An Exploration to Farmer's Vulnerability and Resilience to Shocks: Evidences from Dokur

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DECLARATION

I do hereby declare that the dissertation entitled upon "An exploration to farmer's vulnerability and resilience to shocks: Evidences from Dokur" is an original and independent record of project work undertaken by me under the supervision of Dr. MCS Bantilan (Research Programme Director), Mr. Jaison Davis (Consultant), Mr. Byjesh Kattarkandi (Consultant) at Markets, Institutions and Policies, International Crop Research Institute for Semi-Arid Tropics(ICRISAT), Patancheru, India, during the period of my study as a part of curriculum of Masters in Agribusiness Economics.

Patancheru, Hyderabad By,

Date: 18th July, 2014 Shreyansh Jain

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Abstract

The smallholder farmers in semi-arid tropics are susceptible to a high degree of economic, social and climatic vulnerability due to their inability to withstand and recover from such shocks. The smallholder farmers are already large in number with a growing population leading to an increased fragmentation of land in the coming future.

Therefore, the task of identifying the most vulnerable units in terms of economic resilience becomes of primary importance. These extremely vulnerable units require special attention in order for them to survive and prosper.

This study targets the focus area of Dokur, in the Mahbubnagar district of Andhra Pradesh; an extremely drought prone area, to find out the households among a sample set who have been the most vulnerable (least resilient) or least vulnerable (most resilient) from a focus period of 2005-2011. The study incorporates the climatic and economic dynamics faced by the village and then analyses the income, consumption and asset base trends in the focus period.

A concept towards quantifying the values of vulnerability and resilience has also been explored, a study which requires more refinement.

Identification of the households by nature of their vulnerability has enabled us to meet them in person during our visit to Dokur to validate our findings.

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1. INTRODUCTION

Smallholding units play a key role in food security; they supply a large share of the global agricultural output. There is a dominance of smallholder farming systems in the world compared to large farming units. There are over half a billion farms which are smaller than two hectares, with a readily declining farm size in many countries (Hazell et al. 2007).

However, smallholders have become vulnerable to a spectrum of climatic, health, price and financial shocks against which they need to be made resilient. If such a measure is not undertaken, smallholders will continue to be risk averse and pursue more subsistence based activities causing persistence of poverty and malnutrition.

There have to be effective measures from a move from **subsistence to profit.**

The smallholders farmers have to fight the constraints of volatile food prices in the form of unanticipated price shocks leading to loss in financial and physical assets, nutritional deficiencies impairing farmer's productivity through change in cropping patterns and diminishing crop diversity (Barnett and Rugalema 2001, UN 2004), rapid climatic change, limited access to financial services leading to low saving rates and higher vulnerability. The small size and short maturity of microcredit loans do not adequately address the seasonality of smallholder's production and income cycles or their long term needs for more productive capital investments, such as machinery and storage facilities. (Bateman 2011)

It seems clear that vulnerability to climatic shocks is closely related to poverty, as the poor are the least able to respond to the likes of such shocks. Essentially, sectors such as agriculture, water resources, health, sanitation and rural development are likely to be affected by climate change. The majority of the vulnerable population of the SAT regions is poorly equipped to cope effectively with the adversities of climate change due to low capabilities, weak institutional mechanisms, and lack of access to adequate resources. Vulnerability analysis is a unique attempt to quantify and map vulnerability to find out which of the households are most susceptible to shocks. With an economy closely tied to its natural-resource-base and climate-sensitive sectors such as agriculture, water, and forestry, the SAT regions still has a large share of rural poor and agriculturally dependent population that faces a major threat because of the projected changes in climate.

Such constraints can be contradicted by certain policy measures, namely social safety nets, risk mitigation techniques and pro small holder value chains.

1.1 Defining the Terms

Smallholders: Heterogeneous farm units with a size of less than 2 hectares as per the standard global definition.

Subsistence: The act of self-sufficiency, neglecting the aim of profitability, undertaken with the sole motive of growing just enough for oneself or for the family.

Vulnerability: The measure of exposure to shocks. (Climatic, price, financial, health).Various definitions on 'vulnerability' exist, and are usually associated with natural hazards like floods, droughts, and socio hazards like poverty. However, with increased importance in climate change research, it has been widely used to compute exposure to risk. It denotes the extent of damage a region is expected to be affected by various factors affecting climate change.

The Intergovernmental Panel on Climate Change (IPCC) has defined vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (McCarthy et al. 2001). However, a number of researchers have defined vulnerability; Chamber (1983) described the different sides of vulnerability; Adger (1999) defined vulnerability as exposure of individuals or collective group to livelihood stress as a result of impacts of to the environmental shock or hazards.

Resilience: Any capacity, skill, action, strategy, investment and anticipation which helps individuals, households and communities absorb, accommodate or recover from the impacts of a particular adverse event(shock, stress or unexpected changes) (IPCC)

Resilience is a bit more than just 'adaptive capacity' although we will be using the term analogously. It is the society's capability to draw upon its individual, collective an d institutional resources and competencies to cope with, adapt and develop from the demands, challenges and changes encountered before, during and after a disaster.

The propensity to invest on natural resources, soil fertility, irrigation, preparedness in terms of building up asset bases and alternative sources of income and livelihood, educational status, access to higher education, access to institutional credit, saving productive assets from liquidation in times of need, building social capital through involvement in local institutions, access to input output markets and free flow of information are the factors which lead to higher smallholder resilience and increased profit margins.

Profitability: The capacity to operate beyond the break-even point, bringing excess revenue over costs, making the farmer open to risks and inducing further investment.

2. CONCEPTS EXAMINED

2.1 Shocks

On the basis of the framework on the analysis of vulnerability set up with the help of Dr. Binswanger during the term of the project, we have been able to classify the different levels of vulnerability.

Shock is an event that can trigger decline in well-being, which can affect individuals (illness, death), a community, a region, or even a nation (natural disaster, macroeconomic crisis). – Word Bank (2001)

Shocks can largely be looked at as (a) climate/weather-related and/or (b) idiosyncratic. While the former hits a particular community as whole, the latter allows the affected families to get relief from friends and relatives as not everyone suffers at the same time. Idiosyncratic shocks are thus easier to recover from. The adjustment mechanism is rather straightforward as the most obvious outcome in such shocks is the use of savings and over all reserves may or may not go down. Weather-related shocks on the other hand have long lasting effects as an entire community is washed off its asset-base, either due to the occurrence of the shock or in sustaining its occurrence.

2.2 Classification of Vulnerability:

Class I	Total Consumption remains unaffected.
Class II	Total consumption is maintained with help from Friends and Relatives.
Class III	Total consumption is affected (declines). Food consumption is maintained.
Class IV	Total consumption along with Food consumption is affected (declines).
Class V	Productive Assets are sold.
Class VI	Alternate employment is sought.

Table 2.1: Classification of Vulnerability: Dr.Binswanger

From past experiences of researchers and authors it has been observed that calamity hit households usually tend to lower their overall consumption is the post shock period while maintaining the same level of Food consumption. Hence the classification of Food Consumption being made independent of Total consumption allows for greater insight on the impact of Shocks. Alternate employment such as MGREGA, covered under class VI of

severity of consequences, are a representation of the reoccurrence of shocks and also the expectation of reoccurrence.

2.3 Recovery

The process by which the household regains its original position in terms of asset base, income and consumption expenditure to reach the previous standard of living, from which it had slipped on account of exposure to a particular shock whether climatic or idiosyncratic.

The speed of recovery is a determining factor in the determination of the level of resilience of a household.

Recovery can be brought about by

- Reducing the level of stocks/savings- Prior savings can be used for the purpose of asset or consumption recovery
- Increasing employment- supplementation of incomes by increasing employment opportunities both on and off farm.

Recoveries can be explored in terms of

- Total consumption recovery; where the absolute original consumption schedule is attained again after the exposure to shock
- Food consumption recovery; where the absolute consumption expenditure experiences a decline but the food consumption expenditure remains constant.
- Failure**,** in which both food consumption expenditure and overall expenditure experience a downfall, coupled with the inability to bounce back leading to a state of poverty-"Destitution". In these cases the assets are sometimes never recovered.

In exploring recovery the time by which households recover from a particular shock becomes of primary importance.

- For such an analysis, we can analyse the time for recovery of a household in a given year (taking into account if the particular household is hit by more than one shock in the same year or multiple shocks in the consecutive years).
- Next we can try to obtain if the household is still dealing with the after effects of the shock in the next year; if there is partial or total recovery.
- We do it again for the third year and the fourth year.
- Normally, by intuition, the phenomenon of total recovery will be experienced by the end of the 4^{th} year.

3. NATURE OF VULNERABILITY

Vulnerability can be considered to be a function of the character, magnitude and rate of climatic or non-climatic variation to which a system is exposed, its sensitivity and its adaptive capacity. Thus, vulnerability has three components: exposure, sensitivity and adaptive capacity Vulnerability to Climate Change (Singh, Naveen et al. 1998).

These three components described in the paper are listed as follows:

- Exposure can be interpreted as the direct danger (i.e., the stressor) and the nature and extent of changes to a region's climate variables (Example: temperature, precipitation, extreme weather events).
- Sensitivity describes the human-environmental conditions that can worsen the hazard, ameliorate the hazard, or trigger an impact.
- Adaptive capacity represents the potential to implement adaptation measures that help avert potential impacts. Adaptive Capacity can also be used synonymously with Resilience.

The first two components together represent the potential impact and adaptive capacity is the extent to which these impacts can be averted. Thus vulnerability is a potential impact (I) minus adaptive capacity (AC).

4. ASPECTS OF VULNERABILITY

Vulnerability has almost always been discussed in terms of climatic changed induced shocks, with smallholders bearing the brunt of the negative impacts of climate change, quantifiable variables including increased poverty, negative changes in asset base, food insecurity, forced sale of productive assets.

Vulnerability can have other aspects also as discussed in the paper (Tesso, Gutu et al. 2012)

There may be a social aspect with social vulnerability defined as the predisposition of people, organizations and societies to impacts from natural and man-made disasters. Quantitative description of overall social vulnerability of an area or region is measured based on variables such as proportion of elderly and children, rural housing density, gender, marital status, age, health status, educational level of household heads etc.

Farmers with high institutional participation, family with working potential and participation in social meetings usually have a high social power to withstand shocks.

The economic aspect mainly focuses on the economic status of individuals or social groups. Individuals in a community often vary in terms of wealth, assets, access to credit, access to information and technology and so on. In this connection smallholder farming units are characterised by less diversified livelihoods, low non-farm engagement, low access to credit and market, small landholdings, low holding of perennial crops, small or no land under irrigation, little access to fertilizer, low cash savings and low levels of consumption expenditure(spending less than minimum requirement).

There might be an environmental or physical aspect to vulnerability as well. The aspect includes a narrow range of resources, which leads to a high level of economic specialization, high population densities which can result in degradation and depletion of limited natural resources, small watersheds and vulnerable water supplies and thus easy susceptibility of smallholding units to physical shocks.

5. CONCEPTS OF MEASUREMENT OF RESILIENCE

Resilience, if looked at from the cost aspect as per the approach taken by Carter, 2007 presents a different dimension of study.

According to the approach, resilience can be measured in terms of the costs that a household or a community has to pay to face a particular adversity or shock.

The higher the costs, the lower is the resilience and vice versa.

Resilience costs can be broken down into:

- Preparedness cost or Contingency savings as intrinsic costs, which might be calculated as the opportunity cost of savings not invested in productive activities.
- Real costs or Impact Costs which are the actual losses faced due to shock or impact.
- Recovery Costs which maybe further broken down into
    - Replacement costs- To replace the assets lost due to shock
    - Adaptation costs- The costs of change and transformation
    - Unilateral transfers- calculated as extrinsic costs, implemented through emergency or assistance interventions.

However, Carter did not focus much on the issue of resilience but rather on the issue of determining whether a disaster can be so detrimental that it pushes down the households below a critical asset level under which these households are unable to bounce back or recover, an effect which in one of the meetings with Dr. Binswanger was termed as "Destitution".

Resilience; basically is the ability to cope up with the changes in surroundings brought around by various physical or non-physical shocks in order to regain the previous level of utility. Thus risk reduction or risk management from disasters (physical, social, ecological, economic, cultural and institutional), is a multi-faceted concept, and as such, one cannot operate without the other.

Such a multi-dimensional aspect of vulnerability has been examined in the MOVE (Methods for the Improvement of Vulnerability Assessment in Europe) framework, and has been observed in the paper (J.Birkmann et.al, 2003)

Therefore there is a need for a more holistic approach to the problem resilience, vulnerability and profitability.

RISK:

Resilience, if described as minimization of 'risk costs', measurement or assessment of risk is of primary importance to arrive at a vulnerability or resilience index.

Most of the papers address this problem from a single point of view, mostly climatic shocks.

However, a certain concept from the U.S. Environment Protection Agency quite useful ,the idea being of Cumulative Risk Management.

Cumulative Risk is the combined risk from aggregate exposures to multiple agents or regressors. Management of such involves an analysis, characterization and possible quantification of combined risk to health, economic status and environment from multiple shock agents.

However, most of the papers concentrate on the climatic factor of risk, which is no doubt one of the more important areas of concern.

- Keil, Alwin et al. 2008 aims at measuring household resilience towards drought periods and to identify its influencing factors to deduce policy implications. The research area chosen in this paper is the Palu river watershed in the Central Sulawesi province. It suggests that apart from the external, economic, social and political framework, a household's risk management largely depends upon his **asset base and attitude towards risk.**

It aims at measuring resilience as the observed degree of **drought induced expenditure reduction for basic necessities.**

PCA or the Principal Component Analysis is applied to aggregate the indicators into a Drought Resilience Index (DRI) that serves as a dependant variable in a regression model to identify it's influencing factors.

MLE method was used instead of the OLS method as a substantial share of households was found to be fully resilient, hence the distribution of the DRI would be biased.

It lays down certain **functional relationships**:

DRI=f (Hazard, Risk Management)

Hazard=f (Probability, Pressure, Predictability)

Risk management=f (Asset base, Risk attitude)

(Using Panel data to estimate the effect of rainfall shocks on smallholder's food security and vulnerability in Rural Eithiopia, Demeka, Abera Birhanu et al. 2011) uses panel data to

analyse the effect of rainfall shocks on Ethiopian rural household's food security and vulnerability over time while controlling for a range of other factors.

A time variant household food security index is developed by (PCA)**.** Based of this index, Households are classified into relative food security groups and their socio economic differences are assessed.

The next analytical step involves identifying factors which influence household food security using regression analysis. Food security is hypothesized to be mainly influenced by a household's resource endowment which we broadly summarize in 5 categories- Human capital, Social capital, Physical capital, Financial capital, Natural capital)

Both these papers emphasize on the importance of **a strong asset base** for a strong Resilience index.

6. PROFITABILITY:

In addition to subsistence, smallholder farmers must be made profitable.

In the literature I have read so far, I have come across certain examples which talk of an overall increase in profitability.

- In China, documenting formal land rights has had a positive impact on both farm productivity and non-farm labour supply(FAO 2012, Van Der Geest 2010)
- The Food Security Programme in Ethiopia combines conditional and unconditional income transfers with products and services that promote agricultural productivity and microenterprise development. This programme has increased asset holdings and productivity enhancing investments among beneficiary households in rural areas.(Gilligan, Hoddinot and Seyoum 2009)
- Similar results have been seen in the Vulnerable Group Development Programme in Bangladesh (Ahmed et al 2009)
- Reducing post-harvest losses, as 1/3 of the global food production is lost between the farmer's fields and consumer plates (Gustavsson et al 2011)

Resilience and vulnerability are essentially indispensable to each other and we cannot talk about one aspect ignoring the other one.

According to the recent discussion with Dr Binswanger, we have been able to construct a framework for assessment of vulnerability, with a focus on classification of shocks and asset based recovery analysis.

Change in Total Income and total Consumption Expenditure is a major indicator of the impact of a shock on a household.

Greater fluctuations in income and consumption expenditure would essentially mean that the household is more vulnerable, less resilient and low on asset base/savings.

7. VILLAGE PROFILE: DOKUR

Dokur is a village representative of the wetter irrigated villages in the red-soil, south Telangana region where tank and well irrigation is common, which has been exposed to recurrent drought years. The village is drought prone and adequately represents the semi-arid tropics, with normal rainfall at around 730 mm distributed erratically. It represents the medium to shallow alfisol region with agriculture being the traditional livelihood of the village population. However, due to persistent drought and drying up of irrigation sources, productivity and cultivable are have declined rapidly.

Traditionally Dokur used to depend on community irrigation tanks and in later years, private sources like open wells and bore wells. Over a period of time open wells became on-functional as bore wells began getting dug deeper and deeper. Since 2001 40% of the land has been left fallow in Dokur during the rainy season due to failure of rains and consequent non filling of the village tanks.

The major crops grown in Dokur are paddy, castor and groundnut, which owing to irrigation can be grown in both seasons. Substantial amounts of sorghum are also raised, but only small quantities of pulses are grown, mostly piegonpea. The reasons for low crop productivity are recurrent drought, uneven rainfall, water scarcity, poor soils, prevalence of pest and diseases and the poor economic conditions of the farmers.

Persistent droughts(3 out of 5 years) and resulting low crop based incomes have led to villagers adopting new adaptive and coping methods. Although a majority of households in Dokur own small patches of land, they depend mostly on labour earnings; lack of employment in the village has led to urban migration in search of non-farm employment.

However the income levels of households in Dokur more than doubled in real terms between 1975-78 and 2001-04. While income from agriculture has declined, income from non-farm labour, business, salaried jobs, caste occupations etc. have increased rapidly. The incidence of poverty has declined from three fourths to one third over these three decades. Consumptions levels have improved but a few households still suffer from energy and protein deficiencies.

Change in cropping pattern has been observed since 1975, with sorghum replacing paddy, as paddy requires more water. Since residual moisture can meet the need of sorghum, 60% of the traditional paddy has been replaced by post rainy season sorghum. Over the last ten years farmers have been unable to grow paddy as tanks did not fill up and the open wells dried up.

A third of the area is now either permanently under fallow or long fallow, resulting in a steep decline in agricultural productivity.

This table presents the rainfall scenario from a period of 2005-2012 for the village of Dokur.

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Jan	0	0	0	0	0	0	0	0
Feb	0	0	10	7.1	0	0	0	0
Mar	0	54.8	0	97	29.6	0	0	0
Apr	0	68.4	109.6	14.2	0	0	10.2	48.5
May	0	176.9	41.1	17.4	23.2	26.6	30	0
Jun	42	89.6	207.7	228.2	140.8	66.8	53.6	79.2
Jul	171.8	64.4	66.1	117.4	1.5	194	159.4	157.8
Aug	148.1	44.4	123	184.7	184.2	73.2	128.8	176.6
Sep	208.8	216.6	223.3	112.2	160.2	125.8	18.8	13.5
Oct	275.5	5.4	0	0	180.2	145.6	36	91.7
Nov	22.8	0	16	0	71.4	70.2	0	20
Dec	0	0	0	74	0	0	0	0
Total	**869**	**720.5**	**796.8**	**852.2**	**791.1**	**702.2**	**436.8**	**587.3**

Table 7.1 Distribution of Rainfall (mm)

As we can see, the total annual rainfall has been showing a downward trend with the exception of 2012 where it has improved in the year of 2012 by 34%.

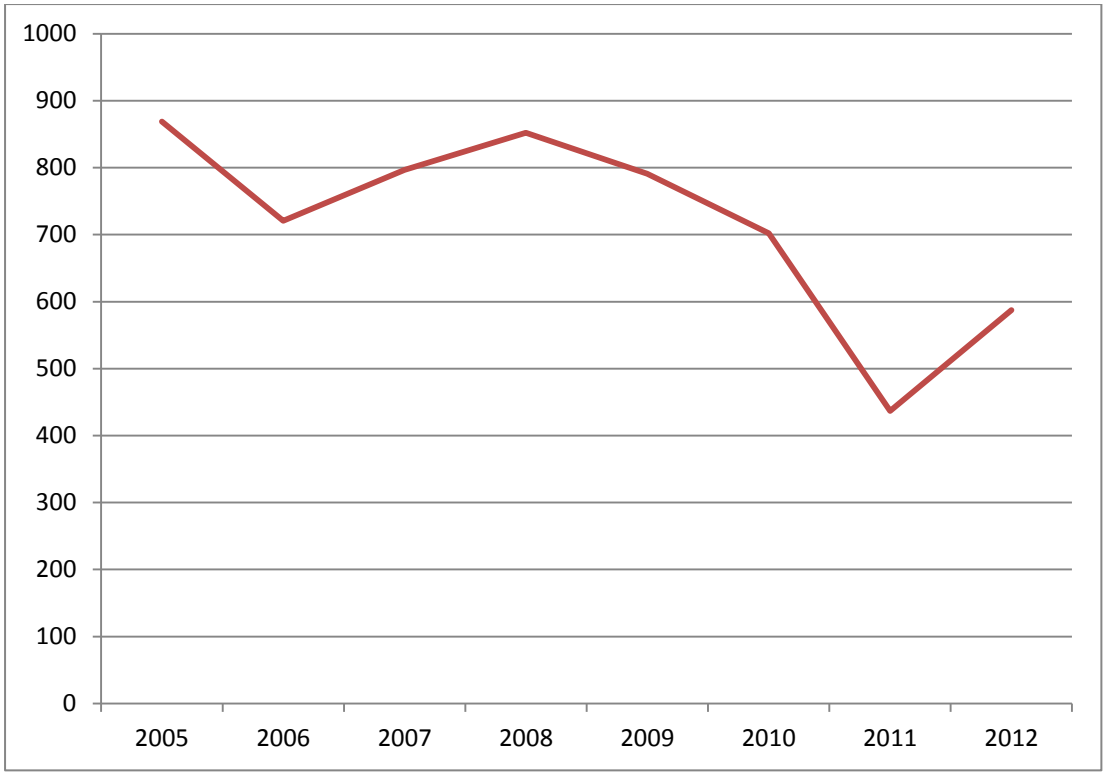


Figure 7.1 Total Rainfall (mm)

Rainfall in the peak season (June, July, September and October) shows a declining trend with minor improvement in 2012.

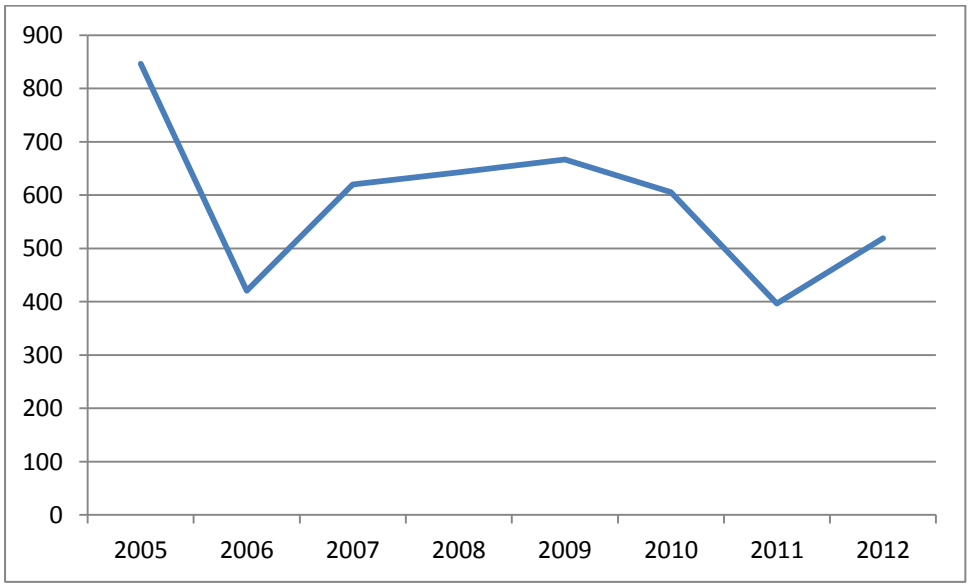


Figure 7.2 Peak Season Rainfall (mm)

Source: VDSA Database

Percentage wise income distribution from 2005-2011

There has been a persistent change in the income distribution pattern of the village from the period of 2005 to 2010 with a noticeable change from farm and livestock income to other non-farm income sources. Non farming activities include business, self-employment, migration, plying autos, driving, tailoring and low level salaried jobs.

Net incomes from crop production have declined rapidly due to a decline in cropped area under paddy and groundnut and also due to the increased cost of cultivation in the last 10 years. With agriculture's decline in importance over the years, the non-farm sector, caste occupations and migration have become more important sources of income.

	Farm income	**Non-farm income**	**Other income**
2005	**25.16**	**52.27**	**22.57**
2006	**33.05**	**48.69**	**18.26**
2007	**32.3**	**45.29**	**22.41**
2008	**16.7**	**67.38**	**15.92**
2009	**29.07**	**64.72**	**6.21**
2010	**14.16**	**75.03**	**10.81**
2011	**40.83**	**45.5**	**13.67**

Table 7.2 Distribution of Rainfall

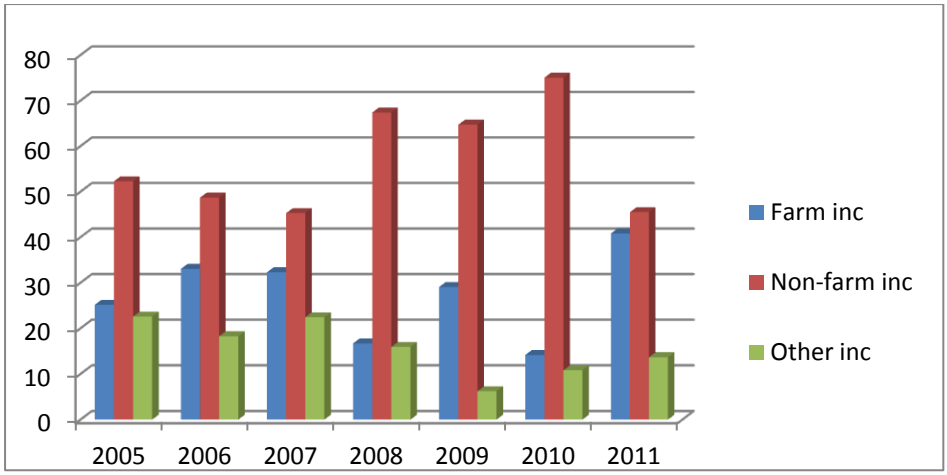


Figure 7.3 Dsitribution of Income

Source: VDSA Database

Wage Rate Averages for Male and Female Labour in Farm and Non-farm sources

Wage rates have consistently increased for both men and women for both farm and non-farm activities in the village of Dokur. However, the non-farm wages have always been higher than farm wages and there is a marked disparity in male and female wages with the male wages at a much higher level compared to female wages.

Income through labour earnings occupies an important place in the total average household income. Contract type farming is seen to an increasing trend in Dokur, where the labour wage rates are better compared to the existing daily wage rate in the village. The demand for labour for non-farm work is increasing due to the construction of new structures in the village, the food for work programme and the national rural employment schemes.

	Farm		**Non-Farm**	
	Male	**Female**	**Male**	**Female**
2005	**54.69**	**33.8**	**71.59**	**35.83**
2006	**73.52**	**46.26**	**90.13**	**48.71**
2007	**106.58**	**66.06**	**116.18**	**71.29**
2008	**115.17**	**70.14**	**136.82**	**77.32**
2009	**130.83**	**71.44**	**150**	**93.42**
2010	**160.67**	**106.51**	**184.32**	**104.25**

2011	**190.79**	**138.1**	**203.73**	**119.14**

Table 7.3

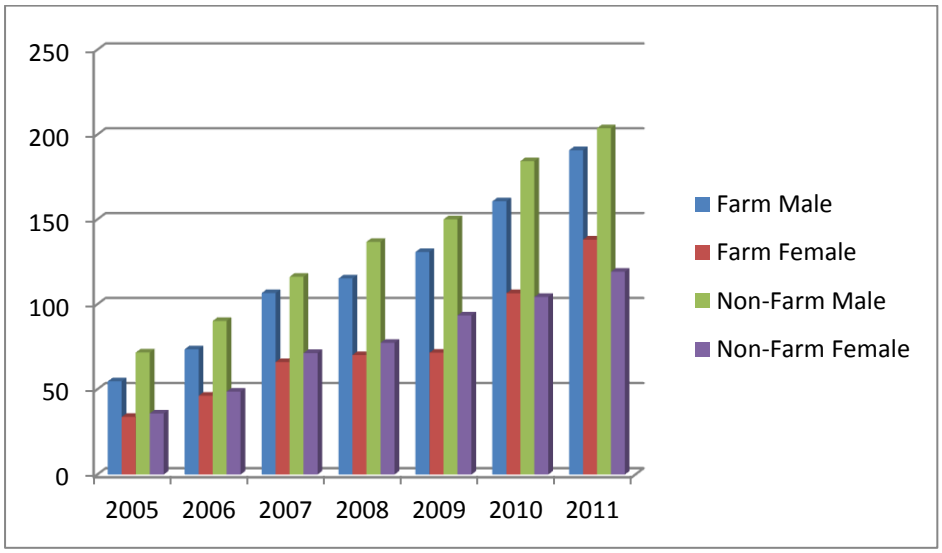


Figure 7.4 Wage Rates

Source: VDSA Database

Average Food and Non-food Expenditure per member

As observed in the data from a period of 2005-2011, the food expenditure does not change much over years but rather assumes a degree of constancy. However a major proportion of the change in total income is brought about by changes in the non-food expenditure of the household.

There has been a marked increase in the non-food expenditure per household with a diversification of both livelihood and incomes in the village.

Year	**Food expenditure**	**Non-food expenditure**
2005	2399.33	2920.79

2006	3414.98	6851.91
2007	4047.41	5631.33
2008	3984.44	6446.16
2009	4702.84	7648.65
2010	5760.8	7345.55
2011	4777.09	9305.25

Table 7.4 Distribution of Expenditure

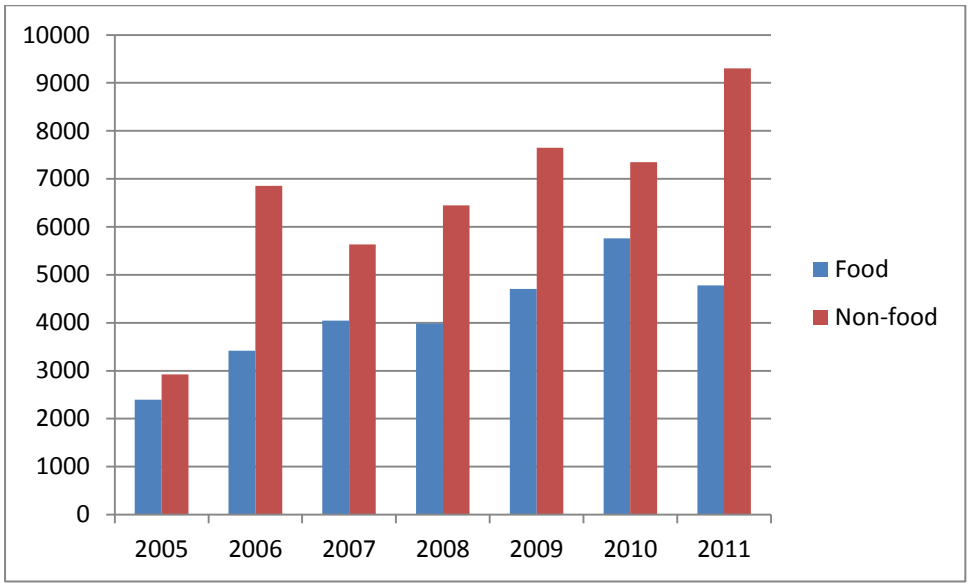


Figure 7.5 Distribution of Expenditure

Source: VDSA Database

Distribution of the different heads of Assets

Over the last four years or so, the land prices in Hyderabad and its surrounding areas have experienced a significant increase. Due to the completion of the international airport at Shamshabad, the price of land along the National Highway 7 has increased rapidly,impact in Dokur being tremendous with land prices increasing by 10-15 times.

Table 7.5 Asset Base

	2005	2006	2007	2008	2009	2010	2011
Total value of land owned	**52445**	**77645**	**155608.**	**176780**	**232291**	**231875**	**287187**
Total value of live Stock	**15904**	**10282**	**26594**	**16633**	**23375**	**23000**	**29750**
Total value of resident house and other assest	**74173**	**88083**	**104782**	**133800**	**135833**	**155000**	**230416**
Total value of stock inventory	**1353**	**2163**	**2951**	**2740**	**2416**	**2978.717**	**6269**
Total value of durables(Consumer and other durables)	**24709**	**48669.17**	**61666**	**92020**	**119666**	**123643.3**	**58715**
Farm equipment	**4665**	**8573**	**6064**	**9372**	**5860**	**5895**	**8993**
Total asset Value	**173252.**	**235417**	**357668**	**431346**	**519443**	**542392**	**621332**
Average asset value per hectare of farm	**330950**	**360295**	**540611**	**728010**	**526605**	**663233**	**792415**

Table7.5 Asset Base Changes

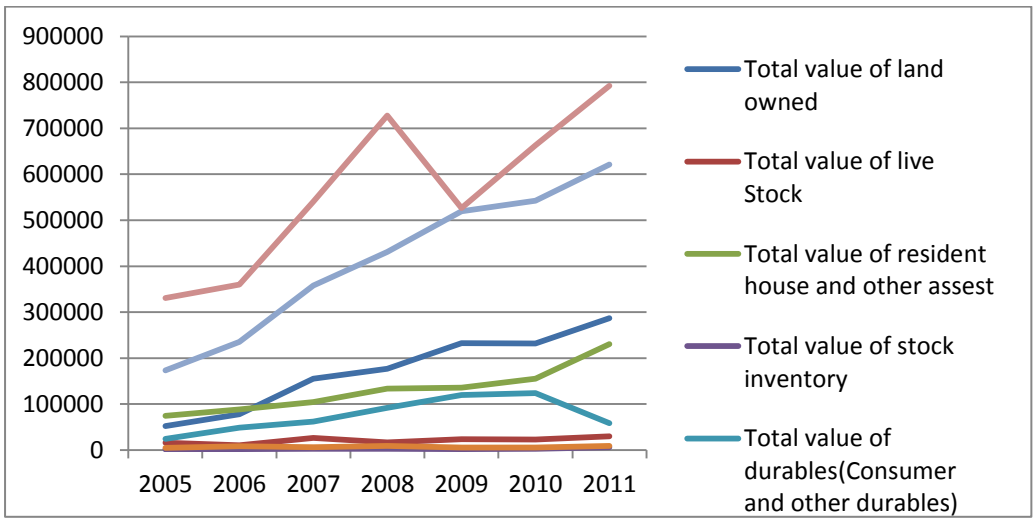


Figure 7.6 Events in Dokur

Source: VDSA Database

The table below lists the significant events which have taken place in Dokur from 1975 to 2008`

1975	ICRISAT unit set up
1978	Private school started
1984	Private school closed
1988	Water reservoir constructed
1988-89	**Good Cropping Season**
1989	Institute of Rural Health Studies set up
1991-96	**Severe Drought years**
1992	Rice mill started
1993	Anganwadi set up
1993	Gram Panchayat office comes up
1993	Public Distribution System Initiated
1994	Water tank Constructed
1994-96	Watershed Programme begins
1997	Youth Club started
1998	**Good cropping year**
1998-99	Self Help Groups start functioning
2000	Yadava Community hall established
2001-02	**Drought Year**
2002-05	Watershed project programmes
2004-05	**Drought year**
2006	NREGA scheme started
2007	Elementary school upgraded to high school
2008	New anganwadi centre created

Table 7.6 Events in Dokur

8. THE CONCEPT IN USE

The paper on the Method of Quantifying resilience, applied to the agricultural system of the Yaqui Valley, Mexico (Luers, Amy et al) provides an interesting insight into the aspects of vulnerability and resilience and can be linked to the profitability dimension as well.

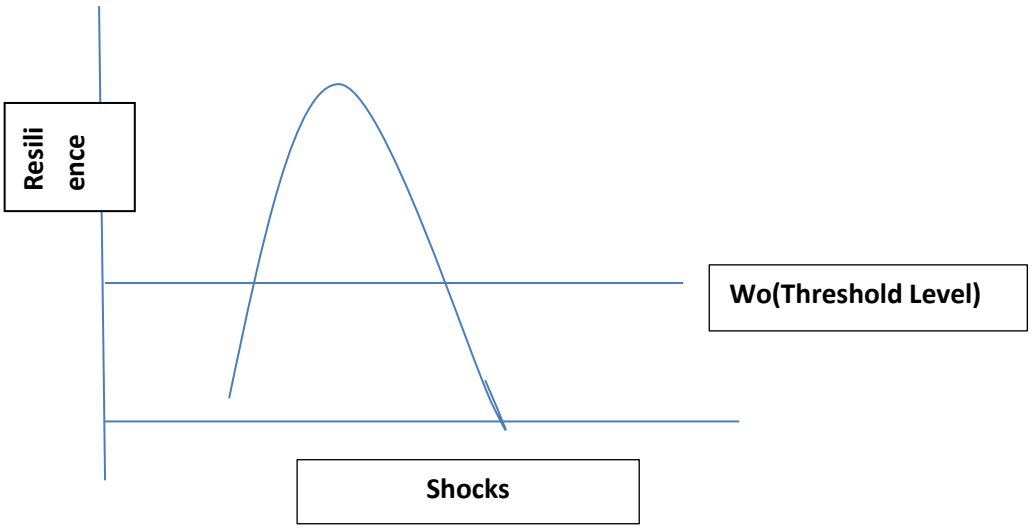
The paper uses the terms Sensitivity, Adaptive Capacity, Perturbation and Threshold which can be used alternatively for the concepts discussed before.

This paper makes an actual quantifiable attempt at measuring vulnerability and calculating resilience from it.

Key Concepts:

Human well-being (W) expressed as a parabolic function of an independent shock variable(x)

$W=f(x)$



Where, well-being (W) can be quantified in Total Income if the concept is applied to the vulnerability framework.

Therefore, *W is directly proportional to I*. (I=Total Income)

Sensitivity can be used a measure of exposure to shock.

It can be defined as the change in well-being with a given shock. Or, given change in income or consumption expenditure with a given change in shock factor.

Therefore,

Sensitivity= dW/dX or dI/dX

In the paper, vulnerability is defined as a function of sensitivity to the state relative to a threshold.

Threshold is the level of well-being at which system is said to be damaged. We can use threshold as the level of subsistence.

Therefore,

Vulnerability=f(sensitivity ÷state relative to a threshold)

State relative to a threshold= percentage change in deviation from a threshold level

Or, ***W/Wo***

Now, **Exposure** is the expected value of a household being vulnerable.

Therefore,

Exposure= f(dW/dX)*Px

Px= Probability of occurrence of shock

Adaptive capacity or in our discussion is the extent to which a system can modify its circumstances to move to a less vulnerable condition.

Therefore, we can define adaptive capacity as the difference between the vulnerability under existing conditions and vulnerability under the less vulnerable condition to which the system can potentially shift.

Or,

Resilience= V (existing conditions) – V (modified conditions)

Or, ***Max Resilience wrt***

[f (dW1/dxi)÷W1/W0] – [f (dW2/dxi÷W2/W0)]

Or, [f (dC1wo/dxiw1)] – f(dC2wo/dxiw2)

9. ANALYSIS

For the analysis of vulnerability, resilience and ultimately profitability we have chosen 48 households from the village of Dokur, both parent and fragmented for the inclusion of the dynasty term.

Codes	Original .Household	Fragmented household				
INAPDOK103	INAPDOK103275000					
INAPDOK105	INAPDOK105276000	INAPDOK105277000	INAPDOK105278000			
INAPDOK107	INAPDOK107280000	INAPDOK107281000				
INAPDOK130	INAPDOK130030000	INAPDOK130200000				
INAPDOK132	INAPDOK132032000	INAPDOK132284000	INAPDOK132296000	INAPDOK132297000	INAPDOK132298000	INAPDOK132299000
INAPDOK135	INAPDOK135035000					
INAPDOK136	INAPDOK136036000					
INAPDOK137	INAPDOK137037000					
INAPDOK138	INAPDOK138038000					
INAPDOK141	INAPDOK141041000					
INAPDOK143	INAPDOK143043000					
INAPDOK144	INAPDOK144303000					

INAPDOK146	INAPDOK146046000					
INAPDOK147	INAPDOK147047000					
INAPDOK149						
INAPDOK150	INAPDOK150201000	INAPDOK150207000				
INAPDOK151	INAPDOK151205000	INAPDOK151259000	INAPDOK151260000			
INAPDOK152	INAPDOK152052000	INAPDOK152287000				
INAPDOK153	INAPDOK153053000					
INAPDOK154	INAPDOK154054000	INAPDOK154288000				
INAPDOK155	INAPDOK155055000	INAPDOK155289000				
INAPDOK156	INAPDOK156304000					
INAPDOK157	INAPDOK157057000	INAPDOK157203000				
INAPDOK158	INAPDOK158058000	INAPDOK158290000	INAPDOK158291000			
INAPDOK159	INAPDOK159059000	INAPDOK159293000	INAPDOK159294000			

Table:7.7 Households List

I had started working on the dynasty data made available to me and have seen how the individual households have fragmented over the years from 1975. Accordingly I have tried to track down the changes in Total Income for each fragmented household, identifying the years

of “dip” and the years of “recovery”, and have applied the methods described previously to arrive at figures of vulnerability and resilience.

For calculation of the changes in asset base, variables taken into account is as follows- total income, land value, consumer durables value, farm equipment value, building value, livestock, stock inventory, borrowings and savings, lending.

With plotting food consumption expenditure and non- food consumption expenditure separately across a number of households, it has become quite evident that food consumption expenditure is a stable factor and does not vary much with the change in total income.

However, if well-being was being considered as a function of total consumption expenditure, and total consumption expenditure is considered to be a function of total income and the net asset base, we can use such a relation in a regression equation to arrive at a vulnerability index.

The vulnerability index will give us how vulnerable the household has been over a period from 1975 to 2011. The vulnerability index multiplied by the probability of occurrence of the shock will provide us with a sensitivity index.

For calculation of Vulnerability, we will need

dI/dW

From the Regression Equation

Y= b1+b2X1+b3X2+b3X3+…+bnXn

Y= Total Income

Xi= Stressor Variables

B will give us dI/dW which will be the vulnerability index if multiplied by Ii/Io which is the relative well-being, calculated as the current consumption expenditure upon the threshold consumption expenditure.

I was previously going with the hypothesis that the level of consumption is the direct indicator of well-being and is affected by the level of Asset Base, but the graphs show that it is the level of income that is severely affected by the changes in Asset Base in most cases, as such income should be considered as a function of Assets and not consumption.

We can obviously consider consumption as a function of income as a Keynesian assumption.

Therefore, now we consider well-being as a function of income, rather than consumption in our further calculations.

W=f(Y)

C=f(Y)

Y=Income

C=consumption

W=Well-Being

Choice of Threshold

The concept I have chosen for use would require a threshold level of income for the calculation of vulnerability. The choice of a minimum threshold remained a problem as different household exhibit different levels of income, consumption and asset base.

This frequency distribution table shows the average annual income levels and the number of households lying between the average income ranges.We see that a majority of the household lie between the ranges of 50000-100000, followed 100000-150000.

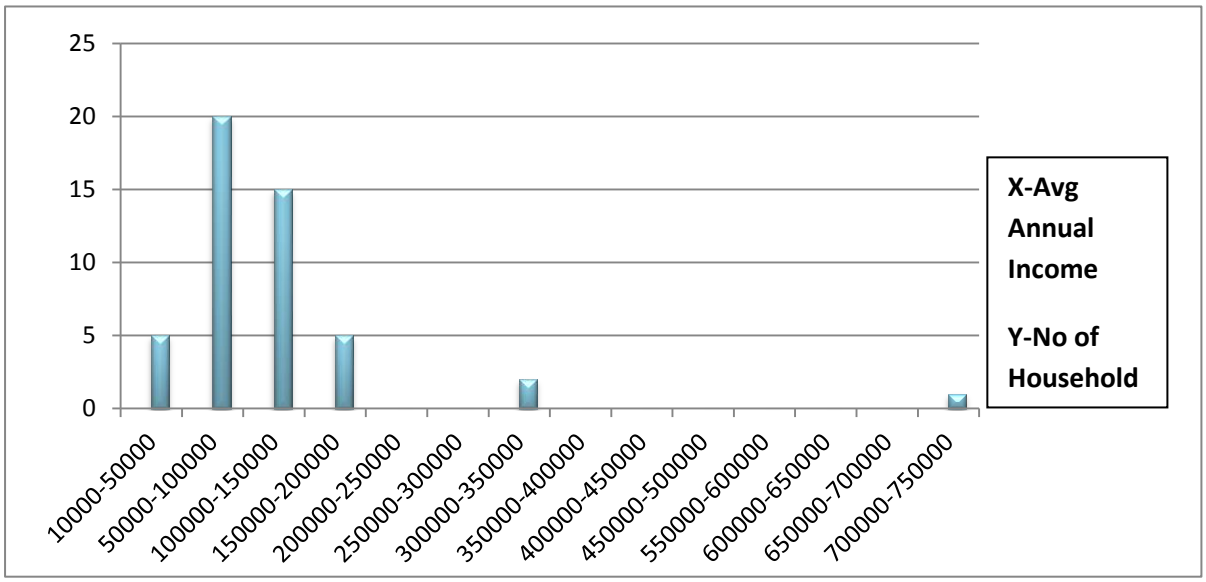


Figure 7.7 Income Groups

This table shows the 25th percentile, 75th percentile and the median incomes for the 48 households in the respective years.

	2005	2006	2007	2008	2009	2010	2011
25th pct	22227.30086	57532.6547	70019.34	52777.39	58973.94	59210.3	70958.8
50th pct	40581.07887	17631.35964	56783.05	34485.66	44523.56	23701.94	55028.6
75th pct	112660.6318	110800.0277	139803.6	115322.9	198344.2	145687.5	205140

Table 7.8 Income Percentiles

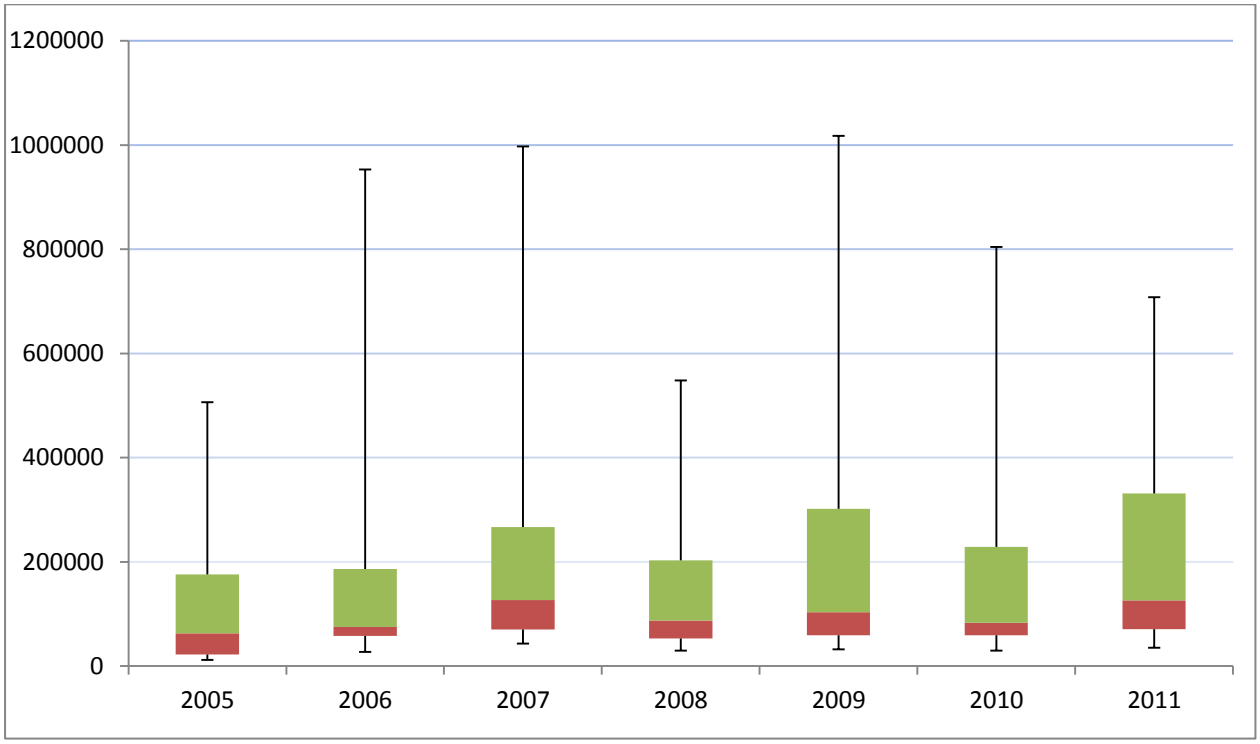


Figure 7.8 Income Percentiles

Household Analysis

Trends for Asset Base, Income and Consumption Expenditure for each of the individual households have been derived from a focus period of (2005-2011) and the households with the maximum fluctuations of income and asset base have been separated from the rest for detailed analysis.

Trends, apart from telling us the individual responsiveness of household's income with changes in asset base(the β2 coefficient in our initial regression equation), will have disclosed the units which have been resilient to external shocks and also bring into light those who have been highly vulnerable.

Income will be divided under the heads as follows:

- Crop Income
- Livestock Income
- Farm Labour Income
- Salary Income

- Non-farm Income

Further the trends for consumption expenditure and Asset base changes have been separately analysed. For calculation of the Asset Base, we take the following variables into account

- Farm Equipment Value
- Building Value
- Consumer Durables Value
- Livestock Inventory Value
- Stock Inventory Value
- Land Value
- Savings
- Borrowings

All such values have been taken at constant prices.

This table lists the income dynamics of all the 48 households in the sample taken from Dokur, making it evident the changes that have occurred in the different quarters of income in the focus period from 2005-2011.

Household Code	Total income	Crop Inc	Livestock Inc	Farm Labour Inc	Salaries	Non-farm Inc
INAPDOK103275000	decr	nil	Incr	nil	nil	incr
INAPDOK105276000	c after fall in 2006	nil	nil	incr	nil	stable
INAPDOK105277000	decr after 2010	Loss	high decr	high incr	decr	incr
INAPDOK105278000	Incr	High Incr	nil	high incr	high decr	high incr
INAPDOK107280000	Incr from 2009	nil	nil	incr	incr	high incr
INAPDOK107281000	decr	nil	nil	incr	nil	incr
INAPDOK130030000	c	High	nil	incr	nil	incr

		Incr				
INAPDOK130200000	high incr	decr	high incr	c	nil	incr
INAPDOK132032000	decr after 2005	decr	decr	incr	nil	Nil
INAPDOK132284000	decr	high decr	incr	nil	decr	incr
INAPDOK132296000	decr	incr	high incr	incr	nil	high decr
INAPDOK132297000	decr	incr	high incr	c	nil	high decr
INAPDOK132298000	incr	high decr	high incr	high decr	nil	decr
INAPDOK132299000	decr	incr	decr	decr	nil	incr
INAPDOK135035000	high incr after 2010	nil	nil	incr	incr	incr
INAPDOK136036000	decr after 2009	nil	nil	incr	high incr	decr
INAPDOK137037000	decr after 2008	nil	nil	incr	decr	decr
INAPDOK138038000	decr	nil	nil	decr	nil	incr
INAPDOK141041000	incr	decr	incr	incr	nil	Nil
INAPDOK143043000	c	incr	incr	nil	nil	high incr
INAPDOK144303000	high incr	decr	decr	incr	nil	incr
INAPDOK146046000	decr after 2010	nil	nil	nil	incr	incr
INAPDOK147047000	incr after 2009	nil	nil	nil	nil	high incr
INAPDOK147256000	decr after 2007	nil	nil	nil	nil	incr
INAPDOK147257000	decr	decr	decr	decr	nil	incr
INAPDOK147258000	decr after 2010	decr	nil	c	nil	incr
INAPDOK149049000	incr after 2008, fall	nil	nil	nil	nil	high incr
INAPDOK150201000	decr	incr	nil	nil	decr	incr
INAPDOK150207000	decr 2009, incr 2010	high incr	nil	nil	nil	decr

INAPDOK151205000	incr	decr	nil	incr	high incr	incr
INAPDOK151259000	decr	nil	nil	incr	incr	incr
INAPDOK151260000	decr	nil	nil	nil	incr	incr
INAPDOK152052000	decr	losses	decr	decr	decr	incr
INAPDOK152287000	decr	nil	decr	incr	nil	incr
INAPDOK153053000	decr	incr	decr	decr	nil	Nil
INAPDOK154054000	decr	incr	decr	nil	nil	decr
INAPDOK154288000	decr	decr	incr	high decr	high decr	decr
INAPDOK155055000	decr after 2005	incr	nil	incr	nil	decr
INAPDOK155289000	decr after 2006, incr	decr	decr	incr	nil	incr
INAPDOK156304000	decr after 2008, incr	nil	nil	decr	high incr	decr
INAPDOK157057000	decr after 2009	incr	high incr	incr	high incr	decr
INAPDOK157203000	decr	nil	nil	incr	high incr	incr
INAPDOK158058000	incr	high decr	c	high incr	nil	incr
INAPDOK158290000	high incr after 2010	decr	incr	Incr	nil	decr
INAPDOK158291000	incr after 2010	incr	c	Nil	nil	decr
INAPDOK159059000	decr after 2010	nil	nil	Incr	incr	decr
INAPDOK159293000	decr in 2007, incr in 2011	nil	nil	Incr	incr	decr
INAPDOK159294000	decr in 2008	nil	nil	Incr	decr	incr

Table 7.9 Household Classification

The task at hand was identification of such households in which a consistent dip in income across all heads, or a consistent dips in income in sectoral heads, or a steady dip in asset base has been noticed with little or no scope of recovery.

Once such households have beensegregated from the rest, we can say that these households have been vulnerable from a certain period of time and need special attention.

Similarly, if the better performing households are identified, it becomes easier to make an example of such and inculcate the same practices for the more vulnerable households to make them more resilient to shocks.

10. DOKUR: STORIES FROM THE VILLAGE

The purpose of the field visit to Dokur was to get the feel of the village dynamics in person and to validate my conclusions based on the data made available at ICRISAT.

I was content to see that the real life scenario matched the trends from the data.

I made a visit to the households who have been resilient and profitable and those who have been highly vulnerable to drought and other stressors and tried to capture their stories for a better understanding of the village.

1. Nethula Ramachandrayya

This a household which has shown a consistent decrease in total income and a decrease in asset base since 2009. Data says that there has been a fall in crop, livestock and farm labour income and also salaried income with a rise in non-farm income. In fact this household has shown losses in crop income.

This household had taken loans for cultivating land. Due to heavy rains in the sowing period, there were high losses due to crop damage. Also, whatever little had survived did not last as there was drought in the subsequent years. Land had to be sold for the repayment of debt.

Both husband and wife have migrated to Hyderabad in search of employment. They try to repay the loans with the income that they can get in the city. They have a younger child who looks after whatever little livestock that they have, and both the son and his wife are into non-farm work to earn income.

2. Kotha Telagangamma

According to the data, this household is a well performing one. There has been an increase in Total income, farm labour income, non-farm income, with a decrease in salary.

The real life scenario has validated in this case too.

This household owns six acres of land, and cultivates three acres. The remaining has been left fallow. Principal crops grown are finger millet and paddy.

Apart from this, he is a tractor driver and his wife is a farm labourer. He aslo makes money by playing in the village orchestra. In addition to this, they migrate temporarily for three to four months every year to Hyderabad to earn non-farm income. The decrease in salary has occurred due to the elder son losing his job in Mahbubnagar. He previously used to earn rupees 600 per month by helping out in a chemist shop.

3. Diviti Chinna

Data shows that this household has experienced losses in farm income and a general decline in total income.

DivitiChinna had two and a half acres of land previously, but suffered heavy losses due to lack of water. He has sold an acre of land recently in order to pay for medical expenses. He had invested heavily in three borewells, each costing his rupee 80,000, but only one of them works.

Now he is mainly engaged in non-farm labour and farm labour (puddling) work. His son is also involved in non-farm labour work

.

4. Ravula Shekhar Reddy

This household is an example of a highly resilient unit. This high level of resilience is a direct impact of the benefits of integrated farming.

They have shown a marked rise in total income, crop income, livestock income and salaried income with a steadily ascending asset base. They save on farm labour income as the total work is being done by the family members itself.

They own a total of 8 acres of land, 6000 hens and 4 cows.

They also have a family member who is highly educated and living in the United States.

They have borewell irrigated land and grow paddy, mostly.

They plan on acquiring more land as they find agriculture as a profitable and sustainable enterprise even in a drought prone area like Dokur.

In spite of very low rainfall, there cropping operations have not stopped due to proper irrigation facilities that they have acquired through savings.

5. Srinivas Rao

This is an example of a household which has withdrawn completely from farm livelihood. There has been a fall in crop, livestock and farm labour income and a minor rise in non-farm income sources.

SrinivasRao sold his land 10 years ago and invested the returns in an eatery which he runs in the village. He is also trying to earn something from the real estate business.

His family suffers from many health problems and as a result, he is unable to save anything. He wants to return back to farming but is being unable to do so because of increased land prices and the uncertainty of rainfall in the region. Also, he has no capital to invest in irrigation and fertilisation.

6. Janardhan Reddy

This household has shown a steady increase in both farm and non-farm incomes.

This is a household of 4 brothers. The first brother is a government employee, the second brother is a school teacher, Janardhan runs a cable network in the village and the fourth brother has just completed MCA.

Together they own 20 acres of land which is looked after by Janardhan as he is the only one among them who lives in the village. As a result there is a high increase in the salaried income of this household. The other brothers do not want to stay in the farming business due to its uncertainties and also because they are well educated and have jobs in the cities. They intend on selling the land as the values increase in the near future. Janardhan says that only ten acres of the twenty acres of land under them is productive. The remaining ten is almost fallow due to lack of water. He needs to run the cable business in order to support his family. He also migrates to Hyderabad and Gujarat occasionally for non-farm work.

11. VULNERABILITY AND RESILIENCE CALCULATIONS

For the calculation of the figures of vulnerability and resilience, we have used the concepts previously described

A higher level of well-being implies a higher level of income, or a higher level of consumption expenditure and vice versa. These terms can be used alternatively and are in fact, very positively correlated as consumption is directly linked with income. But as per the observations made from trends, we see that the change in assets strongly determine the change in income, whereas consumption remains almost constant all throughout.

Any change in income caused about by changes in a shock factor would provide us with a measure of sensitivity.

Now, if a basic minimum level of income (threshold) is to be set and vulnerability is to be expressed as a function of the sensitivity of a household unit to a stressor andthe current level of income to the threshold level, we could arrive at a figure of vulnerability at a given point in time.

If a household was resilient it would have a steady level of income, or in other words, given the amount of change in the stressor, his income would have been a constant component. Just because he is not, there is a change in income (a dip, as an increase in income would be a positive effect), the level of the household's vulnerability at a given point of time would differ from its vulnerability in another point of time.

If a system had high vulnerability earlier, and has low vulnerability now, it is more resilient.

Similarly, if it had low vulnerability earlier, and has high vulnerability now, it is less resilient.

A derivative of well-being (income) to the derivate of stressor(Asset base, Crop Income, Livestock Income, Farm labour Income, Salary, Non-farm income, Rainfall) will give us the level of sensitivity.

To explain such in words,

Beta coefficients will explain the change in income or well-being brought about by changes in the various stressors.

Change in total income due to changes in asset base, change in farm income, non-farm income, rainfall etc. On the basis of quantification of this concept, calculations have been made.

12. CONCLUSION

According to the trend analysis, about 56 per cent of the households have shown a decrease in income from a period of 2005 to 2011.

Around 73 per cent of the households from the 48 households in the survey have shown a decrease, losses or zero crop incomes.

Out of this 73 per cent (35 households), 24 households (69 per cent) have shown a corresponding increase or high increase in non-farm incomes, suggesting a shift in occupational structure in the village.

Around 56 per cent of the households have shown a steady decline in both crop and livestock income but an upward trend is seen for farm labour incomes and non-farm incomes, which shows that the small holder farmers have been substituting crop centred occupations for other means of livelihood.

19 per cent of the households show a decrease in aggregate farm incomes (crop+ livestock+ farm labour), with substantial increase in non-farm or migratory incomes.

Out of the 48, 12 households (25 per cent) have shown a positive trend in income mostly brought about by an increase in livestock income, farm labour income and non-farm incomes.

2 households of the 12 have shown high increase in crop incomes and one household has maintained a stable income with increase in both farm and non-farm income.

This particular household has also been able to maintain steady consumption expenditure and also has recovered most of its lost assets in the previous years.

13 per cent of the households have been able to keep their assets at a constant level or have recovered from shocks previously.

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