calculations. He would try to improve the quality of land by small-scale irrigation and other such means as can be procured with the help of labour. He will tend to leave fallow as little land as possible, and try to cultivate as many crops as possible.

While productivity may be used as a proxy for well-being of agricultural systems in some contexts, the results of this study would agree with the authors of the two studies that it may show the very opposite in regards to small-scale agriculture. Higher productivity in the case of this study can be considered as an adaption strategy of small holders due their higher vulnerability.

The reason why productivity and the inverse relationship has been so intensively investigated and debated within the fields of agricultural sciences, economics and development studies, is that it has important consequences for policy. The existence of an inverse relationship has been used by some as a reason to advocate for land ceilings and land redistribution (Cornia, 1985: 532; Chand et al. 2011: 11). However, based on the findings of their studies, Chattopadhyay and Rudra (1976: 115) and Dyer (1997: 105) maintain that such a policy would only perpetuate inequality and poverty. A claim that the findings of this study, at least in regards to vulnerability within the context of this study region, would support.

The question of whether the relative higher productivity of smallholder farms will remain so should also be addressed. Havnevik and Skarstein (1997) hypothesise from their case study in Tanzania that as smallholders cultivate their land more intensively, with limited resources that inhibit soil preservation practices, the overall productivity of agriculture will decline. This is supported by a study into land degradation in India that found land shortage combined with poverty led to non-sustainable agricultural practices and a direct source of soil degradation, with two main causes being lack of crop rotation and unbalanced fertiliser use (Bhattacharyya et al., 2015: 3532). This is a field that requires further research, especially considering that farm sizes are decreasing in many parts of the world, particularly in Asia and Africa, which could make this a growing problem (Chand et al. 2011: 6).

Chand et al. (2011: 10) state that 0.8 ha (1.98 acres) are needed to keep a farming family above the poverty line, if the family's only source of income is agriculture. This accounts for 62 percent of farmers in India (ibid). Within this study, small farms were classified as farmers with holdings below 2.5 acres (1.01 ha) and therefore the majority (68%) of farmers in this sub-group fall below this 0.8ha. Despite having the second highest productivity, this group had the highest vulnerability. In comparison, medium farmers had the highest productivity and the lowest vulnerability in this study. These are farmers with a land size between 2.5 and 10 acres (1.01 – 4.05 ha), which falls above the 0.8ha threshold stated by Chand et al. (2011). It is therefore important to address the question, especially within the context of decreasing farm size, of at what point are small farms *too* small that relative advantages diminish and they can no longer be productive? Once this is established the question remains how these farmers can be supported. Chand et al. (2011) argue that there are only two ways to improve the livelihood of these farmers. The first is to increase the land to man ratio, which requires a significant number of farmers to move out of agriculture, something that has not been successful in the past six decades in India. The second and only viable option to support small-scale farmers is to increase employment opportunities for small holders but within the rural area in which they live. The results of this study would support this statement as it would further reduce sensitivity of farmers to social and environmental change and greater opportunities for skilled labour would increase their adaptive capacity.

7 Conclusion

This study has taken the developing concept of inherent vulnerability and applied it to a case study of farmers divided by land size and type. In order to do this, the practices and productivity of farmers were assessed and the results of this study show that medium and small-scale farmers are more productive than large-scale farmers, which can be attributed to more extensive use of chemical fertiliser, greater use of high-yielding varieties of rice and also a higher labour-land ratio. Smaller farmers have on average more household labour and use hired labour to a greater extent, increasing the intensity of their cultivation.

Despite this higher productivity, small farmers were shown to have the highest vulnerability, followed by large farmers and medium farmers, based on the results of the SEVI using farmer weights. This study considers the two basic components of vulnerability to be sensitivity and adaptive capacity. Small-scale farmers were seen to have low sensitivity, however also a low adaptive capacity resulting in their higher aggregated vulnerability score. Key drivers of their vulnerability related to rice cultivation were lack of access to farm yard manure and household labour, as well as limited access to institutions and number of skilled labourers in the household.

Based on the results of this study and research conducted by Chattopadhyay and Rudra (1976) and Dyer (1997), this researcher argues that the higher productivity of small farmers can be related to higher vulnerability. Due to the economic pressures and challenges that small-farming households face, the more intensive cultivation practices and higher productivity of the farmers can be seen as a coping strategy for their higher vulnerability.

The vulnerability assessment shows that dryland rice farmers are significantly more vulnerable compared to wetland rice farmers, independent of farm size or study site. This is due in part to reduced annual yields from only one season of cultivation and the greater susceptibility to the negative impacts of erratic rainfall. This was made worse by a lack of coping strategies when this happens, as there is limited employment opportunities outside of agriculture in the region.

Using expert weights for the second assessment resulted in different classifications of vulnerability, with medium farmers being the most vulnerable, followed by large and then small-scale farmers. As all vulnerability assessments are subjective, this has shown the importance in whose perspective is included or not. The case can be made for greater inclusion of the communities and groups that are the subjects of the assessments in both providing weights and indicator selection for indicator based methods or combining vulnerability assessments with other participatory methodologies.

By using the concept of inherent vulnerability, this assessment accounts for the variety of stresses and challenges farming systems face in both social and environmental spheres. While vulnerability assessments are being increasingly used to assess impacts of climate change and identify possible adaptation strategies, the local level impacts of climate change can be uncertain and local ecological processes difficult to predict (Sharma, 2015: 574). It can also be difficult to order its significance in relation to other hazards and risks. Inherent vulnerability assessments show existing strengths and weaknesses of households and communities and can be used to inform and improve policy and adaption measures that strengthen against climate change but also other challenges that may be more pressing. While this is useful, certain results from this study show that highly aggregated vulnerability scores can homogenise the multifarious realities on the ground.

This study, however, also highlights diversity within the study area and show that farming systems are complex, and significant differences exist even at a local and regional level. This shows the importance of individual capacities and perspective of threats and challenges and how the are dealt with and overcome on a daily basis. Therefore, the benefit of conducting these assessments at a local level is to recognise these differences and help that to shape policy and interventions. With the increasing problems of smaller farm sizes and more environmental changes in many part of India and the world, vulnerability assessments can help identify new ways to support small farmers, which will help contribute towards social and economic development and creating better and more sustainable food production systems.

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