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Thousands of Plant Breeders: Women Conserving *in situ* Crop Genetic Resources

– A Case Study in the Medak District of Telangana, Southern India

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Thousands of Plant Breeders: Women Conserving *in situ* Crop Genetic Resources
– *A Case Study in the Medak District of Telangana, Southern India*

Tusentals växtförädlare: Bevarande av grödors genetiska resurser in-situ av kvinnor – ett fallstudie från Medak-distriktet i Telangana, södra Indien.

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Forward

This research really begun from the day I started studying Agroecology. Right from the very first lesson, the term 'holistic thinking' has been ringing through the class rooms, down on the fields, and right through this thesis. It is such an important idea because what the term means practically is for one to embrace and acknowledge **complexity**.

Because Agroecology embraces complexity full force, it will often mean those elegant and simple conclusions we want in academia, become a little irrelevant, and sometimes, obsolete. This is because Agroecology involves many people, all with diverse values and world views. People change, which means a definitive and staunchly stated conclusion becomes outdated very quickly. One main issue that Agroecology tackles is that of agricultural sustainability, which all students of Agroecology will know is an issue with innumerable contradicting facets. That is what it means to acknowledge complexity in agriculture: diverse and changing people, contradictions and multiple truths. It is not easy, but to embrace these 'messy situations' practically, there are tools at hand that have aided me in the culmination of this work. You will see in this thesis some of those, such as: systems thinking, triangulation analysis, reflective interviews, and a disciplined awareness of the omnipresent 'whole'.

There is a conclusion to this thesis, but I have explicitly mentioned in this work that this research was never going to reach a whole truth, nor does it attempt to, rather, it is a work of understanding, and of learning. The farmers spoke for themselves; you can hear their voices through this work via the transcripts. I have interpreted what I think they meant, but their voices are there for you to make your own ideas. It is about listening to what is there, not what we want to hear.

I learnt something very profound as an Agroecology student. It is a point that had a bitter taste to me at first, and it is something I am still making peace with. It simply reads, **you cannot change people**, even as much as you think you know the truth, you cannot change people to your world view, and very often, to your own reasoning. For those of us who care deeply about sustainability, this is difficult to accept; change comes from those who are willing and able to change, to expect anything more than that I think is time ill spent.

And yet, the world does change, people adapt to the winds in the air, those swirling currents that evoke people to move in a different direction. You cannot expect to control it, but you can act as a vibration within it. Agrocecology is a change in the wind, who knows how or where it will end up, but the change has come because people want it, and need it. I like to think this thesis adds a few vibrations to it.

Abstract

This study focuses on *in situ* conservation of landrace crop varieties in the Medak district of the southern Indian state, Telangana. The objective of this work was to investigate two main questions: 1) Under what unique conditions are smallholder peasant farmers willing and able to continuously grow local, landrace crops? 2) What characterises the women farmers who grow local landrace crops in this district of landrace crop origins?

A Systems Thinking methodology was used to develop and analyse the data. 101 surveys were given out across 14 different villages to build a context of what types of farms exist in the region, how they are situated, and the proportions of landrace crops grown in the area. 36 semi-structured interviews were undertaken for a deeper insight into the farmers' values and perceptions concerning landrace and modern varieties of crops. All data was collected via the Deccan Development Society network.

The results showed that there are unique socio and ecological conditions in the Medak that do make the area an important and functioning region of *in situ* conservation efforts for many landrace crops. 1. Ecologically, the district is semi-arid with scarce rainfall and general soil nutrient unbalances, this renders many modern variety crops unsuitable allowing locally adapted landraces the default crop to be used. 2. Socio-economically, farmers are without financial means, therefore, much of the investments needed for agricultural modernisation is inaccessible to them i.e. synthetic pest management inputs, irrigation, land size, etc.

The quantitative results showed that smallholding farmers conserve the most overall crop genetic diversity. This is understood for various reasons: 1. Little market integration characterised by direct on farm consumption of crops grown 2. Functioning and sprawled rural communities 3. Negative perceptions towards modern variety crops 4. Some limited institutional support 5. Functioning markets that demand local, landrace crops 6. Tradition.

The Medak district is a functioning area of *in situ* conservation for many landrace crops, and will continue to be while farmers work within the boundaries of the six points noted above. The continued sustainability of these efforts rests in the next generation whose values may depart from their fore-families while India itself goes through major agrarian changes, and education becomes more accessible.

Table of Contents

Abbreviations

LR	Landrace
TK	Traditional Knowledge
MV	Modern Varieties
SPF	Smallholder Peasant Farmers
ST	Systems Thinking
PGM	Plant Genetic Material
GR	Genetic Resources
CGR	Crop Genetic Resources
PBP	Plant Breeding Programs
Ql	Qualitative
Qt	Quantitative
DDS	Deccan Development Society
FAO	Food & Agricultural Organisation (Wing of United Nations)
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture (FAO)
CBD	Convention of Biological Diversity (FAO)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
PGRFA	Plant Genetic Resources for Food and Agriculture
BDA	Biological Diversity Act, 2002 (Outcome of CBD)
PDS India	Public Distribution System (Government subsidised food grains for farmers)

Note: Since the work of this research, Andhra Pradesh has been divided into two states. The Medak District where this case study was undertaken now exists in the state of Telangana

INTRODUCTION

This study investigates the unique conditions of a particular area of landrace crop origins in southern India, to find out how and why important crop genetic resources are being preserved by traditional smallholding peasant farmers. It is important that the genetic resources held in landrace crops are preserved by smallholder peasant farmers who exploit these resources to farm on marginal lands. By preserving these resources, farmers are creating a genetic pool that provides them with sources for future plant cultivars and aids them in overall resilient farming strategies. Plant breeders require the germplasm of these crops to develop new varieties necessary for climate change adaptation, especially for western agriculture and farms elsewhere that currently depend on a narrow genetic base, and require uniformity of product for selling into large commodity markets. It is likely that their present genetic approach is not sustainable in an unpredictable and changing environment.

Crop genetic erosion is an issue affecting strategies towards climate change resilience, and is occurring due to some specific causes and characteristics of modern agriculture: specialisation, homogenous cropping systems (monocrop), narrow market demands for a few modern bred crop varieties and biological proprietary (FAO, 2012).

There are several methods available for preserving crop genetic resources and they are all necessary for overall, sustained conservation; this study will be looking at on farm, *in situ* conservation.

Strategies working toward the conservation of crop genetic resources are difficult to implement by governments because their effects on climate change resilience are often not immediate, therefore making costs and efforts involved in conservation difficult to justify. Unlike other hard, material resources, useful and biodiverse **crop genetic resources (CGR)** are found in general, sprawled agro-biological systems maintained by millions of farmers, over large regions of land. For this reason, strategies to conserve CGR are most effective when involving entire farming systems, continuously, and communities of farmers that already conserve and aid in the preservation and evolution of important crops, indirectly.

Since almost all landrace crop varieties have emerged from areas that now exist in so called “developing” countries, where smallholder peasant farming is the standard method of agriculture, most emphasis on *in situ* conservation of CGR will be given to these local areas and to traditional farming practices.

This investigation studies the diversity of CGR conserved by farmers, generally, across a specific yet large spectrum of farms in **the Medak District in Telangana, Southern India**. This is an

important area for research because of: 1) The unique agro-biodiversity of the region holds important CGR as an emergent property of traditional farming continued for centuries. It is an area of primary and secondary landrace crop origins for many species. 2) The geographic and climatic conditions of the area make it particularly harsh for farming; including droughts, poor soil quality and scarce rainfall. This makes it an apt region for studies on climate change resilience there and provide results potentially useful elsewhere. 3) The socio-economic conditions that agriculture is developed around: monetarily poor, little industry, small farm holdings, peasant farming (direct land to mouth agriculture), little access to large commodity markets. These conditions exclude many farmers from agricultural modernisation.

The conditions investigated were socio-economic, geographic and ecological. The study extends itself to understand how farmers are conserving these genetic resources, and why. This study contributes to the trove of research being done on *in situ* genetic resource conservation by exploring a **case study** on how important agricultural genetic resources can be conserved by existing farming systems.

This work is structured in six parts. The first will give the reader the scope of work done on *in situ* conservation in the '**Theoretical Background'** chapter. Here the importance of CGR is extended, and what unique characteristics of modern agriculture are causing the *genetic erosion* phenomena and how *in situ* conservation efforts can still function in an increasingly modernising industry. The second chapter reflects on the Systems Thinking **Methodology** used to help the researcher and reader to understand the collected data. This leads onto the third **Methods** chapter, where both qualitative (Ql) semi-structured interviews were used, and quantitative (Qt) surveys given. This section will also include the limitations of the methods used and data collected. The **results** section is split into two parts, beginning with the quantitative results from the survey, followed by the qualitative analysis of the information gathered from semi-structured interviews (SSIs). The results are reflected on in the **discussion** section whereby meaning and interpretation are given to the results. This is all summarized and finalised with the **conclusion**.

THEORETICAL BACKGROUND

Thousands of **smallholder peasant farmers** in a district of southern India are selecting locally-adapted cultivars of important crops necessary for climate change adaptation. Ancient methods of farming indirectly support a manifest of agro-biodiversity by growing landrace crops adapted to local environments, saving successive seeds and exchanging them across sprawling communities. Up to the present, this informal system has developed a microcosm of crop genetic diversity. This is traditionally a feminine endeavor as women are the custodians of botanical and biological knowledge that supports the dietary and medicinal needs of their families. Women farmers of this

region *are* plant breeders and their traditional agrarian livelihoods are contributing to the development of genetic resources used by farmers and plant breeders committed to strategies towards climate change adaptation.

Landrace (LR) crop varieties in areas of crop origins contain the diversity of genetic resources essential for strategies contributing to agricultural climate change adaptation. Most of the world's crop origins lay in today's so called "developing world"; these areas include Central and Southern America, the Middle East, South East, Far East, Central and Southern Asia and Sub Saharan Africa (Andersen, 2008). Within these continents and inner countries there are delimited spaces where almost all of today's popular food crops have originally emerged. These areas are so called the Vavilov centers of crop origins and are important for two major reasons:

Vavilov Centres of Crop Origins

Nikolai Vavilov was a Russian geneticist of the mid 20th century who argued that an area where the greatest diversity of a crop is found represented its centre of origin. He located all the origins for most domesticated plants and his work has since been fundamental for plant breeding programs that use the genetic resources of crops from these areas to develop new varieties for modern agriculture (Vavilov, 1951).

1) **Unique agro-ecological biospheres that have produced crops with an ancient genetic lineage emanating from wild varieties.** Their unique ecological and social environments have developed crops that are particularly apt for environmental adaptation, including in areas of very harsh climates. The manifold genetic traits held within LR varieties are being exploited today by smallholder peasant farmers, which allow them to grow food in marginal agricultural areas. This quality marks the genesis of this research.

2) **The landrace crops that have emerged from these areas have become genetic resources that allow plant-breeding programs to exist and continually breed crops suited for specific environments and economies**. The germplasm (where a plant's genetic material is held) of LR crops is unique because of its historical, extensive genetic material history and collection of useful genes that have coevolved with the women who constantly selected better types. These modified landraces are genetic resources that have evolved over a much longer period than their narrowly selected, modern counterparts, and have originally emanated naturally from the wild making their evolutionary lineage uniquely valued.

Why Plant Genetic Resources are Useful for Climate Change Adaptation

The FAO puts it plainly that plant genetic resources provide the basis of world food production and security and hence contribute to economic development. "*By serving as building blocks for farmers*

and breeders to develop new varieties, plant genetic resources are an insurance for agriculture to overcome future challenges such as climate change and increasing food demands" (FAO, 2012, p.3).

A farmer who selects landrace-based varieties may face an economic comparative disadvantage when compared to farms using modern varieties; this may be due to a range of factors including poor soils, lack of irrigation, limited access to fertilizers and pesticides, and under-developed marketing infrastructure. Yet for the limited-resource farmer, landraces satisfy a complex set of objectives. M. R. Bellon (1996) describes five concerns a smallholding farmer may have for using her own seed varieties:

1) Environmental heterogeneity
2) Pests and Pathogens
3) Risk Management
4) Culture and Ritual
5) Diet

While modern farmers can use concentrated, oil-based forms of energy and nutrients, and chemically remedy their pest, pathogen and weed problems, a traditional farmer must recycle nutrients within their own systems and directly exploit the genetic resources existing on their farm. This is especially true on marginal areas where modern, high-tech farms are not well adapted to difficult growing conditions. Many of the forgone genetic resources in modern varieties that have been substituted with external inputs are well exploited by traditional farmers (Moore & Tymowski, 2005). While climate change begins to exert even more impact on agriculture, both modern and traditional farmers are going to need to exploit the adaptive quality of genetic resources to help their farming systems adapt to changing, growing regimes. Not least, modern farmers who want to begin to farm with less external inputs can potentially use the trove of genetic resources that are available in many crops that may help farmers meet multiple objectives. Crops need to help farmers meet multiple objectives, not just more yield per hectare and total production. Diverse varieties can help the farmer to adapt to an array of social demands such as laid out in the five points by Bellon (1996). Landrace crops have genetic resources that can and do cater to these demands, and that is why their conservation is important for future farming everywhere.

Genetic Erosion

Some genetic erosion is often inevitable in farming systems since farmers and breeders choose specific traits of plants that suit them. Farmed plants are invariably less genetically diverse than their wild counterparts. However, there are different scales of genetic erosion and a farm managed with multiple ecological goals can lessen the limitations associated by selective breeding.

Breeders can do this by becoming familiar with the biology of a species (including breeding system, mode of reproduction, and pattern of genetic diversity). This requires detailed information of the plant throughout its life cycle, making it possible to be able to select for genes that contribute to farmers' yield goals while maintaining diversity and causing as little genetic erosion as possible (Rogers 2004).

Traditional farmers are not well known for keeping detailed written information on selected seeds and the genetic traits they want, especially when such farmers may be illiterate (Almekinders & Hardon, 2006). **They work on experience and traditional knowledge**, and engage in extensive seed exchanges which spread genetic diversity across regional agricultural areas. The information contained in the seed and in the farmers' knowledge of cultivar adaptation has not been recognised as important, compared to that written in technical journals and seed catalogues. To preserve genetic diversity on farms requires that we accept farmer experience as a valid complement to that generally considered 'science'.

Hunter and Franzo (2013) notes that most of the crops eaten today in 'developed' countries, and increasingly elsewhere, are varieties far removed from their landrace forebears, and by necessity these varieties and hybrids have much less, often near zero, genetic variation from plant to plant. This uniformity has been achieved and implemented to facilitate processing and a uniform product. They (2013) reflected work done by the FAO who estimated in 2012 that of 300,000 plant species recorded, 10,000 have been used for human intake since the origin of agriculture. Ninety percent of the dietary energy provided by humans today comes from about thirty crops. Fifty percent of our energy intake is provided by maize, rice, wheat and potatoes (Hunter & Franzo, 2013). The FAO has cited three major reasons for modern rates of genetic erosion in cropping systems:

1) **Modernisation of agriculture normally forces farmers to sell into large commodity markets which drives farmers into specialised, homogenous (monocrop) cropping systems**. Giampietro (1997) observes that this is because modern farms are developed with large capital investments in machinery, chemical inputs, irrigation, extensive land, and market-bought seed, which a farmer must continually compensate for with crop income. Weighing up the costs of investment and return of profit, a large-scale 'modern' farmer works with economies of scale that peasant farmers do not. Rather than feeding a family directly from the land, which characterises most peasant farming, a modern farmer sells **most** of their output into a market. Giampietro (1997) notes again that the most profitable means of farming in market-driven farms are with monocrop systems simply because reportedly these can yield more food, more easily and more efficiently than diverse small scale farms. Monocrop farming directly decreases general crop diversity and indirectly

decreases crop genetic diversity as a consequence (FAO, 2012). This conventional wisdom about higher yields from monoculture has been broadly challenged by other authors (Altieri 2009; Francis 1986; IAASTD 2009). **See Appendix 1.a for further details.**

2) **The largest commodity food markets almost exclusively value a select few crop varieties**, almost all of which are modern breeds, and cross-pollinated species developed as hybrids where seed cannot be replanted by farmers. The most important genetic traits of modern crop varieties are normally limited to yield, size and colour. As a consequence farmers have forgone a manifold of crop varieties with other important genetic traits such as drought and disease resistance, poor soil adaptability, flood adaption, nutrition, taste, and other culturally-valuable traits, and as a consequence have inadvertently endangered many varieties by pushing them to the margins, to seed banks, or to extinction (FAO, 2012).

3) **Biological proprietary and international harmonizing laws** permit companies to patent the source of a plant's genetic makeup in the germplasm, thereby restricting its unlimited use and access by farmers, public plant breeders, and researchers from other companies. This concern was reflected by Professor Steven C Price from results of a survey he conducted involving plant breeders representing 25 universities and 41 crops in the United States.

48 percent: indicated they had trouble obtaining genetic stock from private companies
45 percent: said this had interfered with their research
28 percent: said it had interfered with their ability to release new varieties
23 percent: said it interfered with training of graduates (Price, 1999)

Prof. J. Kloppenburg explicitly comments on the impact of plant patents in the public plant-breeding sector:

"This propriety atmosphere is hostile to cooperation and free exchange of germplasm, and may hinder public sector crop improvement efforts in the future by limiting information and germplasm flow. A new type of germplasm exchange mechanism is needed to promote the continued free exchange of ideas and germplasm" (Kloppenburg, 2010, p.377).

The base genotype of a crop or plant comes from a public source in the first place. Whether it is farmed or wild, it has traditionally always been part of a wider public commons that has been the bedrock of public plant breeding programs and farming for generations. The issues involved with proprietary plant breeding is reflected by Prof. Tom Michaels:

"What does strike me as inappropriate and unfair... is that the base genotype into which the innovation is inserted, a base genotype which at its origins likely came from a public source, is locked away from further iterative improvement by the breeding community. These protection mechanisms accost the spirit of cooperation among breeders. If we look forward 20 years from now, the consequence of a flourishing propriety climate might be a deteriorating germplasm pool for public and private sector breeders alike. Without germplasm, breeding programs run out of fuel" (Michaels, 2003, p.46).

Scientists fear that if LR varieties disappear or become disused, plant breeding programs will be less able to contribute to research that develops varieties necessary for adaptation to climate change and other unexpected changes in the production environment. This is particularly important for western agriculture and large market-driven agricultural areas because of their reliance on formal commercial and genetically narrow-based varieties (Esquinas-Alcázar, 2005). Although this type of agro-biodiversity does not support the same amount of genetic diversity as traditional methods, the accuracy of finding and using particular genetic traits make it a very effective technique towards climate change resilience (GIPB, 2009).

International Awareness

Genetic erosion and the increasing disuse of landrace crops became an issue recognised and taken up in 1992 by the United Nations with the commencement of the **Convention on Biological Diversity (CBD)** signed in the Rio "Earth Summit". The convention's *raison d'être* is made explicit when they recognise "*The threat to species and ecosystems has never been so great as it is today*", most of which is human induced. The conference represents "*A dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources*" (CBD 2014, para.1).

This was taken up further in 2001 with **The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)**, which made legally binding articles against intellectual property rights over 64 crops seen as essential for food security.
The treaty 1) "*establishes a global system to provide farmers, plant breeders and scientists with access to plant genetic material* 2) *ensures that recipients share benefits they derive from the use of these genetic materials with the countries where they have been originated*" (ITPGRFA, 2014, p.5).

In 2011, the **Second Global Plan of Action** was established based on issues raised by the CDB; this builds on the 1996 first Global Plan of Action, signed by 150 countries. These issues encompass genetic erosion, international seed trade, and the need of gene banks for traditional

farmers, food security, climate change and food and genetic resource sovereignty among others). Mainly it is a plan of action to preserve the Plant Genetic Resources for Food and Agriculture (PGRFA) that it recognizes as under threat (FAO 2012).

Conservation of Crop Genetic Resources

Governments may find it hard to justify costs and efforts involved in crop genetic conservation because of the transient and sprawling nature and diverse ecosystems in which plant genetic materials evolve. Useful genetic material is one emergent property of an agriculture practiced by millions of people, over large regions of land, over an historical period of time. Because of this, it is a resource that is difficult to centrally control and regulate and therefore almost impossible for any one organisation to conserve alone. In fact, studies done on *in situ* conservation have shown that minimal institutional development and intervention is preferred when supporting methods of *in situ* conservation. "***The objective of in situ conservation is to encourage activities that are already found in farming systems that support the development and conservation of crop genetic resources****, but which may vanish under social, economic and environmental conditions*" (Brush, 1991, pp. 153-165). It is the overall, general access of a variety of these resources that is essential for farmers and plant breeders to develop strategies for climate change adaptation. Many smallholder peasant farmers in "developing" countries are the current custodians of crop genetic resources and the medium within which these resources are still evolving. For this reason, promotion of *in situ* methods of conservation of crop genetic resources (CGR) encompasses a much wider and grander scale of conservation that includes entire farming systems, such as the farms surveyed in the following case study.

There are a few types of conservation methods used to preserve crop genetic resources. The most well funded and perhaps simplest methods preferred by governments are ***ex situ*****. These include seed banks, gene libraries, germplasm gardens and botanical gardens**. There are difficulties associated with this type of conservation, the typical and most prevalent one being a lack of funding which may undermine the function of seed banks due to dysfunctional refrigeration, badly kept records, scanty rotations of existing supplies, and complicated logistics of frequent regeneration and multiplication of collections (Bahadur, Sujatha & Carels, 2012). In general though, these methods are well supported and a good way of storing alleles and genotypes of important landrace crops (Swanson & Goeschl, 1999). *Ex situ* methods are designed to maintain the genetic material in the state in which it is collected, to avoid loss or degeneration of a variety (Brush, 1999). *Ex situ* methods of conservation and their associated crop improvement programs give rise to one type of diversity because selection is directed by crop science and commercial/public breeding interests (Brush, 1999). Once a seed is kept in refrigeration, it is isolated from the evolutionary process. Likewise for germplasm gardens, although a seed may be

replanted, its conditions are far removed from farms that may later use the genetic material of the conserved crop. This entire effort is likewise divorced from the cultural and informational context which also should be considered an important resource for the future.

- **Ex situ Conservation**

There are a variety of reasons why *ex situ* methods of conservation are still being more readily supported by governments and plant breeding programs than *in situ* methods. Four major perceived reasons are laid out by Stephen Brush as to why *in situ* conservation may not be getting the same support as *ex situ* methods:

1) *"As long as crop germplasm remains in the hands of the farmer, it is not directly useful for breeders*
2) *Farmers cannot be trusted to maintain important genetic resources*
3) *In situ conservation is not popular with breeders because of a long and tortuous road that germplasm must travel between the field and the breeding program*
4) *As long as conservation and crop improvement are directly linked, conservation will be judged by its short term benefits"* (Brush 1991, p.153).

Many of these issues hold a recurrent theme, which is an inability to control the process and outcome of an evolving and complex body of germplasm in the field. Ever since crop genetic material was recognised as vitally important for climate change adaptation, while simultaneously vanishing along with entire indigenous agro-ecosystems, states and private organisations have virulently tried to capture as much of this vital germplasm resource as possible to store and preserve.

The second point on Brush's list is somewhat validated by Zeven's study that showed how the recommendations given during the International Agricultural Institute of Rome in 1927 to conserve many European landraces should be accomplished entirely by *in situ* methods - on farms, school gardens and small agricultural institutes - was a failure that has led to the disappearance of many important landrace varieties (buckwheat for example). This was caused by the total abandonment of spaces during the Second World War where landraces were being supported (Zeven, 1996). Zeven therefore concludes it is insecure to have complete trust in peasant farmers in the 'developing' countries to conserve the world's important crop genetic resources. This seems especially true while fast and affecting economic fluctuations are occurring in agrarian societies, resulting in changes which have already led to a loss of many landrace varieties in favor of modern breeds. Many cases in India validate this concern.

- **In situ Conservation**

Ex situ methods are essential to conservation strategies, and researchers are unanimous in their support on this point. However, they do not see them as sufficient in and of themselves. *In situ* methods are necessary for **sustained** and **useful** conservation of important and potentially important genetic resources and the cultures in which they are imbedded. A list by Brown (1999, pp.30) is given below reflecting on the advantages of *in situ* conservation:

1) *"Conservation of indigenous knowledge: conservation of crop genetic diversity on farms retains the diversity within its proper ethno botanical context*

2) *Conservation is linked with use and change in the field*

3) *Allelic Richness and Genotypic Diversity: on-farm populations have the capacity to support a much greater number of rare alleles and of different genotypes than accessions in gene banks*

4) *Special adaption: in situ conservation conserves a unique array of germplasm, particularly for marginal environments*

5) *Localised divergence: the in situ strategy conserves genetic diversity variation on a relatively fine spatial scale, in theory down to the individual field or even micro conditions within a field*

6) *Diversity to meet temporal environmental variation: diversity itself supports long term population resilience because it helps populations to cope with varying environments. Landrace populations of crops have survived centuries of selection in subsistence agriculture, yielding a definite, yet probably little-known benefit to the farmers that grow them. Presumably they are selected for resilience and stability through modest productivity, rather than outstanding productivity in the more favorable years*

7) *Continuing crop evolutionary process: including mutation, migration, recombination, and selection, this process provides scope for ongoing evolution, particularly in response to environmental changes and pathogen and pest pressures*

8) *Human Involvement: the effort is shared among many players and it thus is less dependent on the commitment of one institute or country*

9) *Dispersed sharing of benefits derived from genetic resources*" .

In situ strategies are mostly concerned with conservation and support of existing farming systems that already maintain the conservation of important and potentially important crop genetic resources. However, all strategies are likely to fail if their goal is to reverse the economic and technological trends that have caused genetic erosion in the first place. Brush observes that *in situ* conservation is not an industry wide strategy for a country's agriculture but one that should target some specific areas of landrace crop origins. *In situ* is not meant as an alternative to agricultural modernisation nor is it appropriate to all farmers (Brush, 1999).

Choosing Suitable Location for in situ Conservation

There are generally two important criteria points to consider when choosing an area of *in situ* conservation. They are **Ecological** and **Social** (Brush, 1999).

- **Ecological**

Firstly, the genetic divergence among crop populations and the level of genetic variation of a population is important to know. This is in order to determine whether a farming area is supporting a large enough amount of genetic diversity that could be generating potentially useful new CGR as well as preserving those in place. This would mean crop germplasm is being spread frequently within the parameters of a uniquely important area of crop genetic diversity. The parameters are important so that local genetic resources are not affected by cross breeding by other, less wanted genetic material; this phenomenon is called ***genetic drift***. Therefore, frequent and localised distribution of crop germplasm is the ideal scenario of a farming area in an important area of landrace crop origins. Brush gives a simple figure to help illustrate this, seen below in fig.1:

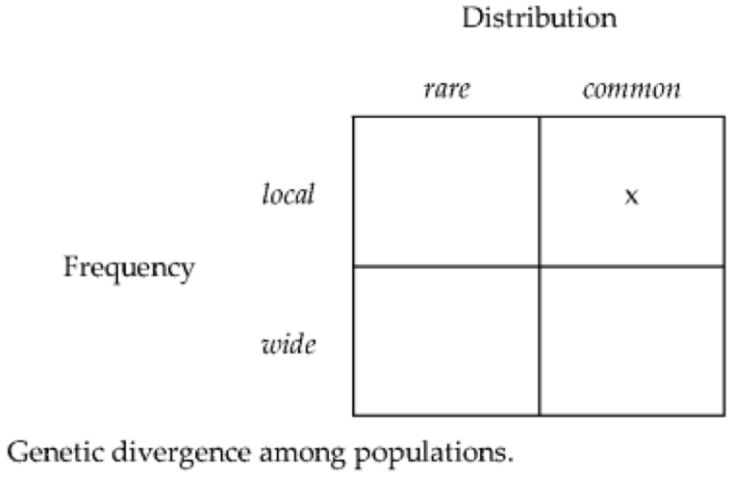


Figure 1 Brush, 1999. Ecological Criteria

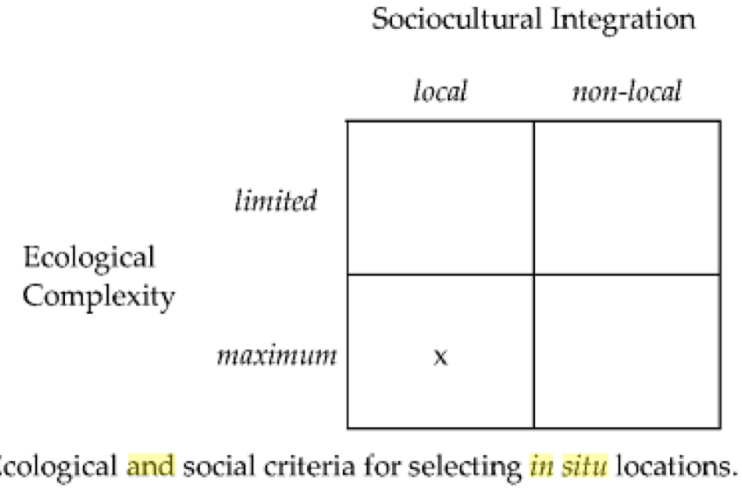
The ecological area of conservation will be based upon three other criteria important for crop diversity and evolution: presence of wild crop relatives, environmental heterogeneity, and seasonality (Brush, 1999). Environmental heterogeneity is indicated by altitude variation, diversity in soils and vegetation biomes. The Medak district where this study is undertaken has limited altitude variation but highly varied vegetation biomes and high diversity in soils.

- **Social**

The social criterion is important because agrarian societies are what define the genetic resources of a region in the first place. Since crop genetic resources are an emergent property of farming, the type of farming is vitally important when considering an area of *in situ* conservation. Characteristics of an area will include 1) what is grown, 2) how crops are grown, 3) what values are in place affecting what is grown and 4) how the resources are shared. The social criteria seen as supporting important crop genetic resources are **economic autonomy** and **strength of social integration**.

Economic autonomy would include factors such as: subsistence production, commercialisation, purchased inputs, amount of off farm employment, distance from markets and access to agricultural extension services (Brush, 1999). Simply put, how much say do farmers have in what they farm? From a lower level of market integration we would assume a farmer has more direct say on what and how they grow crops.

Strength of social integration indicates how the strength and resilience of a community to farm autonomously and independent from external market forces, as well as collectively when support is needed. The latter point also includes trust among people in the community to be able to share genetic resources via seed exchange to enlarge general regional genetic diversity and for overall access to these resources. Brush gives a figure to illustrate this simply in Fig.2:



Ecological and social criteria for selecting *in situ* locations.

Figure 2 Brush, 1999. Social Criteria

Therefore, an ideal area of *in situ* conservation would be:

1) Peasant farmers (direct land to mouth agriculture)

2) Strong community (to share and have ready access to region's genetic resources via seed exchange and general community support)

3) An area of high environmental heterogeneity and ecological complexity (general ecological diversity)

4) In an area of landrace crop origins or secondary centre of crop diversity

5) The area should also have the support of agricultural extension services and some market availability for farmers to sell local crops

Traditional Methods of Agriculture Supporting Agro Biodiversity

Traditional smallholder peasant farmers in the developing south have been utilising agro-biodiversity as a resilience mechanism for generations. They tend to grow a variety of cultivars to suit their diets and tastes but also to protect them from single crop failures during bad seasons. Many of their crops are landraces which are more genetically heterogeneous than modern varieties, and grown from seed passed down from generation to generation. These landraces offer greater defenses against vulnerability and enhance harvest security in the midst of diseases, pests, droughts, and other stresses (Altieri, 2009). In addition to these short-term motivations, farmers maintain crop diversity as an insurance to meet future environmental change or economic need. This is an ancient technique that is still used today and it is one that is being supported by many scientists and farmers as an adaptive strategy to climate change (ICSU, 2002).

CGR are an emergent property of smallholder peasant farming households, the value these farmers give to LR crops is dependent on how these crops benefit the household directly and indirectly. This is extended upon by Brush (1999) below:

*"**Direct values**: assured harvest, economic value, taste, pest management, drought tolerance, adaptation to multi-species cropping systems*

***Indirect values**: environmental services, advantages of poly-cropping, e.g. beans and maize, where beans fix nitrogen, maize produces large biomass, and the two crops complement each other nutritionally*

***Optional values**: future use of the germplasm resource and independence from the industrial system."*

It is the way of life and household demands of these farmers that contribute to the world's genetic resources. Any discussion on the social value of these crops must therefore reflect on the private costs of the preservation of landraces to these traditional farmers (Brush & Meng, 1998).

Many farmers reject plant breeders' offering of modern varieties because they are simply not designed for marginal lands, nor do they often meet the farmer's household needs or local preferences. Veernooy (2003) observes that about one-quarter of the world's population depends on these marginal lands. High yielding varieties are high maintenance. They often require synthetic fertilizers, heavy irrigation and other synthetic chemical methods of pest management to perform well, as well as new purchase of seed each year in the case of hybrids. Vernooy (2003) states that these constraints make many modern cultivars inaccessible or inappropriate for smallholder peasant farmers who cannot afford the high price of seed and fertilizers. He (2003) writes that he current one-size fits all, commercial approach to plant breeding not only fails the needs of smallholder peasant farmers, it also contributes to loss of agricultural and biological diversity.

There is concern that increased market integration by countries within centers of crop origins will undermine traditional methods of farming and put into question the continued use of LR varieties. While smallholder peasant farmers currently conserve most of the world's *in situ* LR crops (Altieri, 2003), they are seen as a valuable resource in and of themselves for farming everywhere because they are sowing, saving and exchanging seeds containing germplasm from LR varieties holding potentially important genetic resources. This issue of genetic erosion and the transient nature of agrarian societies are seen as a real dilemma in the conservation of LR crops and their genetic resources.

India: Center of Crop Diversity

About 166 species of crops including 25 major and minor crops have originated and/or developed diversity in this part of the world. A further 320 species of wild relatives of crop plants are also known to occur here, a place which includes Indo-Burma and Western Ghats/Sri Lanka. As mentioned above, India is a *Vavilovian* centre of origin of crop plants among the 12 mega centers of the world (NBPGR, 2007).

India also holds and supports an array of introduced crop diversity, which makes it a primary, as well as a secondary centre of diversity for several crops. Below (Fig.3, NBPGR, 2007) is a categorised list of crops for which India is a primary and secondary center of crop diversity:

Fig 3: India as a Center of Crop Diversity	
Primary	Rice, Black Gram, Moth Bean, Pigeon pea, Cucurbits, Tree Cotton, Capsularis Jute, Jack Fruit, Banana, Mango, Jamun, Large Cardamom, Black Pepper, Several Minor Millets and Medicinal Plants
Secondary	Finger Millet, Pearl Millet, Sorghum, Cowpea, Cluster Bean, Okra, Sesame, Niger & Safflower. Tropical American Types: Maize, Tomato, Muskmelon, Pumpkin, Chayote, Chilies, Amaranthus
Regional (Asiatic)	Maize, Barley, Amaranth, Buckwheat, Proso Millet, Foxtail Millet, Mungbean/Green Gram, Chickpea, Cucumber, Bitter Gourd, Bottle Gourd, Snake Gourd and some members of Tribe *Brassicae*

Crop groups	Crops (Botanical name)
Cereals and millets	Rice (*Oryza sativa*), little millet (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*)
Grain legumes	Black gram (*Vigna mungo*), moth bean (*V. aconitifolia*), pigeonpea (*Cajanus cajan*), horse gram/kulthi (*Macrotyloma uniflorum*), velvet bean (*Mucuna utilis*)
Fruits	Mango (*Mangifera indica*), banana (*Musa* spp.) jamun (*Syzygium cumini*), jackfruit (*Artocarpus heterophyllus*), Citrus group, lime and others, karonda (*Carissa congesta*), khirni (*Manilkara hexandra*), phalsa (*Grewia asiatica*), bael (*Aegle marmelos*), wood apple (*Feronia limonia*), kokam (*Garcinia indica*)
Vegetables	Eggplant (*Solanum melongena*), ridged gourd and smooth gourd (*Luffa* spp.) round gourd/tinda (*Praecitrullus fistulosus*), pointed gourd/parval (*Trichosanthes dioica*), taro/arbi (*Colocasia esculenta*), yam (*Dioscorea* spp.), jimikand (*Amorphophallus campanulatus*), kundri (*Coccinia indica*), cucumber (*Cucumis sativus*), rat tailed radish/mungra (*Raphanus caudatus*)
Oilseeds	Rai, sarson and toria types (*Brassica* spp.)
Fibres	Jute (*Corchorus capsularis*), cotton (*Gossypium arboreum*), sunnhemp (*Crotalaria juncea*)
Medicinal and aromatic	*Rauvolfia serpentina, Saussurea lappa*, Indian belladonna (*Atropa acuminata*), Indian barberry (*Berberis aristata*), *Commiphora wightii*
Spices and condiments	Turmeric (*Curcuma domestica*), ginger (*Zingiber officinale*), cardamom (*Elettaria cardamomum*), Bengal/large cardamom (*Amomum aromaticum*), long pepper (*Piper longum*), black pepper (*Piper nigrum*), betle leaf (*Piper betel*), cinnamon (*Cinnamomum* spp.)
Other crops	Sugarcane (*Saccharum officinarum*), bamboos (*Bambusa arundinacea, Dendrocalamus hamiltoni, Sinocalamus giganteus*), Sesbania sesban, tea (*Camellia sinensis*)

Figure 4. Major Crop Species of Indian Origin, NBPGR, 2007

Many of the landraces and primitive cultivars have already vanished and some are currently on the verge of abandonment by farmers in favour of high yielding varieties. The remaining ones are genetically deteriorating due to hybridization, selection and genetic drift (NBPGR, 2007). This study looks specifically at rain fed crops grown in a semi-arid tract of the Deccan Plateau.

Semi Arid Area: Medak District

The Medak district is located in the Zaheerabad region of Telangana in southern India. It is part of the large region of the Deccan Plateau through which runs a semi arid tract hosting some of the

poorest populations of the country. It also represents the most degraded farm areas in India (Satheesh, 2010).

The Medak district is one of twenty-four districts of Telangana spread across 9699 sq km of land. The land is made up of plains, gentle slopes and undulating hills. The mean annual rainfall ranges from 600-1100 mm and covers about 40 per cent of annual Potential Evapotranspiration demand (PET), resulting in a gross deficit of 700-800 mm of water. The length of the growing period ranges from just 90-150 days. Most of the district is recognised as drought prone. The mean daily temperatures of the dry season (May) are around 40 degrees celsius and the coolest (December) stays around 29 degrees. Average depth of groundwater is currently 91m deep. The only river of the district is dammed to supply drinking water to the state's capital city, Hyderabad, depriving farms of potential water for irrigation (DDS, 2010).

- **Social Makeup**

The total population of the district is 26.7 million, with a population density of 274/sq km. Seventy eight percent of the work force is in agriculture. The region is a so-called backward area and is predominantly inhabited by historically disadvantaged communities such as *Lambadas* (Scheduled Tribes), Scheduled Castes (mainly *Madigas*) and other Backward Castes like *Mudiraj* (fisher folk), *Kummari* (potters), *Mangali* (barbers) and *Chakali* (washer folk). Literacy rates stand at around 40%. The region has very poor infrastructure with almost no industry outside of agriculture.

- **Agro-ecological Region**

The region is characterised by **red laterite** soils and **alluvial black** soils which host a wide array of crops including sorghum, millets, pulses and oilseeds.

The agricultural challenges include:

1. High runoff during rainy season which leads to severe soil erosion and consequent nutrient loss
2. Under-irrigated agriculture and unregulated use of available ground water plus poor drainage
3. Deficiency of N (Nitrogen), P (Phosphorus) and Zn (Zinc) in soils results in nutrient imbalance
4. Frequent droughts.

Despite these challenges the district produces 160 kg per capita, per year of food grains (DDS, 2010).

Only crops that can stand the infertile soils and scarce rainwater will grow here which has meant many of the generic modern varieties grown in other parts of the country are rendered unusable in this part of the Deccan Plateau. For this reason, despite the harsh conditions of the area, the Medak district is uncommonly diverse in its production of traditional, informally bred crop varieties. Work undertaken by the Deccan Development Society shows us that up to 206 cultivated and non-cultivated varieties of crops and animals help make up the diets of people in this region (DDS, 2010). The most commonly farmed varieties of these are listed in Figure 5 below

Common English Name	Botanical Name	Local Name	Names of intra species varieties	
Amaranthus	Hibiscus cannabinus	Pundi	Yerra pundlu [red]	Tella pundlu [white]
Black Gram	Phaseolus mungo	Minumulu		
Bishop's weed	Trachyspermum ammi	Oma		
Cowpea	Vigna catjang	Bebbarlu	Tella [white]	Yerra [red]
Fieldbean	Dolichos lablab	Anumulu	Tella [white] Nalla [black]	Yerra [red]
Finger millet	Eleusine coracana	Thaidalu		
Foxtail millet	Setaria italica	Korralu	Tella [white] Yerra [red]	Nalla [black] Mansu
Green gram	Phaseolus aureus	Pesarlu	Sundari, Baandari Baalinta Manchi Kidki Pirki Theega	Neelalu Girka Kondenga Ganga Kota Chemki
Horsegram	Dolichos biflorus	Vulvalu	Tella [white] Nalla [black]	Yerra [red] Burkha saaralu [spotted brown]
Kodo millet	Paspalum scrobaculatum	Aallu/aarkalu		
Little millet	Panicum milliare	Saamalu		
Niger	Guizotia abyssinica	Gaddi nuvvulu		
Paddy	Orysa sativum	Vadlu/vari	Porka [gassy] Nalla [black] Yerra [red]	Tella [white] Budda [dwarf] Pedda [large]
Pearl millet	Pennisetum typhoideum	Sajjalu		
Proso millet		Kodi saamalu		
Sesame	Seamum indicum	Manchi nuvvulu	Nalla [black]	
Sorghum	Sorghum vulgare	Jonnalu	Thoka [loose earhead] Gundu [round earheaded] Yerra [red]	Tella malle [white kharif] Akkachellenda Gareeb [poor people's] Athakodandla

Fig 5: Varieties of crops (DDS, 2010)

Figure 6. red star indicates Medak District, googlemaps:
https://www.google.co.uk/maps/place/Telangana,+India/@17.7871348,78.6794681,8z/data=!4m2!3m1!1s0x3a3350db9429ed43:0x63ef7ba741594059 (viewed 01.Sep)

Figure 7. Medak District

The agro-ecology of the Medak has been recognised and venerated since the district has been approved as a so-called **Agro-Biological Heritage Site**, awarded for its unique farming and ecological diversity. The practical effects of this are unclear but it is a powerful symbolical gesture by the government recognising the social and ecological value the region has to the country.

Focus on Women Farmers

"*Through their daily work, women have gained knowledge of their local ecosystems including the management of pests, the conservation of soils and development of plant and animal genetic resources*" (FAO, 1999, p.1). It is estimated that 90% of the planting material used by poor farmers is derived from seed and germplasm produced by themselves (FAO, 1999*).* In smallholder peasant agriculture, women are generally responsible for selection, adaptation and improvement of plant genetic material. Because of their social roles in agricultural families, women tend to have more botanical, biological and nutritional knowledge of wild plants used for food, medicine and fodder (FAO, 1999). Research studies done on agricultural development often bias studies on women because of three main reasons:

1) Women and children are generally more directly affected by climate change than men (ADB, 2013; Lambrou & Piana, 2006).

2) Women generally follow careers in the household in agricultural communities whose responsibilities include family nutrition, cooking, cleaning, health, water collection, animal husbandry and family food crops. Studies show that men and women often have markedly different expectations and knowledge of crops (Vernooy, 2003). For this reason, women are a resource in and of themselves because of the knowledge they have developed with holistic and diverse values of food cropping and animal welfare systems necessary for supporting their families. Many plant genetic resources (PGR) are an emergent property of the demands of farming households and while women generally run the household, they are plant breeders generating potentially important crop genetic resources.

While agrarian societies today are affected by modernisation of agriculture, the conservation effort will likely come out from those who already have conservative values towards traditional farming. As illustrated above by Brush, *in situ* conservation is not for every farmer and efforts to completely reverse a modern agricultural sector are set to fail; rather strategies must support *in situ* conservation by farmers already farming with conservation methods. Women are seen as the harbingers of these conservation values because of the encompassing values with which they grow crops and rear animals.

The roles of women are so markedly important for conservation efforts, the Deccan Development Society (DDS) in the Zaheerabad region of Telangana, south India has a network of about 5000 farmers who are exclusively female. Their goal is to support the autonomous nature of smallholder peasant farmers in this region which means the conservation of all traditional crops commonly used by these farmers.

Deccan Development Society: A Female Farming Network

The Deccan Development Society (DDS) is a twenty five year old non-profit organisation that works with farmers to support their traditional farming communities. They are located in the Medak district of Telangana, southern India and have a current network of about 5000 farmers. They work exclusively with women, nearly all of whom belong to the poorest *Dalit* castes of India. Their mission is to conserve a traditional farming way of life that is otherwise becoming undermined by agricultural modernisation policies and certain market influences. They support these farmers in various ways in organic agricultural production, landrace seed conservation, access to seed germplasm, soil conservation, reforestation, local market access and sometimes with small financial loans. They want the farmers of the region to be able to farm autonomously and have laid out five main points of departure:

- Autonomy over food production
- Autonomy over seeds
- Autonomy over natural resources
- Autonomy over markets
- Autonomy over media

(DDS, 2014)

Village Sangham:
A sangham is a voluntary village farming group. A sangham may consist of many farmers who use the group to communicate and solve common problems, collectively. The Medak district has about 75 all female village sanghams working via DDS.

They achieve this with various methods, the main one is to strengthen the farmer network with weekly *sangham* meetings, which they facilitate between member representatives to discuss general issues each village faces. The women participants solve issues among themselves, while the network merely gives them a space to be together in a legitimate and safe environment. The men initially felt uneasy about this and forbade many of the women to join. With the strength of the network, they were able to convince the men to let them participate. DDS helped farmers cultivate

on lands left fallow and gave farmers access to once neglected seeds via seed banks. Markets were developed by DDS exclusively for traditional food crops produced organically in Zaheerabad and Hyderabad. This includes a restaurant Zaheerabad that sells farmers' local produce. DDS also gives agronomic advice for poly-cropping systems and promote traditional food crops in Hyderabad and wider India, especially the millet varieties.

I interviewed standing project coordinator of DDS Pastapur, Suresh Kumar on the 25th of May, 2014 who explains what DDS stands for:

"Our main goal is to create autonomous farming communities. In this sense, we include food production, over seed, over manure and the market [sic]. In this process, our focus is on small and marginal farmers, particular women farmers who are socially low" (SK).

When asked about why they focus exclusively on women, Suresh said:

"*When you look at men in the region, they always think about money and money-related issues. They don't look at issues of family welfare."* (*SK*)

When asked how DDS helps these farms conserve their traditional farming values and crops, and why they should be conserved, Suresh answered:

"The diversity has lied [sic] *with the farmers for centuries in this region. DDS only keeps that tradition alive. We tried to revive the distinct varieties of the crops here and supported farmers by giving them encouragement, manure and land development, all local food grains.*

Food culture, in the name of subsidies, support of government – the government has introduced a new food culture, which severely affects nutrition of DDS communities.

We are also supporting ecological principles. When the government and large companies introduced new crops, people were forced to use chemical fertilizers. DDS looks at agriculture in a holistic way. Buffalos, cows, chickens, goats, farmers and husband and wife involvement [sic]- This is a set of parameters of ecological farming. If something happens, it affects the whole process. For example, cows and manure; no food crops, animals don't get fodder, which means no food for the family. It's a cycle. If we protect holistic set of these things, of food security; ecological security can be ensured. The first trust is food security, once this is achieved we move to food sovereignty. Food sovereignty means being able to own your own food, your own fodder, your own manure, and working ecologically friendly. We use ecological agriculture, not organic; it's a step ahead" (*SK*)

All data produced from this research has come out of the DDS network and farmers linked one way or another to DDS members.

OBJECTIVES

I. To determine in what ways the Medak district is a suitable area for *in situ* landrace crop conservation efforts

II. To investigate what type of farmers are conserving traditional, landrace crop varieties on their farms

III. To Investigate the unique conditions of the Medak district that affect farmers' ability and willingness to conserve landrace crops where modern alternatives are available

IV. To investigate at what extent farmers are conserving LR crop varieties and how they are conserving these crops

V. To determine at what extent the conservation of CGR is being done indirectly and directly

RESEARCH QUESTION

This piece of research examines whether smallholder peasant farmers in the Medak district of Telangana are *indirectly* conserving potentially important crop genetic resources as an emergent property of their traditional farming livelihoods.

How and Why Are Crop Genetic Resources of Landrace Varieties Being Conserved *in situ* in The Medak District of Telangana, India, by Traditional Smallholder Peasant Farmers?

METHODOLOGY: A CASE STUDY APPROACH

The literature suggests that agricultural genetic erosion is an effect of some specific outcomes of modern agriculture. These outcomes have been extensively laid out in the "theoretical background" chapter. They include: homogenous cropping systems (monocrop), narrow markets that favour modern homogenous bred crop varieties, and issues with biological proprietary; restricted access

to seed via corporate and plant breeding programs controlling important seed markets. Following that line of reasoning, one might then assume “traditional farming” is the inverse of modern agriculture and therefore traditional farming will naturally be conserving extensive crop genetic resources.

Obviously, there is a problem with dividing agriculture into two distinct farming systems. Farms and agrarian communities are diverse and will often not neatly fit into one of the two farming approaches. A modern versus traditional analysis, in and of itself, does not take into consideration the complexity and diversity of farms everywhere, including in the area where this field of study was undertaken. The variables of modern and traditional farmers are too complex to make scientifically universal assumptions on their outcomes.

“General scientific laws invariably go beyond the finite amount of observable evidence that is available to support them, and that is why they can never be proven in the sense of being logically deduced from that evidence” (Chalmers, 1999, p.45)

This is partly why this research was done as a case study. By making this research a case study, it is hoped that it will contribute to the evidence that is being developed on *in situ* conservation elsewhere and that this will help get closer to a more accurate understanding of systems contributing to CGR conservation. The research does, however, not make any claims that the findings are generalisable and universally transferable. As reflected by Chalmers, “*Under precisely what circumstances is it legitimate to assert that a scientific law has been “derived” from some finite body of observational and experimental evidence?*” (*Chalmers, 1999, p.46*)

Chalmers lays out three conditions that must be satisfied for a solidly grounded inductive scientific law, that is, a law or generalisation stemming from facts built up by *hard* evidence:

1) *"The number of observations forming the basis of a generalisation must be large*
2) *The observations must be repeated under a wide variety of conditions*
3) *No accepted observation statement should conflict with derived law*" (Chalmers, 1999, p.46)

There are too many confounding factors and discrepancies in the evidence to say unflinchingly, that all traditional methods of farming are conserving important and useful crop genetic resources. Therefore, from the get go**, this study does not assume to be finding a universal whole truth**, rather as a case study, it may contribute to a general understanding of what types of farming systems are conserving diverse and important crop genetic resources.

Systems Thinking

Systems Thinking (ST) is grounded in a paradox. Its premise is on understanding the world "Whole", or as a "Holon"; the notion is that everything in the world is connected as a whole to each other in some way and therefore any separation of one element is destined to lack a complete understanding of that element. This is because the existence of one element is a result of other elements existing and relating to it. The bee for example does not exist without the flower; likewise many flowers exist because of bees. They evolved and developed together and therefore they are connected. Systems thinkers would assume that you cannot understand the bee, entirely, without also understanding the flower. However, to understand how everything relates to each other, all at once, is a task yet to be achieved. This is articulated by Bland and Bell (2007), "*If all the world is connected, then there are no connections to make, nothing to transcend, nothing to learn*" (p.283). By looking at the world as a whole and not as a set of fragmented pieces from the start one begins to see outcomes of the world as emergent properties, rather than believing in a reductionist way that insights come from breaking wholes down to their fundamental elements (Jackson, 2001). However, is it unfathomable to understand the "whole" world all at once; therefore if we want to begin to understand something, it is necessary at some point to break things down to simpler and more manageable parts. Seeing the world as interconnected *systems* therefore is a compromise between knowing the world is "whole" and yet inaccessibly complex and too large to manage or understand all at once.

A System

A system is something with defined boundaries, with outputs that are frequently unexpected, often unpredictable processes in a delimited space and population and it relates to the whole via emergent properties, both predictably and unpredictably (Jackson, 2001). Ison (2008) reflects a system as a "perceived *whole whose elements are 'interconnected'*" (p.140). The world is all connected but is made up of interconnected elements, nothing works in isolation of itself therefore, even if we do make the compromise to understand one or a few elements and not the whole (everything at once), we must always at least be conscious of the whole and how each element works within it. Ison reflects on Systemic Thinking as a philosophy:

> *"The understanding of a phenomenon within the context of a larger whole, to understand things systemically literally means to put them into a context, to establish the nature of their relationship."* (Ison, 2008, p.142)

By observing a system, one acknowledges and embraces the complexity of a situation while seeing how it relates to other systems and how they are influenced by each other; one should soon observe how together they contribute to something we can call a whole. Systems are tiered into hierarchies observing wider systems and sub systems. For instance, a farming system may encompass many sub systems: social (communities), economic (market), ecological (biospheres), soil, food etc. One cannot understand one system without knowing how it relates and depends on other (sub) systems. This should give us a picture of a web of interconnected spheres making something akin to the ecological nature of a 'whole' encompassing a community of material and non-material forces.

Simply put, the world (whole) is a set of relationships, all working, living and fighting against and with each other; just as in the natural laws of ecology shows us. What relationships do some of the farmers in the Medak district share and face that might be leading them to conserve potentially important CGR? By using a Systems Thinking methodology, this research helps the researcher and reader learn what might constitute for traditional farming and whether traditional farming does indeed conserve useful and potentially important CGR.

How to Define a System Boundary for Traditional Farming

Since we have expressed explicitly in the previous section that this research is incapable of developing a universal scientific law, or whole truth, the research will instead act as an outcome of learning, more than reaching one specific, linear answer to a question such as: 'What farming systems are best for conserving important CGR?' Ison makes this point explicit when he says systems thinking approaches do not attempt *"to manage a goal, but to learn*" (2008, p.148).
So the research begins by *learning* what may constitute a traditional farming system in the Medak District of Telangana. Since this involves thousands of people, the system boundary will not be perfectly defined; there are too many complex variables, but an attempt will be made within the Systems Thinking Methodology to define some sort of (systems) boundary to help determine if and why CGR are being conserved by a specific set of farmers. The boundary made in this research defines what a traditional, smallholder peasant farmer is.
First, a knowledge claim was made to what traditional farming is, aided by existing literature. This helped begin the research by establishing a certain context. Creswell articulates this by saying:

> *"Knowledge claim means that researchers start a project with certain assumptions about how they will learn and what they will learn during their inquiry. These claims might be called paradigms"* (Creswell, 2003, p.6).

One cannot deny the researcher's perception and *paradigms* that are influencing the research. Nevertheless, it is vitally importantly that the farmers who exist in this system we are trying to define are the ones who are defining it for us. To make this as effective as possible, we must ask two questions

1) **"The ontological question:** *What is the form and nature of reality and, therefore, what is there that can be known about it? If a real world is assumed, then what can be known about it*?" (Guba & Lincoln 1994, p.108)

This question asks what is really there, what can we understand as being *real,* explicitly. This should be relatively simple to answer for the participants and it should be understood quite well by the researcher. No moral or aesthetic values should fall into this question.
The second question we need to ask is:

2) **"The epistemological question:** *What is the nature of the relationship between the knower or would-be knower and what can be known*?" (Guba & Lincoln 1994, p.108)

This question asks what subjective values and beliefs farmers are using to shape their reality and how this will affect the boundary we are trying to define on their farming systems.

To define a traditional farming system in the Medak we need to ask farmers there what values and beliefs they have that compel them to farm and live the way they do. By accumulating their values, we begin to understand the ontology and epistemology of a traditional farming system. To do this we must ask farmers general, open-ended questions to extract as much rich and detailed information from them as possible so we can begin to develop an understanding of the web of their farming system. Creswell makes this explicit:

"The goal of research… is to rely as much as possible on the participants' views of the situation being studied. The questions become broad and general so that the participants can construct the meaning of a situation" (Creswell, 2003, p.8).

Constructivism

This is where a constructivist approach to the research comes in, whereby farmers assume certain subjective understanding on objects and things.

[Constructivism] "Assumptions identified in these works hold that individuals seek understanding of the world in which they live and work. They develop subjective meanings of their experiences - meanings directed towards certain objects or things" (Creswell, 2003, p.8).

Constructivism takes the view that we cannot know the whole truth and that it naturally follows that our understanding of reality can at best only be a construct based on our perception of reality. This research was concerned with farmers' perceptions and actions and as such it is underpinned by a constructivist paradigm. The epistemological question is the genesis of constructivism, knowledge is changing and tied to peoples' worldviews and perceptions, therefore knowledge is a collective accumulation of how people see and react to the world. In the context of this work, the concept of traditional farming is malleable and changing; it is a construct this work is attempting to define. Although the concept itself is abstract in nature, it has practical consequences. A farmer's willingness to use modern or traditional varieties is an example of the practical effects associated with how farmers perceive themselves and how they react to the world.

By understanding the farmers' beliefs and values, we can begin to understand how these affect their relationship to landrace and modern varieties, and how that in turn affects what they choose to grow. Generally these meanings are "*varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories of ideas*" (Creswell, 2003, p.8).

Despite the sympathetic nature constructivism has to multiple and varied worldviews, one must acknowledge the influence the interpreter finally brings to a constructivist understanding of a situation. This person is making sense and reflecting on the construction generated by many people and their interpretation undoubtedly affects the articulation of that construction. In this research, there were four main interpreters, 1) The DDS, who chose the interviewees. 2) The translator, who filters what farmers said in the local language via English. 3) The researcher, who articulates and tries to make sense of all the information collected. 4) The reader, who finally makes their own conclusions and reads the information with his or her own perspective.

A number of methods developed and suggested by system thinkers were used to collect and analyse the data. This formed a systems thinking methodology with a constructivist perspective.

METHODS

For this research, a mixed method approach using both **quantitative** and **qualitative** methods together was chosen.

Qualitative Methods

A semi-structured interview for 36 participant farmers across 10 different villages was developed. It included 18 different open-ended questions to help gain an understanding of the beliefs, values, feelings and thoughts of the participants towards their farms, livelihoods and traditional crop varieties. This helped define a system boundary around traditional peasant farming. It also helped to better understand why, and how each farmer farmed the way they did. They expressed their social and ecological constraints and their explicit values on local, traditional crops compared with modern variety crops. "*The text becomes a way to get "behind the numbers" that are recorded in a quantitative analysis to see the richness of real social experience*" (Schutt, 2012, p. 321).

The questions were mostly open ended and were formed around one leading preconceived principle. I wanted to know general perceptions on modern variety and traditional crops, and why they grew the ones they did. The 'why' question was to investigate how much choice, or willingness was involved in their decisions, and how much of it was out of necessity. This would include ecological and economic factors. Out of this, I wanted to know the challenges confronted with both these crops and whether they were satisfied with their current state of farming; did they expect something that they were not getting for example. **The questions are attached in Appendix 1b**.

Each interview was translated from English into Telugu and lasted anywhere from 40-60 minutes. A translator accompanied me during each interview. Each interview was recorded with the consent of all participants. All except one agreed to being recorded. A daily diary was written to help with the later analysis of results; it was used to record my own feelings and the interpretations I made on the day. Most of the farmers were women, all except 4 out of 36. Most of the participants were DDS members, only 5 were not. The sample population was done purposively, that is: "*participants according to preselected criteria relevant to a particular research question*" (Mack, Woodsong, MacQueen, Guest & Namey, 2005, p.5).

Qualitative Analysis

I began by reading and reflecting on all the transcripts of the interviews. From there I began to separate sections into themes, as suggested by Rosalind, "*Themes are a starting point for thinking about the messiness without breaking the mess into bits or losing sight of the detail*" (2011, p.202).

The messiness refers to the complexity and sheer amount of diverse data collected. From the themes, I began to make order out of the data by reflecting specifically what the farmers said, and on general values that arose. I never tried to find a single truth or answer, rather I reflected on Harwell when he says that qualitative research will have "multiple *truths that are socially constructed*" (Harwell, 2003, p.148). This compelled me not to make sweeping, single generalisations even if recurrent themes were expressed; "*Replicity and generalisations are not generally goals of qualitative research*" (Harwell, 2003, p.149). Again, Sofaer referred to this by saying, "*Data from qualitative research are typically suggestive, rarely if ever conclusive*" (Sofaer, 2002, p.334).

Quantitative Methods

A survey was developed consisting of 20 questions sent to 101 farmers across 19 villages. This helped to give general context to the farming systems in the district. It was translated into Telugu and given out by 10 DDS village member representatives. This was important to see how much general CGR are being conserved and what types of farms are conserving significantly more than others. I wanted to find out if there were any specific correlations between certain variables on the farm, and on farm crop genetic diversity being conserved. These included farm size, certain external inputs, market integration, distance from market etc.

Quantitative Analysis

STATA Version 11® was used to test the given variables.

a) Grouping

I began by grouping all the qualitative (Ql) variables into categories, despite the fact that the group names are numbers (0%, 25%, 50% etc.), they are qualitative because the survey asked them to choose from one of the five categories. It was expected that the farmer would not know the precise percentage amount of traditional crops grown on their farm, therefore we asked for a rounded estimate. To make it simpler, one can imagine the group names as none, very little, little, average, large, very large.

b) Bi-Variate Tests Used

I used three bi-variate tests depending on the variables used. I used the Fisher test when both variables were Ql. I used the Wilcoxon Rank Sum test when the dependent was quantitative (Qt) and the independent was Ql. I Used the Kruskal-Wallis test when both variables were Qt

c) Multi-Variate Tests Used

- **Ordered Logic Regression:** This multi-variate test used for the first quantitative hypothesis is an ordered logic regression because the dependent variable is grouped and ordered qualitatively (IDRE, 2014) and the independent variables used are both Qt and Ql. The space between each category is evenly spaced and can be ordered but the space in between each category is not exactly clear.
- **Logistic Regression:** A standard Logistic Regression test was used for the second quantitative hypothesis multi-variate procedure. This is because our dependent variable is a categorical dichotomous variable (i.e. Yes/No) and both Qt and Ql independent variables to test it with are used.

LIMITATIONS

1. One of the most affecting limitations of this quantitative analysis relates to one particular variable. The variable 'Crops' was supposed to measure the amount of crop varieties a farmer grows throughout the year. Although this could have been an estimated amount the variable could not finally be used because it was skewed by an error in translation on the survey. The survey asked, how many crops do you grow? Not, how many crop varieties? This meant if they grew many varieties of millet, only one would be recorded in the survey because they assumed the question just meant crop. This would have made for very interesting results if it had been translated correctly. Therefore, we cannot see how much on-farm crop diversity is being supported by the farmers from the collected information.

2. The variable TradSeedG might be slightly skewed because I discovered in the qualitative interviews that many farmers believed sugar cane is a traditional seed because they can save it and reuse it for up to three years. Sugar cane is not a traditional, local variety. It is also one of the most commonly used cash crops in the region because of the large sugar refinery that operates there.

3. Most of the farmers were DDS members. This undoubtedly affects the answers farmers gave in the survey. This is not necessarily a limitation in and of itself because the participants were chosen purposively. However, in responses connected to amounts of traditional seed used and whether or not they use synthetic pesticides and/or fertilizers, the responses might have been different for want of saving face in front of the DDS organisation.

4. Language was an important limitation in this work. Any conversations I had with farmers were through a translator who interpreted words and phrases in his own style. This affected the QI results because of the subjective nature of the data. This might have been improved with a trained translator who has experience in local traditional agriculture. Time and finances limited my access to a trained translator.

5. Finances limited the amount of participants of the survey since each DDS representative who handed out the survey to the farmers across the district had to be paid.

RESULTS

Quantitative Results

Understanding Who Grows Traditional Seed and Why

This section reports the results of a survey of 101 farmers in 19 villages. It gives a wide context by describing the types of people and farming systems that grow traditional, landrace seed varieties in the Medak district of Telangana. It also gives us a look at what unique conditions a farmer of traditional variety food crops works and lives within that might affect their willingness and ability to use these varieties. This section is important because it includes many more farmers than otherwise could have been gained via the in-person, qualitative interviews. Two hypotheses are given associated with two dependent variables. One is generally associated with traditional seed and the other focuses on the market.

- **Description of Variables**

The table below describes each variable that was tested. The mean and frequencies are given further below illustrated by graphs.

NB: The 'G' at the end of the variable marks that it has been grouped

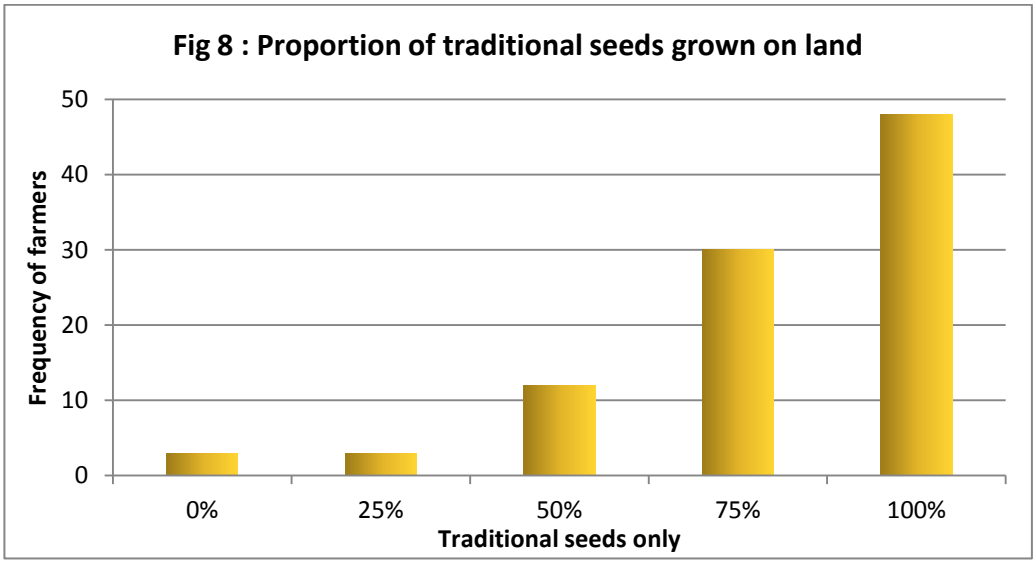
Variables	Description
TradSeedG	The percentage of crops grown by a farmer on their land that are traditional, landrace varieties. This has been grouped into 0%, 25%, 50%, 75%, and 100%
DiffcltSellG	Whether or not a farmer thinks it is difficult for them to sell their food crops on the market. This is grouped as a dichotomous variable: Yes/No.
DDSMKTG	This is the percentage of crops that are sold by the farmer through the DDS (Deccan Development Society) market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
Land	This is the amount of land on which a farmer grows crops. This is a purely quantitative variable, and is measured in acres.
FCropG	The proportion of crops a farmer grows as food directly to eat for themselves and their family. Food crops are not sold on the market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
SynChemG	The proportion of farmers that use synthetic fertilizers and/or pesticides. This has been grouped as a dichotomous Yes/No
IncmeOLG	The overall proportion of income earned directly from a farmer's own land. This is in contrast to earning a wage elsewhere or renting land for example. This has been grouped 0%, 25%, 50%, 75%, and 100%

1. TradSeedG

The table below shows us that half of the farmers use only traditional landrace seed varieties. Only 6% use less that 50% traditional varieties and only 3% do not use them at all. 80% of farmers grow at least 75% of their crops from traditional seeds; therefore most of the farmers surveyed grow predominantly traditional seed varieties.

Proportion of traditional seeds grown on land (%)	Frequency	Percentage (%)	Cum.
0	3	3.12	3.12
25	3	3.12	6.25
50	12	12.50	18.75
75	30	31.25	50.00
100	48	50	100.00
Total	**96**	**100**	

This is shown clearly on the histogram below. The y axis shows the proportion of farmers surveyed while the x axis shows the proportion (grouped %) of traditional, landrace seed varieties farmers use overall on their farms.



1. DiffcltSellG

Distribution between people who feel it is, and is not difficult to sell their traditional variety food crops on the market. Well over half the framers did not find it difficult to sell their traditional variety crops on the market.

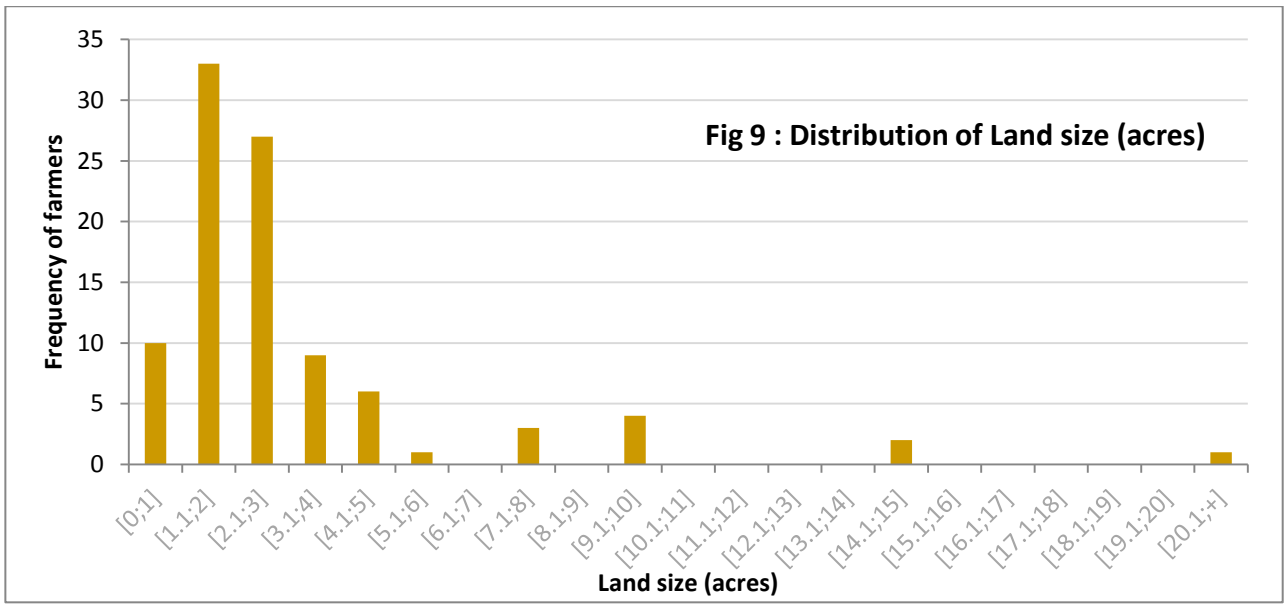
Do farmers find it difficult to sell their traditional crop varieties (No/Yes)	Frequency	Percentage (%)	Cum.
No	66	65.35	65.35
Yes	29	28.71	94.06
Not Answered	6	5.94	100
Total	**101**	**100**	

2. Land

Here we see the size of lands surveyed in acres and the mean size below. Almost 70% of farmers surveyed have less then 3 acres of land. The mean size is 3.56 acres not excluding the largest, and potentially outlying, land size figure of 20.5.

Land Size (Acres)	Frequency	Percentage (%)	Cum.
1	10	9.90	9.90
1.3	1	0.99	10.89
1.5	11	10.89	21.78
2	21	20.79	42.57
2.2	1	0.99	43.56
2.3	2	1.98	45.54
2.5	5	4.95	50.50
3	19	18.81	69.31
3.5	5	4.95	74.26
4	4	3.96	78.22
4.5	1	0.99	79.21
5	5	4.95	84.16
6	5	4.95	89.11
6.5	1	0.99	90.10
8	3	2.97	93.07
10	4	3.96	97.03
15	2	1.98	99.01
20.5	1	0.99	100.00
Total	**101**	**100**	

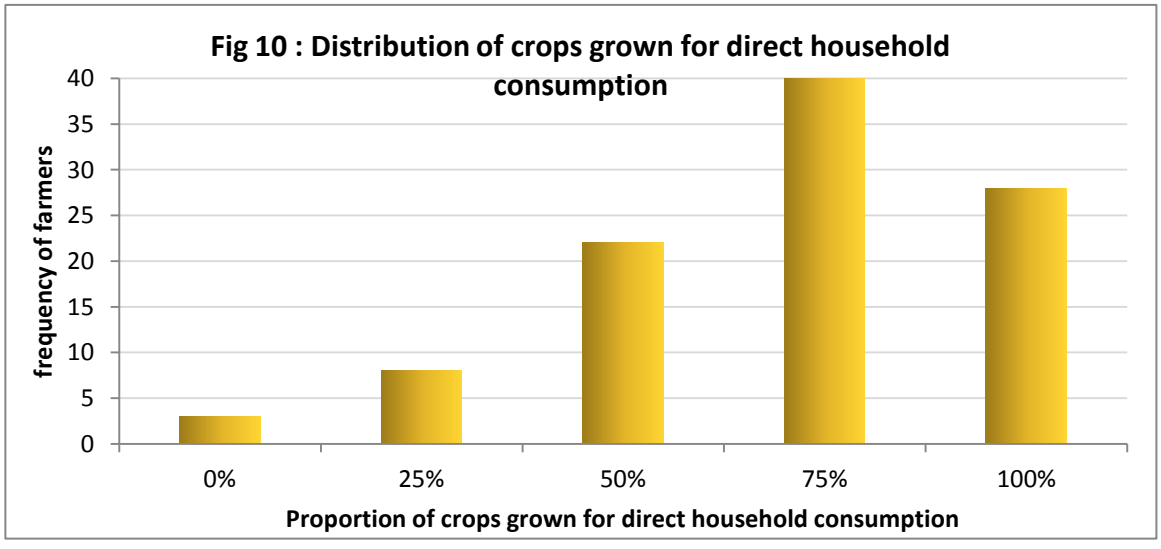
Mean	Std. Dev	Min.	Max.
3.565	3.175	1	20.5



3. FCropG

Below is a table showing us the percentage of food crops grown directly for on farm, household consumption as an overall percentage on their land. 67% of farmers grow 75% or more food crops to eat for themselves and their family directly.

Proportion of Crops Grown for direct household consumption (%)	Frequency	Percentage	Cum.
0	3	2.97	2.97
25	8	7.92	10.89
50	22	21.78	32.67
75	40	39.60	72.28
100	28	27.72	100.00
Total	**101**	**100.00**	



4. SynChemG

A farmer's willingness to use synthetic pesticides and/or fertilizers on their farm. There is quite a high number of farmers who refused to answer this question (17.8%).

Does Farmer Use Synthetic Pesticides and/or Fertilers (No/Yes)?	Frequency	Percentage (%)	Cum.
No	46	45.54	45.54
Yes	37	36.63	82.18
Not Answered	18	17.82	100.00
Total	**101**	**100.00**	

5. DDSMRKTG

Percentage of crops sold by each farmer via the DDS (Deccan Development Society) market. Over 70% of farmers sell under half of their crops via the DDS market, therefore most crops are sold elsewhere.

Proportion of crops sold to DDS market (%)	Frequency	Percentage (%)	Cum.
0	20	24.39	24.39
25	34	41.46	65.85
50	9	10.98	76.83
75	6	7.32	84.15
100	13	15.85	100.00
Total	82	100.00	

- **Exploratory Results**

What affects the proportion of traditional, landrace seeds a farmer sows on their land?

This statistical analysis investigates what variables affect the proportion (%) of traditional, landrace crops a farmer sows on their land in the Medak District, of Telangana, South India. The variables used are illustrated in the table below:

Variables	Description
TradSeedG	The percentage of crops grown by a farmer on their land that are traditional, landrace varieties. This has been grouped into 0%, 25%, 50%, 75%, and 100%
DiffcltSellG	Whether or not a farmer thinks it is difficult for them to sell their food crops on the market. This is grouped as a dichotomous variable: Yes/No.
DDSMKTG	This is the percentage of crops that are sold by the farmer through the DDS (Deccan Development Society) market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
Land	This is the amount of land on which a farmer grows crops. This is a purely quantitative variable, and is measured in acres.
FCropG	The proportion of crops a farmer grows as food directly to eat for themselves and their family. Food crops are not sold on the market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
SynChemG	The proportion of farmers that use synthetic fertilizers and/or pesticides. This has been grouped as a dichotomous Yes/No
IncmeOLG	The overall proportion of income earned directly from a farmer's own land. This is in contrast to earning a wage elsewhere or renting land for example. This has been grouped 0%, 25%, 50%, 75%, and 100%

- ***Bi-variate Tests***

The dependent TradSeedG variable is tested with other independent variables. In this section, four bi-variate tests have been undergone to see if there are any significant associations between them. The two variables we will use together are shown side by side followed by the bi-variate test used in brackets. All p values under **0.05** have some significant association between the two variables.

Dependent Variable	Independent Variable	Test	*p* Value
TradSeedG *(proportion of traditional crops grown)*	**SynChemG** *(synthetic inputs used)*	Fisher	**0.00**
	FCropsG *(proportion of household crops grown)*	Fisher	**0.001**
	Land *(land size)*	Kruskal-Wallis	**0.0098**
	IncmeOLG *(income earned from own land)*	Fisher	0.126

❖ ***Multi-variate Tests***

Since finding some significant correlations between our dependent variable (TradSeedG) with three of the tested independent variables via the bi-variate test, we now undergo a multi-variate procedure. An **Ordered Logic Regression** was used because the dependent variable is grouped and ordered qualitatively (IDRE, 2014) and the independent variables used are both quantitative Qt and qualitative Ql. Despite the fact that the group names are numbers (0%, 25%, 50% etc.), they are qualitative because the survey asked them to choose from one of the five categories. The space between each category is evenly spaced and can be ordered but the space in between each category is not exactly clear. It is a qualitative answer and therefore our dependent variable is an interval scale of measurement.

Three independent variables were significantly associated with the amount of traditional crops grown by farmers (TradSeedG), when tested in a multi-variate procedure all but one remained significantly associated.
When the independent variable was tested together with the dependent variable (TradSeedG), the *p* value for all but SynChemG became significantly disassociated from our dependent variable. FCropG became 0.289, which is significantly different to the p value of 0.001 from the bi-variate test. The p value for Land in this mixed procedure became 0.260, which was previously tested as 0.0098 in the bi-variate. SynChemG remained highly significant with a new p value of 0.003. This is seen in the following table. Note that the variable FCropG has been separated into its own groups. The coeffients show that the proportion of food cropsincrease only marginally when land and synthetic inputs are not used. Both land size decreases and sythtic uinputs used when tested together, although only SynChemG remained very significant.

Dependent Variable	Independent Variable	Test	*p* value	Coef.
TradSeedG	**FCropG**	Ordered Logistic Regression	0.289	.0093
	Land		0.260	-.0697
	SynChemG		**0.003**	-1.412

See original STATA table: Appendix 0

FCropG was tested again with the dependent variable and Land. Its association with TradSeedG became insignificant (p = 0.079) though much less so then when it was tested with SynChemG. The coefficients suggest that food crops grown increases, though only slightly when tested with land. Land size becomes lore significant as it seems to get smaller with the proportion of traditional crops crown even when tested with FCropG.

Dependent Variable	Independent Variable	Test	*p* Value	Coef.
TradSeedG	**FCropG**	Ordered Logistic Regression	0.079	.0143
	Land		**0.025**	-.1291

See original STATA table: Appendix 1

Land in the test with FCropG and TradSeedG remained significant with a new p value of 0.025. However, when tested against the dependent and SynChemG alone, it became significantly dissociated with a p value of 0.232. The coefficients show that the higher proportion of traditional crops grow, the less synthetic inputs are used, regardless of land size.

Dependent Variable	Independent Variable	Test	*p* Value	Coef.
TradSeedG	**SynChemG**	Ordered Logistic Regression	**0.002**	-1.442
	Land		0.232	-.0742

See original STATA table: Appendix 2

- ***Confounding Factors***

SynChemG: It should be noted that the variable of SynChemG has a very low response rate with almost 18% of the participant farmers not willing to answer the question. One assumption we can make from this is that almost all the participants were DDS members. The organisation is quite firmly against the use of synthetic pesticides and fertilizers, and some of the farmers may not have answered for fear of disappointing the organisation, or at least of showing themselves in lesser esteem in front of them. Everyone was asked to write his or her name on the survey sheet, which made the survey quite personal. This has undoubtedly affected the results because it is quite likely that those who did not answer do use some synthetic pesticides and/or fertilizer, although this cannot be evaluated in the results given.

- ***Review***

The findings from the quantitative survey showed some varied results. There were some strong associations found during our bi-variate test analysis. The multi-variate procedure gave an even deeper context and from this some pretty strong assertions about both of the questions we asked in that section. They will be given below under a bolded sub-heading.

Farmers of traditional crop varieties are less willing to use synthetic pesticides and fertilizers than those who grow modern varieties.

Both the bi-variate and multi-variate tests show us undoubtedly that the more traditional crop varieties grown by the farmer, the less synthetic pesticide and/or fertilizer a farmer is willing to use on their farms. This is irrelevant of land size and overall food crops grown; it is such a strongly associated variable to the proportion of traditional variety crops by farmers, no other variable alters its significance. Therefore, we can say quite confidently that growers of traditional crop varieties are much less likely to use synthetic pesticides and fertilizers than those who grow modern cultivars. We can add from conversations, observations, and interviews several things

1) Growers of traditional crop varieties have generally less access to resources than farmers who grow more modern cultivars. Our interviews validate this, as many farmers told us simply that they do not have the financial means to invest in synthetic chemical inputs.

2) Farmers who grow traditional varieties think more about health issues generally than farmers who grow modern cultivars and are therefore less willing to use synthetic chemicals. Our interviews strongly suggest this with an unanimous agreement by farmers that grew predominantly traditional food crops. This cannot be entirely validated by our quantitative results because there is no link between amount of overall food crops grown for a family's own consumption and the use of pesticide.

3) Traditional varieties require less chemical inputs because they are potentially more resilient to pests and diseases than their modern counterparts. This was observed in results of interviews but none of our quantitative results can validate this

Farmers who grow predominantly more food crops for their own direct household consumption are more likely to grow predominantly more traditional varieties.

The bi-variate test shows us that farmers who grow a higher percentage of crops for direct, on-farm household consumption; are more likely to grow more traditional crop varieties on their farms as an overall percentage. This is only true when considering food crops alone with traditional varieties, when other variables are considered, such as land size and the use of synthetic pesticides and fertilizers, it become an insignificant association. We can make a few assumptions from this:

1) Those who sell fewer crops on the market have less money to spend on modern bred varieties and their necessary inputs, such as bore well water, synthetic pesticides/fertilizers etc.

2) Those who grow food on their farms to eat directly from their lands prefer the taste of traditional variety crops. This is validated in our interviews.

3) Those who grow predominantly food crops for direct consumption feel that they are healthier than modern varieties. This is strongly validated in our interviews.

The larger the size of land a farmer has, the less overall traditional seed varieties a farmer will grow.

One can say from the results of this study that farmers with larger lands will grow overall less traditional variety crops. This is strongly associated in the bi-variate test but also when compared with the amount of food crops grown for direct consumption. We can assume one thing from this:

1) Larger farmers will generally grow proportionately more cash crops than smaller farmers. Most of the cash crops are modern cultivars of species such as sugar cane, maize and soya. Farmers have the space to grow modern cultivated cash crops as well as traditional varieties if they choose. If farmers grow traditional varieties for their own consumption, which is likely as indicated from the bi-variate test, that tested the proportion of traditional landrace varieties grown against the proportion if crops grown for home consumption (TradSeedG and FCropG), the rest will likely be modern cash crop cultivars which may take up a higher proportion of land depending on the size of their land.

There is no association between the proportion of income a farmer earns from their own land and the proportion of traditional variety crops a farmer grows.

The bi-variate test showed us no association between the amount of income a farmer earns on their own land, in contrast to earning a wage from elsewhere, and the percentage of traditional variety crops grown on their land. This was slightly surprising because one assumes that the smaller farmers, who grow predominantly more traditional variety crops (as suggested by our results) are also more likely to earn more of their income off their land via wage labour than large farmers who earn most of their money via selling cash crops. This is obviously not the case as shown with the insignificant association between these two results. This can only be explained in one way:

2) Smaller farmers have a much smaller income than larger farmers and therefore as a percentage, they earn much the same on their own lands.

- **Exploratory Results**

What affects a farmer's ability to sell their food crop on the market?

In this statistical analysis, what affects a farmer's ability to sell their food crops is investigated. The variables used are illustrated in the table below.

Variables	Description
TradSeedG	The percentage of crops grown by a farmer on their land that are traditional, landrace varieties. This has been grouped into 0%, 25%, 50%, 75%, and 100%
DiffcltSellG	Whether or not a farmer thinks it is difficult for them to sell their food crops on the market. This is grouped as a dichotomous variable: Yes/No.
DDSMKTG	This is the percentage of crops that are sold by the farmer through the DDS (Deccan Development Society) market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
Land	This is the amount of land on which a farmer grows crops. This is a purely quantitative variable, and is measured in acres.
FCropG	The proportion of crops a farmer grows as food directly to eat for themselves and their family. Food crops are not sold on the market. This has been grouped into 0%, 25%, 50%, 75%, and 100%
SynChemG	The proportion of farmers that use synthetic fertilizers and/or pesticides. This has been grouped as a dichotomous Yes/No
IncmeOLG	The overall proportion of income earned directly from a farmer's own land. This is in contrast to earning a wage elsewhere or renting land for example. This has been grouped 0%, 25%, 50%, 75%, and 100%

❖ ***Bi-variate Tests***

Here we are using DiffcltSellG as a dependent variable with four different independent variables.

Dependent Variable	Independent Variable	Test	*p* Value
DiffcltSellG *(difficulty selling traditional crops)*	**TradSeedG** (*proportion of traditional crops grown*)	Fisher	**0.00**
	Land (land size)	Wilcoxon Rank Sum	0.190
	DDSMKTG *(proportion crops sold via DDS market)*	Fisher	**0.003**
	FCropG *(proportion of household crops grown)*	Fisher	**0.05**

❖ ***Multi-variate Tests***

In this multi-variate procedure we use a standard **Logistic Regression**. This is because our dependent variable is a categorical dichotomous variable (Yes/No) and we are using both Qt and Ql independent variables to test it with.

Once I found the three variables that are significantly associated with our dependent variable (DiffcltSellG), I tested them all together in a Logistic Regression test. The results show that the variables TradSeedG and DDSMKTG remained very significantly associated with new p values for TradSeedG (0.019) and DDSMKTG (0.013). The already little significantly associated variable FCropG became very insignificant with a new p value of 0.156. This is illustrated in the table below. The coefficients below show how much easier the DDS market helps farmers to sell their traditional crops when food crops and proportion of traditional seeds grown are taken into account. The amount of food crops grown does not seem to make much difference to a farmers ability to sell traditional crops.

Dependent Variable	Independent Variable	Test	*p* Value	Coef.
DiffcltSellG	TradSeedG	Logistic Regression	**0.019**	-.0296
	DDSMKTG		**0.013**	-.0404
	FCropG		0.156	-.0177

See original STATA table: Appendix 3

I tested FCropG again without the variable DDSMKTG, thinking that the two together are not very relevant. I found that FCropG became even more disassociated when tested alone with TradSeedG against our dependent with a new *p* value of 0.223 and coefficient of -.0024, which

means the proportion of food crops grown has almost no significant affect on a farmers ability to sell their traditional crops.

Dependent Variable	Independent Variable	Test	*p* Value	Coef.
DiffcltSellG	FCropG	Logistic Regression	0.223	-.0024
	TradSeedG		**0.020**	-.0045

See original STATA table: annex 4

Taking the two most significantly associated independent variables, I tested them together with our dependent variable and found that they both remained significant with TradSeedG becoming less than what we found in the bi-variate procedure, and when tested together with DDSMKTG it gave a new *p* value of 0.020 while DDSMKTD remains a strong 0.013 as shown in the table below. The coefficients for these remained almost the same as when tested with FCropG. These two variables clearly strongly affect a farmer's ability to sell their traditional crops as suggested by these results.

Dependent Variable	Independent Variable	Test	*p* Value	Coef.
DiffcltSellG	TradSeedG	Logistic Regression	**0.020**	-.0295
	DDSMKTG		**0.013**	-.0391

See original STATA table: Appendix 5

- ***Review***

Farmers have little trouble selling traditional variety crops on the market

The results show us that there is little trouble for farmers of traditional crop varieties to sell their produce on the market. When asked if they found it difficult to sell their food crops on the market, 65% answered 'No'. This is demonstrated in the bi-variate procedure but it also remained strongly associated to the dependent variable when tested among other variables in the multi-variate tests. We can assert a few things from this:

1) Almost all the participant farmers are DDS members, which afford them access to not only to its own market, but also an extensive network of other farmers.

2) There is a strong demand for traditional variety crops in the region, even without the help of the DDS market.

The DDS market makes it easier for farmers to sell their traditional crop varieties

There is a strong association between farmers having little trouble selling their produce and the percentage amount of crops sold through the DDS market. The more a farmer sells into the DDS

market, the less problem they have selling their produce. This suggests that the DDS market is helping farmers to sell traditional crop varieties.

Even small quantities of food can be sold via the markets with little problem

We can make quite a strong assertion that farmers who produce small quantities of food for the market have no particular issues selling their crops. We can conclude this because there is no significant association between land size (Land) and overall food crops grown for direct household consumption (FCropG). We can assume that those who have larger lands will sell more crops on the market than small farmers. We can also assume that the more FCropsG grown, the less a farmer has to sell on the market.

Land size does not affect a farmer's ability to sell traditional crops

We can say that land size does not affect a farmer's ability to sell traditional crops on the market because farmers with large lands grow proportionally more modern variety crops for large commodity markets. Most of the traditional crops grown are for direct, household consumption, with small surpluses being sold only after catering to a farmer's household needs. As suggested in the QI results, the local markets are not large enough to sell huge quantities; therefore only relatively small amounts of traditional crops are sold via the local markets, irrelevant of land size.

Qualitative Results

Please note: I have edited some of the spoken grammar that was directly translated between farmers so it reads and flows better. I have tried not to let this interfere with the general tone and style of the farmers' responses.

Please find attached a copy of the questions asked in ***Appendix 1b***

The (F) followed by a number from 1 – 36 corresponds to the farmer interviewed. Each number refers to a particular farmer.

The (CB) within the transcript corresponds to the interviewer's question: Christopher Bradburn

- **Traditional Peasant Farming**

In this section, results will be given for what constitutes a traditional smallholder peasant farmer in the Zaheerabad region of the Medak district. Thoughts, feelings and beliefs of the 36 participants are given and reflected from their livelihoods and what it means to them to farm traditionally. In so doing, a picture of these farmers' values will appear and how their values shape the way they farm, and how they might indirectly or directly be conserving local crop genetic resources as a consequence.

- ***Food Security/Sovereignty***

Food security and sovereignty, terms referring to many underlying complex values, means different things to different participant farmers. The results show below what it means to the participants to be secure in food: having access to enough 'good' food, and deciding what to eat and how it is produced. Both terms are readily used by DDS but when the participant farmers were confronted with these concepts (directly translated into Telugu), they were sometimes confused. A couple of the participants who worked closely with the DDS organisation understood them and reflected on them articulately and directly:

F9. Food security means owning everything: food grains, food crops and having a good environment around us. Good health, crops and good food depends on our own mentality and own knowledge. This means not asking for food from anyone else.

Food security for F9 is very clearly understood as control over the means of producing food. In so doing, F9 attributes the good health of her family, her crops and quality of their food on being able to produce her own food with her own means. This is dependent on the surrounding environment and one's knowledge of using those means. Independence here is reflected strongly as a virtue.

When making the concepts less theoretical and less general, the participant farmers answered passionately and knowingly on what it means to them to be secure in food. The responses were diverse, but overriding themes and shared values are explicitly clear.
Many other farmers shared many of the qualities F9 reflected on. The point on "owning everything", that is growing what the farmers eat and save, is often contrasted by the converse theme of "Having to buy from the market". Repeatedly, this was reflected with anecdotes of "crisis":

F15. Food security means having enough food to feed your family… Last year we had to buy grains from the market because we didn't have good crops - we faced some issues. The crisis came last year, I bought 10kg sorghum, and other millets. The crisis was caused by the heavy rains - they fell and many crops were destroyed in the field: Pigeon pea and green gram, cow pea, black gram

The major characteristic of these smallholder peasant farmers is that they survive by eating directly what they grow. The ratio of what farmers eat from their land to what they buy at the market differs, yet almost all the farmers interviewed depended of their own food crops to eat in some form. Therefore, food security is almost always referred to as growing enough to eat for the family and their animals.

F2. Protecting your own food is food security. You should have your greens from your farm. Your grams, pulses and oil seeds from your own farm. That is food security for us and food security for our animals. Having fodder for animals, then the cycle is complete.

Two values emerged from farmers being able to grow most of the food they need to eat. The first is marked by a farmer's unwillingness and fear of having to buy grains at the market. The **cost** of market goods is a huge contributing factor to farmers' values of food security. Most of the money

that is earned by these farmers is either from selling their labour during harvest season, selling any surplus crops after feeding themselves, and buffalo milk. There is little money to spend in the first place. The second is **pride**. There is great pride given to feeding oneself from one's own land and means. Most of the farmers are from the *dalit* class who are historically the poorest people of India, and landless. Many have come from families who were traditionally landless and lived off bounded/wage labour inherited from their caste. To feed all your family, and guests with one's own grains means security and pride for many farmers interviewed.

F22. [Food security is] Having our own crops from our own land. Most years, our farm is able to support our family without going to the market… We get all our food from our land, sometimes if we don't have enough we work and they give us wages then we can buy oil and chilies from the market.

All farmers who lived directly from the land had some members of the family working off the farm for wages. Money contributes to food security yet the amount depends on the situation and mindset of the farmer. Generally it was understood that the more food eaten from a farmer's land directly, the less money was needed outside.

F4. [Food security is] Having every grain in my house. If you have local food grains you don't destroy the land. I tell my daughters and sons that local varieties support the land and the animals. If I have large amount of food from my land, I give to others this is another type of food security. Money is also included in food security.

Food security in rural India is aided by the government's Public Distribution System (PDS), whereby highly subsidised grains (mostly rice, sorghum & pigeon pea) are sold to so called "poor" farmers. All the participants interviewed took PDS grains, especially rice which is scarcely grown in the Medak. A kilo of rice for instance can be sold from 3-8 rupees (0.04€-0.1€) under the PDS (ORYZA, 2014).

F14. [Food security is] Having all the food grains for feeding my animals and my children in my hand. That is why I grow my own food. We won't buy food from the outside, after we have enough, we will sell in the market. We have everything except PDS rice.

Farmers mentioning food security often referred to the local ecological environment. Farmers often referred to themselves as responsible to the quality of the land. Most of the lands in the region are marginal making crops sensitive to climate change and other environmental disturbances. Caring for the land is seen as an essential part of securing the season's food for the family.

When it comes to concepts of food sovereignty, the question was asked indirectly (thinking the explicit concept too abstract). Farmers mentioned being able to eat the crops they wanted and produced the way they felt most suitable. There was a recurrent suspicion and contempt for market food grains (including the PDS grains). This was justified with notions of taste, quality and health. Being able to grow one's own crops contributed significantly to underlying meanings behind food sovereignty.

- ***Community***

One of the main directives of DDS was to establish a stronger community network among the farming villages in the Medak. The reasons for this are manifold but primarily it was to support the autonomy of traditional smallholder peasant farmers so they can be freer from negative market forces, while conserving and using local seeds. All the farmers interviewed were dependent in some way to their village community and it seems to mark a recurrent characteristic of traditional farmers.

One of the leading functions of a village community is a space to exchange seed. Seed is readily exchanged to neighbours in the village that creates a symbiotic relationship between those who use local seed. Exchanging seed is a transaction without money, almost all farmers are willing to, and do give seeds to neighbours they know or who work within DDS. Most farmers have a great store of seeds saved in their homes, if a crop does not grow well, and a family is without seed for the next season, they borrow seed from their neighbours and pay the neighbour double the amount the following season in grain. The farmers trust that the seeds will grow so the risk of lending seed is almost never cited as an issue. The community acts as a diverse store of crop genetic resources because there is a free flow of germplasm precisely because farmers are willing to do it for free. This engenders trust among neighbouring farmers and in turn strengthens the community spirit.

F2. I exchange seed because if someone needs seed, I get repaid in double. If I have a seed bank in my family, I am more comfortable with local (in village) exchange. I feel uncomfortable buying seed from the market. If I have a seed bank, you take my seed and I won't demand money. If your crop fails, I will demand another variety from you. This is cooperation and trust between farmers in local village. People see seed banks in own house, they want one; the idea spreads. You get a name for sharing, spread to other villages and get good reputations.

People are dependent on their communities for seed. An entire store of seed could be lost in a bad season and without money to buy seed from the market, the mutual exchange of seed from neighbors and friends is vitally important for many farmers. All farmers trust they would get their seed repaid, and normally in double. The trust is engendered because most farmers interviewed know they may need the same service themselves one day. Beyond providing a service, it develops a community spirit of sorts, because it 1) gives farmers a "good" reputation in the villages. 2) It affords farmers more village autonomy because they do not need the services of seed markets. 3) The villagers who use local seed know how to grow them and what the crops are good for, this traditional knowledge is shared throughout villages and survives precisely because so many people grow, save and exchange local seeds.

F9. If you don't have any seeds and I have, I will give to you. If you don't have a variety and I have, I will give you. We exchange [seeds] based on our requirements. We exchange food crops too, dhal, millets etc.

"CB: Why?"

Because after the end of the season, she will return back the seeds.

F13. If I do not have any seeds, I can borrow from others. If they do not have [seeds] I can give to them. We do this out of generosity. I will give seeds to my neighbors because the crop will definitely grow, so they will repay me in more [sic].

This long tradition of community seed exchange has developed trust among people within the villages. Farmers know their lands and the lands of their neighbors; they know that the seeds are well adapted to the lands of their villages; therefore the participant farmers hardly think it is a risk to take or give seed. This knowledge is communal and it is what makes for a cohesive community exchange.

F30. Our seeds are good; we trust that they are good for our land. For the sake of our land, we must use these varieties. Others trust the seeds too, so I must give to others too. The people who need some varieties will come and ask me. We trust that if we give seeds to others, the seeds will give next year. We trust the seeds and the land of others that they will grow because we know the land.

DDS has tried to strengthen the village communities by providing safe spaces for women farmers to meet and discuss issues within their villages. They facilitate meetings where women farmers can solve common problems. This is where the community spirit shines explicitly. One farmer reflects on one meeting where the community was discussing an issue involving a lack of yellow sorghum:

F14. Last year we lost yellow sorghum so we are now discussing how to get the varieties at the sangham meeting (current). Wherever is it available, we will buy from other villages and distribute them amongst ourselves, all members place money, and they will buy good seeds from others. We only buy direct from other farmers.

Because one village lost all their yellow sorghum due to bad weather, they have the capacity to meet together in the community *sangham* meeting and find a collective way to replenish their lost seeds from other villages.

The community villages also act as an open space for the spread of germplasm. The ready willingness of farmers to exchange seeds across extended spaces for all communities to access a range of local variety seeds. The trust and cohesiveness of the communities allow for this free and extended exchange of seed.

F4. If I don't have one [seed variety] and you need one, we can exchange the seeds. If both exchange varieties that we don't have we will have double amount after next season. We exchange seeds to surrounding villages up to approximately 50km.

The community indirectly and directly grants farmers all throughout the Medak district access to local seed varieties in large volumes.

- ***Seed Availability***

The availability and access to seed is a very important issue concerning all participant farmers. The cost of market seeds is often prohibitive and very often, local traditional varieties are not available in stores. Therefore, almost all the traditional seeds used in the Medak come from the villages themselves. Farmers have either saved the seeds themselves or they acquire them from the village seed banks provided for by DDS, or as observed above they use the community exchange system of borrowing seed from neighbouring farmers. DDS was first initiated because the local traditional seed germplasm was becoming harder to access. One of their first projects was to start up village seed banks whereby farmers could come and borrow seeds and repay the grains in double. No money is exchanged in this transaction. Since the seed banks were introduced in the 1970s, they have become much less used as farmers began developing seed banks in their own homes and using the community village exchange system if they were ever in want. Seed availability is no longer the dilemma it once was.

F.1. If I want different types of grains I will find them from a neighbor; it saves me from buying from the market. We borrow from neighbors and search villages for the seeds we want, if one village doesn't have a variety, I go to another village, and another, and another etc. There are always some available seeds. It hasn't happened yet that there is no seed available.

The availability of local, traditional seeds has fluctuated throughout the decades. During the 1970s and 1980s when modern varieties were being given to farmers by the government, many farmers began to experiment and grow them. As a consequence many local varieties were becoming disused and when the drought of 1972 came, many people struggled to find old seeds they felt were better adapted to the harsh climate.

F11. I had no trouble up until now [access to seed]. The middle time of my mothers [twenty years ago approx] there were not enough seeds for saving, now it has recovered. ***"CB: What was the issue?"*** *Government supplied us with seeds; our parents took the seeds and the seeds failed. For example, a variety of sorghum which when you ate the powder [flour], it caused skin disease. We don't use that variety anymore so we recovered back our old seeds. We don't enable that crop in our area. No one eats it anymore and there are none in our surroundings.*

One man recounts the season of the great drought of 1972 when their modern seed failed and they needed governmental support for access to new seeds:

F12. 1972: We had trouble with a strong summer season, we lost everything (man cried), then the rainy season came and they [government] gave us good quality modern varieties. Each packet was 3kgs and gave us sorghum (20 baskets), the food was not good though. The bread became very black and the food gave us scabs - skin diseases. The crops wouldn't grow food for us or our animals. At the time the government helped us if farmers had animals, they went where the grasses were, where we can find grass and they stayed there only [sic]. They gave us food grains.

This period was referred to the middle times, which is the space between grandparents and now. Seed availability was a dilemma then, if farmers wanted to convert back from modern varieties or use varieties their grandparents used. Also, because fewer farmers were using the local varieties, the community exchange system was less efficient which is what warranted the need for the DDS seed banks.

F27. We had trouble in the past [seed availability], but then we joined DDS so there is no problem now. ***"CB: Why trouble in the past?"*** *At the time we only owned a few of our own seeds. Now we are saving more than 10 in our villages.* ***"CB: Why such little diversity in the past?"*** *At the time we didn't find some types of varieties now with DDS we have all varieties. The older people had all types of diversity, the middle aged didn't have. Now we have all varieties. Some in the middle days didn't have all varieties.*

A couple of farmers mentioned how the higher castes who own large commodity farms now come to their villages in search of seeds they themselves have since forgone. This seemed to come with great pride to the small farmers whose old family members used to work for them:

F10. The big farmers in India, the higher castes; they don't grow food crops, only commercial. They use horse gram for marriages - they don't have - so they come to me for horse gram for their marriages. They are coming to my home for their grains, and the seeds. We are not going there, they are coming to me for my seeds. My forefathers were cleaning the houses of those higher castes, now they come to us. The forefathers cleaned their houses for the sake of having food. Cleaning and farm work. After DDS has come into these places, we were trained now we are growing the food crops much better than the higher castes.

This illustrates how the village farmers themselves are the custodians of many local crops that are otherwise non-existent in the market stores.

- ***Modern versus Landrace Varieties***

There are generally mixed feelings towards modern variety seeds. Most of the famers interviewed exclusively used local traditional crops but some have used modern varieties in the past, and some mix them today with their local varieties. One leading reason people use local varieties over modern ones is that they know how to grow them well, what lands they will grow best in and when to sow them. Traditional knowledge has been earned over time with the long-term use of these local crops therefore people want to remain using them:

F.1. If you have own seeds it is more reliable. Can save the seeds and will always have seeds to use later. The seeds grow up exactly when they expect with these local seeds. We trust them and understand their crops. If you save seeds, you don't waste or wait or need to ask from seed bank. Can sow when they want if you save seeds. If you sow exactly on the time of the season, you will get food for animals and family.

Farmers know when their local seeds need to be sown, in what season and in what conditions of the month. It is vitally important that the seed is readily available to sow when the farmers are ready. The best period for sowing could be within a matter of days. One recurrent issue with modern varieties is their varying availability. The seeds are generally always available from the

markets, but may not be at the precise time farmers want to sow.

F13. Our seeds that we save will grow compulsory. It's an issue with time flexibility; if you want to place the grains in the land, and we have the seeds in our home we don't have to go to the market, rush and wait etc. We don't know if the modern variety crops will grow or not.

F18. For our flexibility, if we own our seeds, there is no problem, if we don't, we have to go and find the seeds from someone else or the market. Sometimes we have lost the season by not having the seed in our hands on time. We don't have modern seeds; we don't buy modern varieties from the market. Local neighbors said he was happy with modern variety, chickpea for example.

The availability of seeds for the exact time of sowing is very important and so is the cost. Since money is scarce, the money to buy market seeds may not be available on time either, which further delays the sowing season. It seems that money is in constant circulation for these traditional farmers, in that it is used almost immediately once it is earned.

F17. We don't have enough money to buy seeds from the market. If I want modern varieties, and I don't have money; the money will take some time to find and I will lose the season. The local saved seeds are in my hands and we won't lose out on the season.

Modern seeds require more economic inputs than local varieties with the exception labour time. The participant farmers all observed that modern seeds require pesticides, synthetic fertilizers and irrigation. Only farmers who have paid for the drilling of a bore well use modern variety seeds since modern varieties will normally not grow with rain fed water alone in the Medak. According to the farmers, a bore well costs approximately 10,000 rupees (1200€). All farmers agreed that pesticides and synthetic fertilizers are "expensive". The willingness of farmers to use modern varieties then is normally conducive to their willingness to use debt from banks, seed companies or local loan shops.

F17. If we have money, we will try [modern varieties], if not, we won't use.

Some farmers, who do not use modern varieties, would be willing to do so if they had the means to buy them. Again, cost is a major contributing factor for demand of modern seeds. Buying them from the market in the first place is prohibiting for some farmers.

F20. We have to put extra amount for buying modern seeds so we don't do it. The only difference is the cost at the market. They yield more (modern). If we had money, we would buy them. If I preserve the modern seeds, they won't grow so we have to keep buying them.

Many of all the modern seeds are hybrids and therefore impossible to save and replant. This is probably because they are hybrid varieties. Sugarcane is a modern variety that many farmers grow in the region because of the large sugar refinery that opened some years back. These seeds are provided for by the company (on payment) and can be replanted up to three years before the crop

must be rotated. Some farmers do not use pesticide for sugarcane, which makes the crop potentially more accessible to small farmers. This will depend on how the farmers grow the crop and on what area of land. Farmers repeatedly referred to sugarcane as a traditional variety because they are able to save the planting material. Sugarcane is only grown by those who own a bore well and can afford to hire labour during harvest season.

The commodity crops (crops grown exclusively for the market) are generally always modern varieties. This may not be because the markets in the region only demand modern variety crops rather it is because yields are more highly valued. Large commodity farmers are willing to grow traditional crops along side their cash crop for their own household consumption.

F19. Large farms only use commercial crops, before they saved seeds, now they just buy commercial seeds. They are only interested in commercial crops; they only buy modern varieties. I suggest to them that they use local seeds too, and use his seeds for own food grains.

Again, many farmers interviewed referred to sugarcane as a traditional variety, which they do not class with other modern varieties. Almost all the participant farmers reflected on health as a negative consequence of modern variety crops.

F21. Some people have no patience so they are willing to buy from the market. They don't know if these seeds are good. Our traditional seeds, they are good for our health, tasty and good for the land, we save our seeds for the next season. The yield is important but modern seeds are not good for health, the sorghum for example; if you farm with them [modern variety] the rotis (local bread) are not good. They are black, not tasty and unhealthy. All company seeds are not good. ***"CB: What about sugar cane?"*** *We are taking sugar cane seeds from the local factory, it is an agreement.*

Some farmers believed that modern variety seeds caused diseases or did not give them enough nutrition. Farmers referred to "skin diseases", which may be caused by improper use of pesticides, though this is not clear. Some farmers also felt that for staple crops, such as sorghum, they needed to eat more food to feel properly satisfied.

F33. We only eat small amounts of the traditional variety crops; the older seeds [traditional] give more strength compared to the modern varieties. We eat two rotis with modern variety crops; we only need to eat one with old varieties. They are more nutritious. I had a leg pain, so I ate older seeds (ragulu) and it cured my disease totally. Yields of modern varieties may be higher but it will be wasted. There is a lot of difference between older and modern varieties; compare them yourself. ***"CB: Would you ever be willing to experiment with modern varieties?"*** *- We won't try.*

For some there is a total unwillingness to try modern varieties. This is often caused by a fear from health either from experience in the past, or rumors from others in the village.

F8. We trust that the local seeds will grow compulsorily. Modern varieties are not edible, if you eat them, they will cause skin diseases. They are not for good for health, they cause fevers and they are not tasty. Local crops are good for health. Modern variety have no taste etc. no food for animals. If you pour pesticides in the field and the rains do not come, the seeds will burn.

Some farmers use traditional food crops directly for treating health problems and ailments. They believe the nutritional properties of the crops can cure some diseases and fevers.

F25: Our seeds are good for our health; we use local seeds for special purposes. For example, if you're sick, you will eat local Jowar (sorghum). We use only local seeds and crops. Never used modern in the past. We use only local seeds from local tradition. It's good for everything.

Diseases and illness from modern varieties are seen as, caused by, both pesticides and the food itself. They often reflected this against local varieties that are often grown without pesticides and that may contain medicinal properties. One woman noted that when she feeds her children PDS rice for example, they have lower energy levels than when they eat bread from local sorghum and millet varieties.

F11. We trust that our seeds will grow compulsory, we don't know about the government seeds. We don't know how they are for health. Our local crops are good for health. For modern varieties one must use pesticides and fertilizers. We use only vermin-compost and neem (local tree) pesticides and animal manure for local crops, if we eat these things we can avoid going to hospital frequently. Some of the food grains are recovering the diseases of peoples' high blood pressure, and sugar levels; we will eat foxtail millet to cure these problems.

Another major reason people do not use modern varieties is a general lack of knowledge of how to grow them, when to grow them and of the quality of seeds, including how they are stored and for how long.

F14. We don't know how they are preserving these seeds; we don't know how old they are. We don't know if they will grow or not. If it gives double, we don't care. It gives bad health for us and our animals. We don't know about them so we're not looking at that side [sic].

F19. We don't have any trust in modern varieties if they will yield or not [sic], we don't know. People say they are good but we don't know how they are being preserved. We trust our local seeds and we know they will yield. The modern ones use pesticides too.

The main promoted virtue of modern varieties is that they yield well, and often better than traditional varieties. Some farmers believe this and readily take the risks in investments. There are many positive reflections on modern chickpea for example. Generally, the participant farmers who mostly only grew traditional varieties either did not believe modern varieties yielded better, or that yield alone was not a strong enough factor for conversion or experimentation. The higher yields of modern varieties were sometimes not justified by smallholder farmers, who felt the costs of investing in modern varieties is only viable if one has large lands that are connected together and not dispersed around the region. A few farmers felt that modern varieties do not yield better than their own traditional seeds. One farmer felt that modern variety crops grow tall and impressively, but the available food on them is less than her own traditional varieties.

F31. The modern varieties do not give good food yields, they only give plant yields [sic]. The rest is damaged. Our crops will grow. We trust it. We want our seeds, so we will not buy any from the market. They

look good but will not grow any crops.

The last major point in difference between modern and traditional varieties is the amount of work needed for growing the crops. It was noted by participant farmers that traditional food crops required more work and more patience than modern varieties. This is because weeding and biological pest management takes more time with traditional crops. Pest management takes a lot of local knowledge and repeated applications of traditional home made recipes. It also means farmers need to be more aware of what is happening on their crops than otherwise routinely spraying synthetic pesticides. Also, the work involved with saving and storing seed is very time consuming including threshing, drying, cleaning and storing. It is much easier to buy seeds ready in packets from the market.

F25: It requires more hard work to use our traditional seeds, so some people don't use them but our crops yield well.

- ***Diet & Taste***

PDS rice is changing the dietary habits of many local people in the region. Many children who board at school are fed on modern variety rice which is a crop otherwise not normally grown in the region. Peoples' tastes are changing, but repeatedly the taste and nutritional value to the participants was paramount. The cuisine is very important in the Medak district and quite distinct, the diversity of crops used is testament to the large variety of dishes these farmers eat. All participant farmers felt traditional food crops taste better than modern varieties.

F3. Modern varieties don't have any taste. From experience, they are not getting fodder food either, they are not good for our animals; the buffalos are not giving enough milk from modern varieties.

This could be due to smaller protein levels in modern varieties or the yields themselves. Many farmers refuse to adopt modern varieties simply because they do not taste as good as local varieties.

F16a: The modern varieties are not edible; they have no taste. You get a lot (yield) but it is not useful for us. We will not use that type of modern variety (sorghum for example); we refuse to use them. We only like our seeds, not the ones from the market. If we do buy from the market, we only buy small quantities. They are not good for health; the market seeds are unhealthy.

I readily reflected with the farmers after they spoke highly of taste; whether they were attracted to the higher yielding varieties, even if they felt they were inferior in taste.

F27. Some of the modern varieties won't even grow; ours will absolutely grow. We trust our seeds so we don't buy anything from the market. **"CB: Are you interested in higher yielding varieties?"** It's helpful for us, but they are not for the purpose of eating, and neither for our animals [sic]. They are not edible, not good for health, not tasty.

People were obviously attracted by the higher yields, but it seems that many people who are willing to grow modern varieties are only willing to do so for the market. They themselves were

often not willing to grow modern varieties for their own consumption except for sugarcane. Sugarcane is a commodity crop but many farmers will eat their own raw cane for desserts and drinks.

- ***Peasant Farming***

The most important characteristic of peasant farming is that they grow food to eat directly for themselves. In the years before the land reforms by Indira Gandhi, many of today's *Dalit* classes would work as bonded labour to farmers in higher castes on their large farms. They would not be paid in money; rather they would be paid in seed, which they could grow for themselves.

Dalit Caste:
The Dalit caste refers to a mixed population of numerous social groups in India who make up some of the country's poorest people. Traditionally referred to as the *un-touchables*, this class is often landless and are born into some specific artisanal occupations. Literacy rates among this caste are low and social mobilisation is limited. The Dalit caste consists of around 201 million people in India, or 15.5% of the population.

Today, farmers once bounded to their work on other farms have their own lands thanks to land reforms of the 1980s. Most of these lands are marginal. The peasant farmers interviewed today in the Medak district now own their own land and their own seed.

F13. We do not have problems today. We had trouble 30 years back, at the time we farmed under landowners: higher castes. We grew the food for the higher castes and when the season would finish, they would give us only small amount of seeds to grow for ourselves. We had problems at that time, not now. ***"CB: How do you get seeds today?"*** *We now have all types of seeds that we need on our farm. We lost sorghum [one variety] last year; we are using seeds from two years back.* ***"CB: And the quality?"*** *They are good now. They are growing now. For security, we always have seeds stored in our house.*

Since the peasant farmers interviewed grow food for themselves, on relatively small lands (all under 10 acres, most under 1.5 acres) and seldom for the markets, money is always scarce. This makes the perspective of peasant farmers different from commodity farmers since their future plans are always limited to small financial means. It requires financial investment to use modern varieties and since money is scarce, plans for growth are constrained.

F18. We have a lot of plans for our farm but or plans are wasted. We would like to get a bore well; we would like to grow sugar cane, chilies and potatoes (commodity crops). We don't have the water or good land so our thoughts are wasted. These thoughts are not useful; there is no point of planning for the future. We think about food. With our hard work, we don't have any good life. If we had a bore well, we would have a better life in the future.

Peasant farmers live day to day; there is little space to grow outside of their own way of life. There are certain boundaries on peasant farming which are very often financial. The *dalit* classes have a very high illiteracy rate, most of the farmers born before the generation of the 1990s are illiterate;

this makes social mobilisation very limited for peasant farmers making the few other industries inaccessible to them.

F4. I am illiterate; I only know farming; that is all my knowledge.

The peasant communities are generally religious which affects the way they perceive their farms and sometimes, the way they farm. If the climate changes for instance, it is often referred to as the hand of God. The results show that for many participant farmers, religion and superstition affect some of their negative views towards pesticides and sometimes, modern varieties. The traditional varieties and the land are seen as part of God for many farmers, therefore making it sacred.

F26. God will let us do what we have to do with the diseases.

F4. Having the relation with these local seeds is with God; the land has a God so do the seeds. We treat earth like God, if you put old local varieties in the soil; we have happiness with the land and God [sic]. Especially for the seed, we celebrate the seed during a festival just for seed once a year. Local seed is sacred.

- **Ecological & Environment**

In this section, the results give us a picture of what values, challenges and methods are held by the smallholder peasant farmers on their local ecological and environmental surroundings. This should help give an understanding of what environmental conditions these farmers live within and how it affects the way they farm and if it contributes to the conservation of crop genetic resources.

- ***Local Soil and Climate***

The local soil and climate of the Medak district are distinct. The summers are long and very hot with scarce rainfall and the soils, in particular the red laterite soils, are generally of poor quality. For this reason, many modern varieties are simply not suitable for the region. This marks some of the negative feelings towards modern variety seeds and the continued reverence for traditional, local landrace seeds that are adapted to the harsh conditions. As mentioned above, all modern commercial crops require irrigation,

F17. ***"CB: What commercial crops do you grow?"*** *I have a bore well: sugar cane, turmeric and ginger.* ***"CB: Are you eating from the market or your own land?"*** *If we don't have enough food for the year, we eat crops from our own farm, then we will buy from the market. In summer, we don't have enough water in the well; the crops are not going well.* ***"CB: Are you happy with price of sugar cane?"*** *It's not good; there is no water so the crop is not yielding well. For food sake, we will farm some land; foxtail millet, sorghum, which are our own seeds.*

F7. If you use modern varieties you will get into debt, if bad raining season comes, you lose everything. Our local seasons are harsh, if raining seasons are heavy, sorghum not come, we can use another of our local seed [sic]. Modern variety has no taste. If you place manure in the field, the plants will grow, if you use pesticides they will grow slower. They create disease.

F31. We don't have any problem, we place one rupee and we get four back. ***"CB: So why do you think not everyone farms like this?"*** *The bigger farmers only grow cash crops, maize and cotton. We are quarrelling with them that they are destroying the land with Bt cotton. It will cost you one day, you will face trouble in future.*

Sugar cane requires more water than is available from rainfall, which means farmers need a bore well. This farmer has trouble with irrigation on her commercial crops with the consequence of little market returns. She still uses her own seeds for her own consumption, which means she is not completely dependent on the market.

Farmers agree that modern variety crops are generally cited as more prone to diseases than local varieties.

F2. I feel they [local seeds] are good for the land, I feel they are good quality seeds. Comparing with other seeds, other seeds are more prone to diseases and never come to their full potential. I trust our own seeds. These grains are important for our health; I feel they are better than other crops.

It is not to say that local seeds are not without their issues. The climates are very harsh and sporadic, local crops are still sensitive to these climates and potentially to climate change and deforestation. Yellow sorghum seems to be struggling with climate change, which has led many to discontinue the variety.

F11. We eat local variety crops, which are good for our health and gives strength to our bodies. If the rainy season is not there, we get in trouble. We don't use any fertilizers or chemicals. If insects come, we get smaller crops

F34. Now we are not doing commercial crops, if we are willing we have to take water from others. The birds are destroying our crops. The pigeons and the peacocks destroy my crops. ***"CB: Would you like to grow commercial crops?"*** *I am willing to grow but the biggest obstacle is water, I would grow ground nut, sugar cane, ginger, turmeric .*

F23. Due to weather, we face trouble. This season we had too much rain. ***"CB: What do you do?"*** *We buy food grains from other farmers. We don't buy pulses, only sorghum and rice from PGS.*

F30. The seasons are not good now. Presently, it's full of rain so people have totally lost their crops. Due to this season we have lost many crops.

F33. We are exchanging seed so we don't have any problems, we take from our relatives. Yellow sorghum isn't yielding well so we stopped growing it 3-4 years ago. The rainy season is not good since 3 years, so we don't use it now.

F34. There is never a problem, in the past we had trouble for 2 years, we lost all crops so we borrowed from other farmers. Approximately 40-50 years ago. There was too much rain, so we didn't harvest. The seed germinated too quickly due to heavy rains, too fast to preserve. We didn't own land at that time, so we didn't face much trouble.

F34. A few years back, we didn't have any troubles with birds, now many pigeons and peacocks come to the fields. Due to deforestation all the birds are coming, the wild pigs are destroying our land.

Despite the harsh climate and soil conditions, farmers understand their environment as they understand their local seeds. They know the seeds are adapted to certain conditions and exploit the genetic resources of these plants directly.

F3. If you preserve these seeds we have faith that we will get a good crop. It is compatibility; we do not have to search for seeds from other places. We grow them depending on the quality of the soil. For our lands, we have faith that our local seeds in our family will grow well.

F4. We have trust that these seeds are good for our land and good for our food. I have 4 types of land, I know where to distribute the seeds depending on the soil, and I understand the local seeds I am growing: Where they should be sown, what season and how. When the rainy season is big we put rice in the black soil. Depending on the season, we use the original seed our grandfathers used.

F7. We experience that it [local crop] will grow, compulsory. We know where to sow them depending on the soil. We know which land will give which crop. Depending on the soil, we have the seeds to suit. We know when to sow the seeds; which month, which season. We know how many seeds one acre will take. We have relations with seeds, with the land and the festivals.

F8. We know each type of period we can grow in which period. We know why one seed will be suitable for one land, and not another. Depending on the seasons, we know which crops to grow. We know which seeds are suitable for higher lands, and deeper lands, and water contained lands, and dry lands. If grains are not working, we use other seeds.

- ***Biodiversity***

Modern variety crops to most participant farmers were often associated with less on-farm crop diversity. This is because modern varieties are usually grown as monocultures as already reflected in the literature review section of “Genetic erosion”. Local seeds are generally not intercropped with modern seeds. This is either because the company advises against this practice, or modern varieties require pesticides while local varieties are normally grown without these inputs. The participant farmers generally do not like to mix pesticides on their own food crops.

F4. I don’t want to use modern varieties because they are not good for the land. When you use local varieties you get food for animals and leaves for curry. If you use modern varieties you cannot grow diverse cropping systems because they need pesticides and it will affect other food crops. ***“CB: Does the potential to make money from modern varieties appeal to you?”*** *If you use only one variety you have too much risk. Modern varieties need urea and pesticides so they are not edible. Compare the modern and local varieties, we get same amount of money. Local is less risky, local variety like green gram, chickpea, field beans and black gram dhal has good demand - better than cotton.*

F3. They [modern varieties] are not good for the land because one is only using monocrop on the land, which means there is only little amount of organic matter. I haven’t used modern varieties but I have listened to others.

F7. If I buy modern varieties we need to use pesticides - they are only for money but we can’t rely on this crop [sic]. They are not edible. I never think about modern varieties - if you use them you must use

pesticides and urea, if you use heavy quantities [of pesticides], the seed will burn and it won't grow - we don't trust them. ***"CB: Do the higher yields appeal to you?"*** *They are not edible at all, so much pesticides they need, not usable for next year, and they don't give food for animals either. If the seeds mix with pesticides, they will not work for next year (could mean modern variety hybrid seeds). We use many crops with local seeds, with modern varieties; we can only use one crop (Monocrop).*

F2. The commercial people misguide farmers. In the company, if you don't pay, you don't get seeds. Don't have any faith of the seeds will grow or not [sic]. They will sell pesticides with their seeds. The company say don't mix the traditional varieties with the purchased seeds. We are restricted to grow only one seed when we buy modern varieties.

The participant farmers often referred to biodiversity as a food security strategy. If one crop fails, they can rely on another crop. The methods farmers use to grow food is often based around biodiversity, either by intercropping various crops or by using multiple varieties of a specific crop. For example, many farmers used up to four varieties of millet, and many varieties of lentils and beans.

F9. We are growing so many varieties, these will feed the birds too. If you put sugarcane, there is no food for birds. We are indirectly serving the birds. The food is good, the environment is also good, and so we are happy

F12. We are having the good seed we trust that they will grow, the ones the government gives us, we don't know if they grow or not [sic]. We took the good grains from the crops and preserve them separately by our need. They are not eaten by the birds or insects. We place it in the baskets with ash and neem. Close with mud. It will be ready for the next season. We are feeding the land, minimum 15 varieties in the field, type of varieties in sequence, e.g. finger millet, cow peas, little millet and sorghum. Mix together. Doing like our great grandfathers [sic]. Some plants are smaller than others so we can harvest them together with little problem of separating each seed.

F3. If you sow 18 varieties, some might perish so we can rely on the other varieties to grow well. We share and exchange from one to the other.

F2. The biodiversity means if one crop fails, I have other crops to rely on.

F9. We don't have trouble, if we have difficulty we go to another village. One km away we have sangham (farming union) meeting where we can ask other fellow members. Now we have all crop varieties, over time people have saved and accumulated many varieties.

Here, the farmer sees biodiversity as having many stored and saved seed varieties.

F26. If you want a seed you don't have, I will go to a neighbor. I will save 30 types in my family home.

F6. I don't use synthetic pesticide or fertilizer. I intercrop my sugar cane with various plants, like pea dhal. I have no problem with insects. Until now, I have not used any synthetic pesticides. I believe in local varieties. I planted 1 acre of local variety mangos. It takes three years longer to grow fruit than modern varieties but the trees are bigger, I use the food to sell in the market.

This farmer does intercrop his modern variety commercial crop with other local varieties. This

could be because some farmers do not use pesticides on their sugar cane, like this farmer. Note also his willingness to use local varieties of mangoes (a landrace crop) despite the extra time it takes to grow.

- ***Organic Pest Management and Fertilizers***

Organic agriculture to participant farmers is either practiced by choice, or by default. There are mixed feelings towards the use of synthetic pesticides and fertilizers. Generally, modern variety crops will require the use of pesticides with some exceptions involving sugar cane. Traditional varieties are generally used without synthetic pesticides and fertilizers, though there are exceptions to this too. Many farmers use local concoctions from traditional recipes as pest management strategies that many farmers attest to:

F13. Until now we have not used any chemical fertilizers or pesticides. We use oil from neem. We are using neem as a pesticide.

F23. I never use pesticides, only raw sugar and water that I put on pigeon pea. This attracts the ants and insects that eat the eggs of pests.

F26. We are using our solution: we mix water, ghee, raw sugar, chilies, bananas; mix together and put it in a jug. It's good for all crops, the ants come and eat the insects – this solution is only helpful to get rid of pest insects. God will let us do what we have to do with the diseases.

F13. After the plant has grown a little higher, we use waste from manure, mixed with urine, calcium (lime) which we use for all our crops; it only requires small amounts. After the plants have grown heavier, when flowers bloom, we sprinkle with neem oil for insecticide. If we have serious problem with insects on our crop, we mix chilies, garlic (soaked in kerosene) with water (1:3 ratio). We use this as an insecticide while the crop is growing. We separate chilies and garlic and mix them with water. We place 1 cloth beside trees, shake the tree and insects fall onto the cloth, and then we burn them. We only have serious trouble with pigeon pea. We clean the insects off one by one for chickpeas [sic]. If insects are still there, we pick off them by hand.

Some farmers readily use pesticides and feel they could not survive without it. F17 felt helpless while she thinks pesticides were a necessary component of her farm and yet very expensive:

F17. If we use pesticides, we will get good crops. With so many insets on our farm, we would lose total crop [sic]. This season we didn't use pesticides and lost all our pigeon pea from insects and diseases. We lost it all. Pesticides are expensive, if we don't have enough food, how can we buy pesticides in the market? We are doing hard work in other farms for wages. Money is sufficient for food sake only, how can we buy pesticides in market?

F18. We use pesticides. We will buy from the market, especially for chickpea. ***"CB: How do you feel about crop yields with pesticides?"*** *If we use pesticides, we will get good yield, in a bad season, I didn't use pesticides, I lost a lot of crops. The crops were not enough.*

Some use chemical pesticides on some crops while growing others organically. In this instance, pesticide is used on commercial crops:

F21. I will only use [pesticides] on three crops; chickpea, pigeon pea, and potato.

It is unknown whether F21.'s chickpea and pigeon pea crops were modern varieties crops.

F19. Only for pigeon pea, we sprinkle sugar (rowan) on the pigeon pea. The ants will come and eat the insects' eggs. We use manure, which means we don't have so much problems with other insects [sic]. We won't use pesticides. ***"CB: Why not, others say it yields much better with pesticides?"*** *They don't know the importance, if they use modern varieties and pesticides; they are destroying the land [sic]. We know, so we don't use it.*

Pesticides are very expensive so farmers who use them will generally expect high yields to be able to sell at the market to justify the costs. One farmer mentioned the stress of the extra costs involved with chemical pesticides:

F30. Pesticides: No, ***"CB: Why when so many people say it's necessary for them?"*** *People don't think about their health so they use pesticides. So much pesticides will fill up in the crop so it leads to so many diseases [sic]. People only think about yield, so they will use more fertilizer. By using modern crops, people need good money; some of the people use more pesticides if the crop isn't good enough. The pesticides eventually kill the crops; the farmers are now drinking the pesticides to kill themselves. We don't think about the high yield crops, we think about food crops and good health so we don't face the same problems as others.* ***"CB: Why are people killing themselves with pesticides?"*** *The pesticides cost so much money, so they borrow money, if something happens and the crops don't yield, the debtor comes for the money and they have nothing. If family members are good, they will manage, they will adjust with the debtors. They can't take the land, the government is helping.*

Traditional knowledge extends to many cropping techniques that farmers use instead of chemical pesticides and fertilizers.

F34. I grow up to nine crops on my farm for my family's pulses and food grain. We always grow pigeon pea, the leaves of the crop falls and it is good for the land, it gives us a type of manure for our soil. We are sowing pigeon pea, some insects come, so we plant marigold and they insects are diverted from crops to marigold.

- **Socio-Economic**

This last section encompasses what values and beliefs the participant farmers have towards their socio-economic circumstances and if these affect the crop genetic resources that are conserved. It includes economic influences and reflects on how these forces may or may not affect what these farmers grow. The results show how much these farmers understand of the external economic markets and what they feel about them, including their ability and willingness to integrate into the formal market. This should give a picture of what market influences affect what and how smallholder peasant farmers grow their crops.

❖ ***Market Integration***

Almost all participant farmers have some relation to a market; this varies according to size of family, size of land, DDS membership and amount of commercial crops grown. There are largely two types of markets:

(1) Local markets that are village-based and will extend to the local towns. These markets are run and managed by the farmers themselves.

(2) Larger scale, more formal commodity markets existing outside of the villages, run and owned by external agents. Commodity markets extend nationally and internationally.

The local markets of the Medak district are confined to the district, though DDS has extended it further to Hyderabad, Telangana's capital city. Market integration here refers to a farm's willingness and dependency on a market. Those selling all or most of their crops into the commodity markets will have very high rates of market integration and dependence. Generally, modern varieties are grown for large commodity markets.

A farmer's willingness to integrate into a market will depend on how much they buy and sell into it and how much money plays a part in their livelihoods. The less willing they are to integrate, the more willing they are to grow crops for their own consumption:

F30. Modern varieties are not good for your health. People who eat modern varieties suffer a lot in my village; they frequently go to the hospital. Compared to others, my family is good. ***"CB: What varieties are people growing?"*** *Maize, soya, etc. they make people sick - the people who grow soya and maize, ask for cash, they will then buy food from the market. They don't think about health, they think about money. I will also think about money, buy the food sake I want to grow food, the rest I make money. Healthy and make money. They only think about cash. So they are suffering.*

F30 is willing to integrate into the market since money plays an important role for her, yet she is not prepared to integrate entirely since she feels modern variety food crops are unhealthy. Here is an example of part integration into local markets which is not an uncommon scenario among smallholder farmers in the region

Local markets are used to sell local crops among farmers themselves and in nearby towns. Although they are much smaller than the commodity markets, they seem to be more flexible and willing to demand native crops. Many farmers are satisfied with these markets:

F9. We have so much demand for our crops because they are good for blood pressure and sugar levels. People are rushing from other villages for our local crops. Some doctors are taking foxtail millet, and sorghum as medicine.

F12. There is no problem selling our local crops, they are selling well in the market, except no one is purchasing the foxtail millet.

F7. They [local markets] are giving the same amount for modern and local varieties, but local crops give extra money because people think it's better for the health. ***"CB: Why doesn't everyone sell local seed then?"*** *Only local people sell local crops, for food sake, the big farmers sell crops only for money sake,*

people use modern varieties: we are habituated to local seeds.

Some farmers have different experiences; they feel the local markets are not big enough and the demand for local crops is not sufficient. Here a farmer expressed his issues with the costs of buying from the markets and the little comparative returns for the crops he sells. He feels there is no good market for local crops. F20 grows a high percentage of commercial crops.

F20. I grow soya, maize, sugar cane, chickpea and pigeon on 2 acres of land. ***"CB: How much of the food is bought from the market?"*** *50% is from market****. "CB: Are you happy with price and yield of your commercial crops?"*** *We have difficulty, if we buy from the market, they will charge more than what we sell our crops for. I feel that there is no market for local crops.*

Some are quite happy with the markets as they are; F16a feels she gets a fair price for her goods though she has little market integration because she does not buy from the market herself. She has two acres of land and the only modern crop she grows is maize. This means she is happy with the commodity market for maize as it is now.

F16a: We sell but won't buy. We have no challenges with the market and we don't sell to the DDS market, we only outside. We won't sell any food crops to DDS. ***"CB: Do you feel that you get a fair price for your crops?*** *We will get a good price. Our quality has a demand.*

A farmer's ability to integrate into a formal market is often associated with the size of their land and number of household members. The results show that the willingness to grow modern varieties relates to the size of the land. F13 notes that only big farmers can grow modern varieties because they have the land to make money from them. Small farmers use local seed because they eat the food directly and prefer local food crops. Many farmers noted that if they had more land, they would try more modern crop varieties to sell into the formal market.

F13. We don't have a problem selling our local crops, we have a demand now. ***"CB: Why doesn't everyone sell traditional crops on the market if there is no problem?"*** *We are encouraging the other members [local farmers] to, we initiative them into the village. Only big farmers with over 20 to 30 acres will grow modern crops for the large markets, they prepare 4 acres for food grains, and the rest for commercial crops. The small farmers are growing our local, traditional crops only.*

F18. We do not enough crops to sell on the market.

One farmer noted that local crops are simply not suited for any market because she feels they yield so poorly. She had 5 acres and grows commercial crops and local crops. It seems she would like to have more modern varieties but the price is inhibiting. This is considered to be a large piece of land.

F17. We are not getting good price for our crops. The modern will yield good [sic]. Our local crops yield badly so we get little money.

Many feel that formal markets are not flexible enough to suit their livelihoods and farms. This could mean that there is simply no demand for local crops, or the price of market food and seed is too high.

F34. We have to pay a lot for seeds in the market. If we don't have seeds, we can exchange for the next season but we don't have any flexibility with the market.

Some organisations and companies help the farmers to integrate into certain markets. F19 gets help from the sugar refinery by giving set market prices. This seems to develop trust between the farmer and the company and marks the willingness to grow sugarcane.

F19. We grow sugarcane. The factory gave us the modern variety to begin with, before we plant sugarcane we have to make an agreement between the company and our farm. We should compulsory sell sugarcane to this company and we will get exact money [price] each year. If agreement is there, I will sell to the factory. I buy the seeds [sugarcane] from the company only one time [sic], it will give crops for three years.

Some just simply do not have the resources to integrate into the formal market, even if willingness exists. The modern varieties require more external inputs, as mentioned many times in the above sections; water is the biggest contributing factor.

F17. Having our own crops is having a good farm, buying crops is not good. It will only ever be a small quantity and it won't be enough. If we have crops on our own field, it will be enough. We think less about commercial and more food crops. The water is not enough so we plant some varieties for our food sake only, some for commercial and some for food [sic], The issue is water, we have a lot for problem with water. ***"CB: How much of the food you eat comes from the market?"*** *30% from the market. The challenge is water, if we have enough water, we will farm our land well.*

DDS has developed some local markets for local, organic crops. They have extended the market to Hyderabad where a growing demand for local, organic food exists. Many DDS members have since been able to grow their local crops because a market exists for them. DDS gives 10% extra return for the crops since it is labeled organic

F11. A few years back there was no good rate for foxtail millet, cowpea, kora millet and little millet. After DDS came, we have a good price and the market is giving us a good rate. There is now no problem; if we have enough seeds after eating we will sell.

F14. We have our own DDS market; DDS gives us 10 % for our local traditional grains that are organic. ***"CB: Why isn't everyone farming like this if the market is so good?"*** *The rich people that are farming commercial crops can sell a lot for a lot of money, we are small and we only cultivate in a local traditional way. They have a lot of water in their bore wells, they can grow sugar cane.*

- ***Farming Autonomy***

As reflected in the food security section at the beginning of this chapter, growing one's own food develops a sense of farming autonomy. Autonomy comes in various hierarchies, from personal and family, to village and regional. Autonomy here means being able to farm the way farmers want to farm and to grow the crops they want. For some, more autonomy means having more money to be able to uphold a desired livelihood, for others it means farming in the traditional method while supporting their families and communities. In the past, farmers had to act and farm autonomously

because there were no large commodity markets to sell into or buy modern external inputs to develop with. However, as mentioned above, caste played an important role since many worked as bonded labours. Increased autonomy was won by the land reforms of Indira Gandhi in the 1980s, yet it was also a period of agricultural modernisation which some participant farmers feel negatively affects their farming autonomy.

F32. I have never bought seeds from the market. There was no market in older times nor was there chemical fertilizers or pesticides. We only used manure and our own seeds and we choose to farm like this today.

F2 feels that traditional farming means being able to farm autonomously and this can only be achieved with local, traditional knowledge passed down from older generations. Being dependent on the market for F2 means having little autonomy and therefore, it is seen as a negative characteristic of farming.

F2. Traditional farming is a type of knowledge our grandfathers taught us, and I will hand it down to our children. It is a knowledge system. We learn it from our ancestors and it is our responsibility to do it because we cannot depend on others for this kind of knowledge. We don't want the next generation to depend on others and the consequences for not having this knowledge means they will depend on someone else. Some people have lost the knowledge to grow local seeds; it is technical. For not having knowledge, it may stop people from saving seeds and they will purchase seeds instead [sic].

For F12, being a small farmer helps one to farm more autonomously because one only requires small amounts of inputs. Small farmers can therefore rely on themselves more than large farmers who have to buy many external inputs:

F12. If you don't have varieties of seeds, I will give you and vice versa. If you are a small farmer, you only need small amounts of inputs. You can sell the seeds that you grow. We have used these seeds for last 50 years.

Autonomy can also extend to a village or community. By working within a community, some farmers believe one can farm more independently than if they farmed alone. This is because farmers can work together to solve problems that large, independent farmers cannot, such as finding new seed varieties.

F14. We have enough seed; we will always only use our seeds. We have lots of varieties so we don't need to buy any more, 2 years back our sorghum was bad quantity [sic]. We don't use yellow sorghum now. We are having a meeting to find a variety that we miss; other members will provide them for us. We only have to go to the next village to search for new seeds.

As expressed by the farmers before in previous sections, by saving seeds and using the community seed exchange system, farmers can act without the need of buying from the markets. This is seen as a strong point of farming autonomy.

F6. We have enough seeds in our home, we don't need more seeds. Until now, I have not bought seeds. The local seeds will give much better yield than the company seeds

- ***Access to Resources***

The results from the interviews show us that limited access to resources is one of the major reasons determining whether farmers will grow modern variety food crops or not. The above results have already shown that resources such as chemical pesticides, synthetic fertilizers and bore well water are often too expensive for small farmers to access, which generally renders the use of modern varieties inaccessible. Many farmers are willing to grow modern varieties as commercial crops but simply do not have access to necessary resources. What the participant farmers have suggested is that land size is one of, if not the most important deciding factor for modern variety commercial crop use.

F30. We only grow food crops, if we have any extra, we will sell in the market. We secure for one year, the remaining we sell in the market. Our land is big enough to grow cash crops. ***"CB: Why don't you grow commercial crops then?*** *We have land, but it's fragmented, it is located in many places. It is difficult to grow commercial crops. I own a bore well but we don't utilize the water - we give water to the Alana factory (large meat processing plant). Our bore water is good for drinking; the water in this area is generally not good for drinking. They take it for drinking (Alana).* ***"CB: Would you like to grow commercial crops if you had the right land?"*** *Yes, I am willing. We feel better with our food crops for now; normally we won't look for cash crops.*

F18. What we grow is not enough for us for one year [sic], so we will buy extra. ***"CB: Would you prefer more money, or more land to grow food on?"*** *We are a big family, we are not self sufficient with what we have from our crops, if we have bigger land, we will be more self sufficient.*

F27. We don't have any land in our villages [owned land], most people in my village don't own their land. ***"CB: Would it ever be possible for you to buy land one day?"*** *If the government will help us one day, I will buy land in my village.* ***"CB: How would life change if you owned land?"*** *We have to pay rent now; we would save money and put it on our fields [sic].*

F22. We don't face any troubles and we never had trouble in the past. ***"CB: Why does not everyone farm like you if there is no trouble?"*** *Depending on the farm, farmers will farm differently. If the farm is bigger, they will do commercial crops. We are small so we only grow food crops.* ***"CB: If you had bigger land, would you grow commercial crops?"*** *Yes, we would.*

- ***Financial***

Finance and costs involved in agriculture are particularly important for the interviewed farmers because they have so little money and access to funds. It is evident that many of the farmers farm the way they do, that is growing food directly to eat for their families, because of their limited funds. All farmers interviewed were asked directly about the greatest challenges they face each year, and all of them mentioned a lack of money. Outside of agriculture, the most cited and important cost was educating their children. The government subsidies schooling for poorer children; kids can board at school with highly subsidised costs, including tuition, board, and school uniforms.

Because of this, many children even from the poorest castes are getting educated. The costs involved are still expensive for many farmers, which makes money even more important,

F25: We face many problems with our family. Our children require shoes and books for school. Our biggest challenges are to do with money. ***"CB: Do you work outside farm?"*** *Yes. It's not enough land for us, we grow our food and gain wages from others [sic].*

With regards to agriculture, as reflected in previous sections, money is a limiting factor for the way farmers farm; this includes the use of modern varieties. It is one of the main reasons why these farmers save and exchange seed: to save money.

F20. We save seed for the next season because we don't want to buy from the market. The reason is money; that is why we save the seeds.

F6. The [onion] seeds in the market are heavy cost [sic]. Cost criteria are important to us [sic]. Tomato, the seeds come in small quantities and they cost a lot, if you preserve the seeds, it's better for money. I sell seedling (onion) in market, I sold all for 1100rs to DDS (own seedlings), and I got 1 rupee for one plant.

F18. We don't have any experience with the others [modern seed varieties]. We don't have money so we won't buy from the market. ***"CB: If you had money would you try?"*** *We would experiment.*

Money is still needed in these smallholder peasant farming societies for continued management of their farms. Many participant farmers have expressed this. Their access to immediate money will often mean getting into debt. Debt is an important part of the participant farmers' lives. Getting any sort of money on loan is always difficult for these farmers. F32 reflects her challenge of getting 100rs (1.20€ approx) from a larger farmer. It shows firstly how limited her access is to any sort of money, and secondly, how even very small amounts are so important to her.

F32. We use bular carts to prepare our land to sow for the season to come, we sowed exactly before the rainy season. We didn't have money at the time and if we wanted 100 RS we had to ask from the bigger farms and they would take 8 days minimum to give 100 rs with 2 % interest.

Despite the issue of finance as affecting one's ability to use modern variety seed, it is not the only value, as expressed explicitly by F35. She mentions the cost first but when asked if she were given the seed for free: "would she try them", she answered with a resounding, 'No!'

F35. I don't know how the modern seeds are when I get them. I don't know the quality of seed in the packet. We will never use them, they cost too much money. The pigeon pea is not good, our pigeon pea is good. ***"CB: If you were given modern variety pigeon pea for free, would you try it?" 'No'***

- **Labour**

Labour is an especially important input for smallholder peasant farmers. Without mechanised inputs, almost everything is done by bullock and by hand. All the participant farmers used labour from their own families. The cost of labour is very high for all farmers interviewed; yet many still hired some labour during harvest season and sometimes for weeding. Traditionally, the children

would take over the farm and run it as their parents did. This trend is changing while many children are becoming educated, some up to university level thanks to state subsidies.

F24. We have a lot of trouble to face: if the crop is not good, we have to borrow from another farm, buy food from market etc. I'm growing sugar cane, the other land I rent out to others: if crop grows 6, they take 2 (her way of expressing percentage). My husband has died 16 years back, so I face trouble and I rent for others. My children are only kids; they are being educated at school. They don't do so much hard work as I do [sic]. My son is helping. We know how to farm the land; we know how to handle it. We will teach my son to farm like this, to work like this [sic].

Most participant farmers interviewed did some off farm work for money. This was usually harvest work on larger commercial farms. This waged work marks a very important component for the livelihoods of the farmers. The hired people who do harvest work are referred to as *coolies*.

F18. We will feel some difficulties [sic], we don't have water so farming is difficult. We don't have enough food for the year and we find it difficult to buy food from the market. ***"CB: How do you make money to buy food?"*** *Coolie harvest work. We work on other farms for wages.*

F22. I face challenges, if the crop is not yielding well; we have to farm other land to make wages. It was not such a good harvest, because crops didn't yield well. At the beginning of the season, workers didn't come on time because they said they were not available, if rain comes: we lose out on crops. This was an issue for us this season.

The quality of labour hired by the participant farmers was often mentioned. Many farmers felt hired labour was done poorly and not as efficiently done, as they would have liked. This can prove to be a serious problem while money is scarce and exact harvest periods are so fickle,

F35. We are facing many problems, for example we have to prepare land for season, we have money to pay for tractors to prepare the land, they take so much money, one day is 500rs (6€ app.) They will come at 10am, 3pm, and they don't do their job [sic]. The people are not doing their job, if the rainy season is coming, they won't do total day's work, if it's too hot, they will take rest. For weeding we pay 200rs (2.50€ app), I would rather just do it myself.

- ***Institutional Support***

Many of the farmers interviewed mentioned the need for some sort of organisational and institutional help. There are various large organisations that are involved in farmers' lives that affect the way they farm and live. The largest is the government. As observed above, the government provides subsidised education for young children and staple food grains via the public food distribution program (PDS), which every farmer interviewed took part in. They also work with plant breeding programs and seed companies to help make modern variety seeds easier to access; usually with subsidies. Note, this is not a continuous subsidy.

F25. The government gives discounts for modern varieties if a person has more than 5 acres, they give subsidies. Farms under 5 acres receive no subsides. - chickpea, soya, (Janumu).

DDS is the most consistent and impactful of the smaller organisation in the region. Most of the farmers interviewed were DDS members. Farmers repeatedly mentioned three important actions DDS does for them. 1) Facilitating and organising weekly *sangham* meetings which many of the interviewed farmers attend regularly. This was seen as an important means of solving common problems among the farming villages. 2) Initial seed banks that provided so many of the food crops they grow, save and exchange today. 3) The most cited point is the markets they have developed for the farmers to sell their local organic crops in. They receive 10% above common market prices if they sell to DDS. This is because DDS has managed to label their food as organic.

F7. Depending on the caste, large farms are for money, we are small farmers, we think about food before money [sic]. Local means organic, DDS gives 10% extra for organic, outside market doesn't give more for organic. We are small farmers.

F12. We don't use pesticides or chemicals in our field. This year we added pigeon pea, we sold to the DDS market and they gave us 10% more.

There is no functioning market in the Medak district that rewards organic agriculture. Whether the market food has been chemically sprayed or not, it will all be mixed and sold together. DDS extended the market to Hyderabad where a growing demand for organic food exists. There is also a small shop in Zaheerabad and a restaurant, which sells the organic food too. It is about 10% more than conventionally grown food. This does support and affect farmers who choose not to use synthetic pesticides and fertilizers; this is explicitly reflected by F29.

F29. I don't use pesticides. I will initiate people not to use pesticides from the market. We don't want people to use artificial fertilizers. After joining DDS, we are not using anymore, we are stopping other farmers in other villages too.

F8. We sell to DDS, we have no problems, I get a gain in fact [sic]. ***"CB: Why does not everyone join DDS, in your opinion?"*** *50 % of the people are coming to DDS, the others are large landowners, and they are getting extra money outside.*

F8 has exaggerated the percentage of farmers who are DDS members in the region, never the less it marks DDS's explicit support for smallholder peasant farmers in the region.

F19. ***"CB: Do you feel it is challenging to sell your local crops at the market?"*** *They [common market] give us an equal rate for all farmers.* ***"CB: Are you happy with the rate?"*** *We are somewhat sad. There is no good market for local crops. Now we sell to DDS and they give more than market rate, now we benefit. Last season, I gave 120 kg safflower to DDS market.*

F26. We sell pulses when we have our fill. ***"CB: Challenges?"*** *there is no problem; we are selling to DDS market.* ***"CB: Fair price?"*** *They give 10% extra than market price*

DDS provides many seeds to farmers who are in need, or who want to begin growing local seed varieties if they have not already. The requisite is that one does have to be a member (free).

F4. We face no problems, only happiness: Local food crops are working in our village because we are all sharing the seed. And DDS helps the village too. They [farmers] can use the DDS network to get seeds from other farmers.

F12. No problem. Since DDS has come, at the time [past time unknown] we had lots of trouble; we lost all our local seed for three years.

DISCUSSION

The results show us explicitly that a large section of agrarian society in the Medak district is conserving many diverse landrace crops on their farms that hold important, and potentially important genetic resources. Farmers are directly and indirectly exploiting the genetic resources of these crops for many of the reasons already observed in the literature: pest and disease resistance, drought tolerance, taste, health, yield and tradition. This area of study is therefore an active and functioning area for *in situ* conservation of important landrace crops. Many of the requisites laid out by Brush (1999) (see theoretical background chapter) for useful and important *in situ* conservation efforts are fulfilled in the Medak district: 1) Presence of wild crop relatives 2) environmental heterogeneity 3) subsistence production 4) commercialisation 5) access to agricultural extension services.

The evidence given states that the region is an area of landrace crop origin with unique agro-ecological characteristics and, therefore an important geographical area for *in situ* conservation efforts. We follow this further to see how potentially important CGR are being conserved *in situ.* Also, under what unique conditions these farmers are living and working in that compels them to conserve these increasingly marginalised crop varieties. A recurrent issue in the literature is that modern agriculture is increasingly undermining the conservation of many important crop varieties. There is a great fear in the scientific community that when farmers convert to modern agricultural systems, much of the important and evolving genetic material in less marketable crops will disappear. We endeavoured to understand why those who do still conserve LR varieties choose to keep growing these varieties and indeed, what conditions allow them to remain conserving these crops.

The results show us many diverse points as to why and how farmers are conserving LR crop varieties. The points will be laid out in sections below, they include geographical, ecological, socio-economic and tradition. The latter point includes factors such as culture, health and taste.

The Traditional Medak Peasant Farmer

Conservation of this type is being done by a particular type of farmer who we are calling (and the farmers themselves) **traditional** and **peasant**.
In this section, we reflect on the results and see what it means to be a traditional peasant farmer as reflected by the farmers themselves, and how this particular type of farmer in the Medak district is quite likely to be conserving LR crop varieties.
They include:

1) Land size
2) Amount of food crops grown for direct household consumption
3) Limited social mobilisation
4) Culture and Religion

We can see from both the Ql and Qt results sections that **most of the farmers have small landholdings; less than 3.5 acres**, though larger farms are conserving LR crops too. Almost all the farmers interviewed mentioned that the larger farmers do not grow 'traditional' crops because they grow everything for the market and most of what they grow are modern varieties (MV). Farmers gave the sense that traditional varieties are for small farmers and they regularly and happily identify with these varieties. This is illustrated in our Qt results section that **the larger the amount of land a farmer has, the less overall traditional seed they will grow.**

A peasant farmer by definition is a farmer who is dependent on what they grow to eat directly for their own households. Any crops sold come after feeding their families. This is true for most of our participant farmers.
A peasant farmer in this region is therefore always restricted by the size of their land, this means that a farmer's willingness to invest in modern varieties is also restricted since one's land needs to be large enough to account for the investment necessary for agricultural modernisation. Giampietro (1997) points this out when he observes that modern farmers work with economies of scale that peasant farmers do not, this is because the money earned from the crops a farmer sells needs to be more than the initial investment (and recurring costs) of modernisation. Land size therefore becomes a greater issue for modern farmers. Many farmers interviewed said they did not have enough land to grow modern varieties, which validates Giampietro's point. Both Ql and Qt results show us that larger farmers grow more modern varieties and less traditional varieties overall. This means that **smallholder farmers are generally the most important source of *in situ* conservation of crop genetic resources**.

However, even larger farmers grow traditional varieties although significantly less as an overall percentage of their land than smaller farms. Almost all farmers in the research used traditional

varieties for their own, on-farm consumption. This means that even larger farmers, who sold crops predominantly for large commodity markets, would still grow some traditional varieties if they grew crops to eat themselves. This means most farmers prefer to eat traditional varieties than MV. This was overwhelmingly evident in the Ql interviews but also in the Qt results. We used the variable FCropG to work out the percentage of food crops a farmer for direct household consumption and tested it with the overall percentage of traditional crop varieties (TradSeedG). It shows us that **farmers who grow predominantly more food crops for their own direct household consumption are more likely to grow predominantly more traditional varieties.**

One noticeable characteristic of traditional peasant farmers is the **high rates of illiteracy within their castes**. This does make social mobilisation rather difficult, a point that was reflected many times in the Ql results when farmers said that this type of farming is all they could do to live. In regards to conservation efforts, this could mean there is less chance of farmers giving up on their farming livelihoods and consequently abandoning their conservation efforts. However, the **younger members of the family are becoming increasingly educated** since the government highly subsidises school and university for the *Dalit* castes. This could **pose an issue for *in situ* conservation efforts if the younger, more educated generation chooses to abandon farming altogether, or whose values may increasingly be more economic in nature**.

A strong point of traditional peasant farmers is how they identify themselves culturally with local seeds. Traditional variety seeds embody their historical lineage via their families and their land. Farmers often keep growing LR crops simply because they identify the seeds with their families, culture and local lands. They referred to their grandparents who grew these seeds and by growing the same crops as their ancestors; they are continuing an historical familial tradition they revere very much.

This is also expressed in their religious values. Many reflected their seeds as God. Although it is difficult to define what that means explicitly, it is clear that **the seeds and the land hold a sacred dimension**. To be sacred by definition means that something is deserving of veneration and is too unique to be interfered with. Practically, this means **many farmers refuse by default to use modern variety seeds**. Although this is a very abstract reason, it is a strong and compelling one. The local Hindu religion also forbids meat. This has unquestionably added to the overall crop diversity farmers grow since they have fewer animals to feed. The local diet is very diverse and some dishes can have many different local ingredients. **The cultural diet is emblematic of the diversity of crops grown and the sort of crops farmers grow**. This is probably why most farmers prefer the traditional crop varieties, even large landholding farmers.

Community

The agrarian communities for traditional peasant farmers are vital for making seed available, and consequently for spreading and evolving germplasm. It is because strong farming communities prevail that there exists such diverse, important crop genetic resources. Useful CGR are an

emergent property of these diverse and functioning village communities. The very LR crops that have evolved from this region are an indirect cause of farmers sharing and exchanging seed. This traditional practice still exists and thrives today and traditional peasant farmers are dependent on these communities for a variety of reasons. Five strong points are found from the results, in that communities serve in:

1) Making seed accessible and available
2) Spreading and evolving germplasm
3) Helping farmers maintain a sense of autonomy
4) Extending farming network
5) Creating collective space for solving common problems

The QI results show us that all participating farmers are involved in, and contribute to a rural community. This is especially true since most farmers interviewed are DDS members.
The most practical reason for belonging to a community is to access seed. Farmers who belong to strong rural communities have access to every available seed without any monetary exchange. This is essential for traditional peasant farmers who are often monetarily poor. **Every farmer said they had no difficulty finding traditional seeds.** This is a very important case in point because the literature shows in regions and countries elsewhere, seed availability is a very urgent issue which negatively affects *in situ* conservation efforts (Setimela, Monyo & Bänziger, 2004). It works by farmers exchanging seed freely with other farmers with the condition that the seed is returned in double once the harvest has been collected. There are no institutional mechanisms that maintain this exchange, and it occurs from a traditional agrarian community *spirit*. The farmers all said they **trust** that their seeds will grow and therefore know they will get seeds in return. Many farmers are reluctant to use modern varieties because many of them cannot be saved and re-sown owing to the nature of hybrid breeds. It is evident from the results that **a strong and trusting rural community is necessary for farmers to grow diverse LR crops. This means that an existing and sprawled rural community is an essential component for successful efforts of *in situ* conservation.**

An important emergent property of community seed exchange is the spread of diverse and useful crop germplasm. The results show that farmers very often share and exchange seed within their own villages. However, if one particular crop fails within a whole village, farmers go in search of seed elsewhere. The distance depends on each farmer and their circumstance, but when asked how far farmers are willing to exchange seed, most said up to 50km. This is important because it means **important genetic resources are being sprawled across the region and therefore increasing genetic diversity and enriching the evolutionary process of a crop**. The distance of exchange is also important to **maintain allele richness within a particularly important agro-**

ecological area. This limits the affects of genetic drift by keeping genetic resources in its area of origin and preventing LR crops from mixing with less important or useful breeds. **Farmers mentioned they only exchange with farmers they know**. This reduces the risk of exchange while also reducing the distance farmers are willing to travel.

The village community also functions as a sphere of farming autonomy. An important question to ask when thinking about *in situ* conservation efforts is, how are farmers *able* to conserve and grow LR crops? As previously explained in the Theoretical Background chapter, modern agriculture can undermine conservation efforts and therefore farmers who do want to maintain LR crops on their farms need to have the choice and freedom to do so. This very often means an element of independence is necessary. Farmers need to have overall access to resources and have the choice to be less dependent on large commodity markets. The village community acts as a space for farmers to farm autonomously because they do not require the services of large and often expensive markets to farm. Farmers reflected on this in various ways by sharing seed, labour, seed banks and pasture land. This is important for *in situ* efforts because even beyond deciding whether a farmer should conserve LR crops, they need to be able to farm in a way that allows them to make choices regarding LC conservation.

The village community acts as a space for solving common problems, collectively. This relates somewhat to the previous point on farming autonomy. Problems that arise are very often only solved together as a community because a smallholder peasant farmer alone does not affect much change. One example many farmers were giving was the scarcity of the yellow sorghum seed. The year had been very difficult for this crop variety and it was difficult to find all throughout the region. It was necessary in this instance to buy the seed from villages further afield that they did not know. The farmers were planning together in their weekly meetings a way of pooling their money together to buy the seed in bulk. They would then organise a way of distribution amongst themselves to see who was most in need of the seed. None of the farmers alone were likely to afford the seed, yet as a community they were able to find the seed they wanted for making sorghum breads. This also extends a region-wide farming network whereby people in the Medak can mobilise together to work in a way that supports their conservation efforts. Seed exchange is one point of this, but also as a means of affecting regional wide policy, as will be explained later in this chapter.

Farmers' Perceptions of Modern Variety Seeds

There are two main points of difference amongst those who do not grow modern variety (MV) crops. There are those who would like to grow them, or at least try to grow them, but cannot because they lack the resources to invest in them. Then there are those who simply do not want to grow them, either from negative experiences or prevailing prejudices.

There are some very important points discovered from this research in regards to farmers' perceptions towards MV crops. They include:

1) Almost all farmers that do grow MV, grow traditional varieties along side them
2) Farmers often do not know how to grow MV properly
3) Farmers often do not trust MV
4) Many farmers feel MV are bad for household health
5) MV usually require synthetic pesticides and fertilizers
6) MV do not yield enough fodder for animals
7) MV taste inferior to traditional seeds
8) MV are difficult to access at the right time

The first most striking point is that most of the participating farmers who grow mostly modern bred cash crops, grow traditional varieties alongside their MV. This is evident in the Qt results. Only three farmers exclusively used MV. This means that **conservation efforts need not be exclusive to smallholder peasant farmers. Commodity farmers are conserving some LR crops too.**
Many farmers commented on the varying yields on MV compared to local varieties. There is a difference in opinion on this point. Some said plainly that MV yield more and that is simply why they choose to grow them. Other farmers felt the opposite and said traditional varieties yield better. They feel that although the plants may be larger, the actual food coming from these crops yield less. **Almost every farmer interviewed said they struggle to feed their animals properly with MV** and that they have to find fodder elsewhere. This may be less important for farmers who use MV because they will tend to use synthetic fertilizers and not as much animal manure.
Most farmers who grow MV are growing crops exclusively for the market. It is a financial investment.

Farmers often mentioned a lack of knowledge in MV crop growing as a major reason for not buying or experimenting with them. Farmers know how to grow traditional seeds because the knowledge has been handed down from their ancestors. They know the lands they grow well on, the right season and time for sowing, they know how to preserve them and what crops grow well with other crops. They often do not have this type of knowledge for MV. This had lead to a lack of trust among farmers for MV. They either get information from fellow farmers who do, or have grown them in the past, or from advisors at DDS who are fundamentally against MV. **Farmers are often just not willing to try MV crops because of rumours, other peoples' negative experiences, or prevailing prejudices.** Some farmers mentioned the distrust they have for companies that sell the crops, farmers often believe seed companies lie to farmers and give no support to farmers once they convert. These points are important because farmers may be willing

to try MV if they are given the right training. Seed companies may be more willing to do this and this may affect *in situ* conservation efforts.

Most farmers thought that MV requires synthetic pesticides and fertilizers to grow. We can see this in the Qt results section when comparing the overall percentage amount of traditional crops grown (TradSeedG), with a farmer's use of synthetic pesticides and/or fertilizers (SynChemG). The results show that **farmers of traditional crop varieties are less willing to use synthetic pesticides and fertilizers than those who grow modern varieties.** There are some exceptions to this; sugar cane is sometimes grown without synthetic inputs. This is important because farmers either do not wish to use synthetic chemical inputs on their farm, or they simply do not have the means to buy them. This affects a farmer's ability to invest in MV.

Perceptions on health were a major reason why farmers choose not to grow MV. **Almost every farmer who did not grow MV mentioned the negative affects MV have on health**. Some of these reflections are from experience. Skin rashes and scabs were referred to as a cause. It is not clear if this is a cause of the pesticides or the crops themselves. Farmers mentioned they need to eat more bread from MV food grains to suffice their hunger than they otherwise would with traditional crops; many also referred to getting less energy from MV.

Access to MV seed is an issue. One obvious reason is because of the costs involved in purchasing seed from the market. This is inhibiting. Yet another point was accessing the right amount of seed during sowing season. Farmers said that the seed was simply not available on time in the market, which could owe to logistical inefficiencies, or they simply cannot get the money needed for seed on time. In contrast, traditional seed that is saved in a farmer's own home is readily available, or at least available more quickly from local farmers themselves.

The last point is on taste. Every single farmer felt that traditional varieties tasted better than MV. That is a major reason why even large holding farmers grow traditional crops for their own consumption. **Taste is a very important reason for prevailing conservation efforts.**

Ecological: Soil, Climate & Biodiversity

As already observed in the literature, farmers exploit the genetic resources of LR crops to adapt to harsh environments. The Medak district is generally regarded as marginalised land because of the poor soil quality, little rainfall, frequent droughts and the long and hot dry-season. Farmers also depend on crop diversity for overall farming resilience. Many of these points appeared in the QI results. They are:

1) Only traditional crops are suited to local soil and climate conditions
2) Traditional crops are less prone to diseases than MV
3) Rains are affecting traditional crop harvests
4) Traditional varieties promote more crop diversity

All farmers mentioned the weather and the region's harsh climate. Although research done in the region shows unbalanced and insufficient soil nutrients, no farmer regarded their land as infertile. Farmers were mostly concerned about the limited rainfall. Traditional, local crops have adapted to the scarcity of water in the region, especially the millet varieties. Farmers said that without a bore well for irrigation, MV cannot grow in the region with rainfall alone. This is a major deciding factor as to why farmers grow local LR varieties. **Traditional varieties are the only varieties that can withstand the scarce water conditions of the Medak district.** This makes a compelling reason for support of *in situ* conservation efforts; the environment significantly limits a farmer's ability to grow MV.

Although I did not mention climate change explicitly to the farmers, they mentioned changes in climate, independently. The rains of the region are much less predictable and arriving earlier than other years. This is affecting the viability of some traditional crops; sorghum varieties in particular. Farmers often mentioned sorghum was becoming more difficult to grow because of the sporadic rains, which has led some to discontinue the yellow sorghum variety. One hesitates to say explicitly that this is a cause of climate change, especially since farmers' perceptions on climate change is not an entirely valid source of evidence. However, water is the number one concern of farmers.

Because this region's environment is so harsh, it is an important region for support of *in situ* conservation efforts to undergo research on crop adaptation for marginal farmland around the world. This is important because one third of agricultural land is classified marginal (Vernooy, 2003).

Farmers felt that traditional varieties are less prone to disease than MV. Traditional crop varieties have evolved without the extensive use of pesticides and since they have originated in the region, they tend to be hardier and more resilient than foreign varieties. Farmers use an array of natural home remedy pesticides that many of them testify to. Farmers do say that this type of home-based pesticide requires more work that synthetic formulas. Birds are becoming a problem, according to many farmers it is due to forests being cut down.

Most farmers feel that growing traditional crops increases on-farm biodiversity. The reasons for this relate to the literature on traditional peasant farming whereby farmers use crop diversity as a resilience strategy: if one crop fails, they can depend on another. Farmers generally associated MV with monocrop farming cultures. Traditional varieties are mostly grown for direct on-farm consumption, which means the diet influences the diversity of crops grown. This is important for *in situ* conservation efforts because it relies on a high diversity of LR crops to be grown. Traditional peasant farmers in the Medak are supporting and growing crops diversely as a consequence of household demands and risk management.

Socio-Economic: Market Integration, Access to Resources, Caste, Finances

In addition to the unique agro-ecological characteristics discussed earlier, what makes the Medak district a unique area for *in situ* conservation efforts is its socio-economic demography. As already shown in the Traditional Peasant section, farmers live within certain social boundaries that indirectly support LR crop conservation. These social boundaries will be extended upon further in this section. There are various socio-economic characteristics of the Medak district that supports *in situ* conservation efforts; the results show nine explicit points clearly:

1) Market integration
2) Local versus large commodity markets
3) The markets are good for selling, not for buying
4) Market flexibility
5) Demand for traditional varieties
6) Access to resources
7) Financial
8) Traditional seed requires more work
9) Most work as waged labours for money

What marks the greatest socio-economic point of difference between modern farmers and traditional farmers in the Medak district is their contrasting level of market integration. This is often reflected in the literature when peasant farmers are normally characterised as having limited market integration. Instead they grow food directly for household consumption and little, if not any, crops for the market. The crops that are sold by these smallholder traditional peasant farmers is surplus quantities left over from meeting their own household food needs. These quantities are usually small and they are usually sold via small, local markets of the region. The Qt results show us that **farmers who grow traditional crop varieties have little trouble selling them on the market.** This was somewhat validated in the Ql results but opinions do vary depending on the type of farm. The results show us that there is a functioning market for traditional variety crops, which unquestionably supports *in situ* conservation efforts. Farmers can sell small quantities of traditional crops without much problem in the region**. The main complaint of some farmers who grow commodity crops is that the small local markets are not large enough to demand large quantities.** They therefore must rely on the larger commodity markets, which may not demand the local variety crops as readily as MV. These results are in contrast to some of the literature that cites markets are failing *in situ* conservation efforts because of the limited and exclusive market demands for MV crops that leaves no space for more diverse, traditional varieties (FAO, 2012). This is also aided by the DDS market, which will be extended upon later.

Farmers felt that the markets were good for selling local, traditional crops into, but not for buying food. The costs of buying from the market is hugely inhibiting for small farmers who are often without financial means. The market then fails these farmers in one way, but contributes to

their livelihoods in another while indirectly supporting *in situ* conservation efforts. The markets can limit a farmer's flexibility in their work. One reason was already pointed out with the inflexibility of the seed markets, which in turn compels many farmers to save and exchange seed instead. **Farmers have very little say on what price their crops can sell for, especially in the large commodity markets, therefore farmers prefer to grow food for their own household consumption while selling any surplus left**. This is a deliberate resistance to market integration on behalf of small farmers and it an important decision in regards to *in situ* conservation because it means they have more freedom to grow LR crops if they choose.

Access to resources is a major contributing factor to a farmer's decision to grow LR crops instead of MV. MV crops are a financial investment because they cost money to buy and to maintain. A farmer that does not have the means to invest in MV simply cannot grow them, even if they wish to. The QI results show us that **there are many farmers who would like to grow MV crops, but simply do not have the resources to invest in them.** Land size and having a bore well are the two major requisites for growing MV crops, both of which are very expensive according to the farmers. The seeds themselves are costly and every farmer felt that synthetic pesticides and fertilizers were expensive. This means that because of the socio-economic status many of these farmers belong to they are indirectly prevented from accessing MV. This has meant a very large proportion of farmers are conserving traditional LR crops as a consequence of their restricted access to resources. This is important because **there is a willingness on behalf of many farmers to invest in MV, if they were given access to wider resources, the effects of *in situ* conservation could be negatively felt**. When asked what the farmer's greatest challenge is, every single farmer in the QI results mentioned money. Money issues mostly included issues with medical expenses and schooling costs (new shoes, books etc). For many farmers, investment in MV is a remedy to their financial limitations, and therefore many farmers aspire to MV investment in a hope to make more money.

Labour is a very important aspect to farming for smallholder peasant farmers in the Medak. Not only for harvesting their own food grains, but also as a means of supplementing their incomes. The QI and Qt results shows that almost every participant farmer worked off their land to earn money since selling crops alone was hardly enough to financially support their households. The only farmers who did not work waged labour were the larger farmers who sold most of their crops into a market. The Qt results show that **there is no association between the amount of income a farmer earns from their own land and the proportion of traditional variety crops a farmer grows.** This means that farmers are still willing to grow traditional varieties even if they do not generate the farm very much income. This further validates the fact that traditional variety crops are generally grown by lower socio-economically classed, smallholder farmers. This makes sense because farmers who produce most traditional variety crops grow predominantly more food crops for their own household consumption and therefore rely less on money earned directly from their farms. **Money therefore does not seem to be a very great determining factor influencing**

farmers to grow traditional variety food crops, especially while they have such limited market integration. One important point many farmers mentioned in the QI results is that traditional varieties require more work than MV crops. This is because of weeding, laborious pest management practices, diverse cropping systems, saving and storing seeds etc. This might be important to note as the values of new generation farmers are changing. Many participant farmers mentioned that their children are "Lazy" and "Don't like hard work", or they "Are not as strong as the older generations". The extra work traditional crops involve may affect the next generations willingness to grow them, and therefore affect *in situ* conservation efforts.

Institutional Support: Government and the Deccan Development Society

Farmers need some institutional and organisational network to help them effectively support efforts *in situ* conservation of LR crop varieties. Brush (1999) states clearly that although some institutional support is necessary, it should be limited and not interfering. Brush makes the point that any institutional support should help an already existing farming system that grows LR variety crops to keep on supporting conservation efforts, it is not to reverse a modern agricultural framework. There are two major institutional support networks in the Medak district: The Deccan Development society, and the government. They both directly and indirectly support conservation efforts in three particular ways:

1) The DDS developed and maintains markets for local traditional crop varieties
2) The DDS supports a network of traditional peasant women farmers that allow farmers to mobilise to affect regional policy and collectively solve common problems
3) The government subsidises staple food crops via PDS

The DDS market has extended and expanded the local markets of traditional variety food crops for DDS members. They have extended the Medak market to Hyderabad and opened up a store and restaurant in nearby Zaheerabad. They only sell regional, organic varieties and only by members of the DDS community. As seen by the Qt results on traditional seed grown and willingness to use synthetic pesticides and/or fertilizers, their exclusivity to organic would not likely be inhibiting for farmers who sold via their market because farmers of traditional varieties use significantly less synthetic chemical inputs than farmers of MV. What the Qt results show us is that **the DDS market makes it easier for farmers to sell their traditional crop varieties.** This DDS's alternative market then, unquestionably aids conservation efforts. This was validated in the QI interviews. Farmers mentioned that the DDS involvement has helped them to be more seed and food secure and have dramatically increased the quality of life for many farmers of traditional varieties. This is mostly due to the markets they have developed and maintain.

The DDS organisation also helped farmers gain initial access to traditional variety seeds if they chose not to grow MV crops. This has helped many farming families convert back to traditional food crops if they had been farmers of MV in the past. The organisation also helps build the

network of farmers and strengthen local village communities by facilitating weekly meetings among participant farmers. This has allowed farmers to act collectively and solve common problems, as was mentioned in the previous paragraphs. The DDS membership has significantly contributed to a region wide farming network. DDS uses this network to mobilise farmers to affect agricultural policy and by gaining the support of MV famers to grow more local, traditional varieties. They do this via village manifestations, using their local media sources (The DDS Radio Network) and by educating children about local variety crops via the elementary school they founded (The DDS Green School). Unlike the suggestion by Brush, DDS is strongly against the MV seeds agricultural modernisation supports. They do actively want to reverse agricultural modernisation in many parts of the region. It is not exactly clear how this may affect *in situ* conservation, but farmers who already are growing traditional varieties are being strongly supported by the DDS organisation.
The government support the conservation of traditional crop varieties in an indirect way. Their public distribution system (PDS) highly subsidises staple food crops for farmers, which supplement a household's demands. This has unquestionably lifted some of the burden off smallholder farmers and has allowed farmers of traditional varieties to sell surpluses they may not have without the PDS food grains. **The Qt results show us that every single farmer took advantage of the PDS system**.

In Situ is not infallible

As important as *in situ* conservation is, it is not an infallible system of LR seed preservation. Indeed, governments and plant breeding programs have little power over what farmers choose to grow or how they grow their crops. It is a system that relies on a lot of trust and faith that it will support important CGR. Some people are reluctant to put so much trust into the *in situ* conservation effort because of its uncontrollable and transient nature. That is why *ex situ* efforts are so well supported and funded. Zeven's (1996) article reflecting the fallible quality of *in situ* conservation of important LR crops shows how such efforts supported in Europe failed in the 1940 after World War II, with the consequent extinction of a buckwheat variety. The results show us that *in situ* conservation in the Medak district is equally fallible and cannot be relied upon without constant research and some support. Two cases are given that illustrate this point.

Farmers in the Ql interviews frequently referred to the "middle times", the period of their parents and even the period of their younger selves. Modern varieties were really pushed through via the 1970s and early 80s by government and seed companies. Many farmers abandoned their traditional varieties in support of high yields promised via MV. This period inhibited access to local, traditional seed because fewer farmers were growing them. When many of the MV failed in the region for some farmers, they had to rely on the DDS organisation to regain access to the local, traditional seeds their ancestors used when MV were non-existent in the region. It is not explicitly evident from the results, but this period could have been disastrous for the conservation of many

LR variety crops had farmers remained using MV. This period is called the middle times because it marks the period between now and their grandparents' era.

Yellow sorghum: The increasing disuse of yellow sorghum as it struggles to grow with the early and sporadic rains does put some *in situ* conservation efforts into question. It may not be adapting to climate change fast enough, which has already seen some participant farmers discontinue their support for the crop. A crop must be able to fulfil a household's demands and requirements; a farmer will not grow a crop just because it is valued by the scientific community. The yellow sorghum could be proof of this and although it is not fully clear from the results, its usefulness and value to farmers could be put at risk and therefore, its existence in *in situ* conservations efforts may also be at risk.

EXTENDING THE RESEARCH

Efforts of *in situ* conservation of LR crop varieties require unending research because of the transient and diverse nature of the farming systems that are involved. This work can be extended upon directly with a few important points of departure.

A very important and interesting study could be done to investigate the overall amount of crop genetic diversity that is being conserved by farmers in the Medak. Simply asking farmers how many crop varieties they grow on their farms can give a useful picture of the overall diversity that is being supported, and amount and quality of crop genetic diversity conserved. This could be combined with the names of the varieties where possible. A similar study was done in Western Turkey investigating how modern agriculture is affecting *in situ* conservation of LR wheat varieties. Researchers quantified the amount of on farm genetic diversity conserved by 287 households. They simply asked what varieties of wheat farmers were growing and compared the amount of LR varieties to modern varieties grown (Brush & Meng, 1998). This simple test proved an effective way of seeing how much diversity is actually being conserved, and the overall type of diversity. A similar test could be done in the Medak district to get a clearer picture of amounts and quality of diversity being conserved.

A test such as this would require many more participant farmers for sound and reliable results. This work would be much improved if the surveys were extended to more farmers across the district. The 101 farmers of this study represent only 2% of the DDS network's population (5000 people). This percentage should be increased to give a richer representation.

All *in situ* conservation strategies must constantly see these efforts on long term basis. Although one generation may successfully and wilfully be conserving important LR crops, the next

generation could potentially undermine these efforts because of certain economic factors or change in values. Therefore, studies should include research on younger generations to understand the context in which they are growing up, and how their values will affect future conservation efforts. Each farmer was asked how he or she could help ensure conservation efforts are supported by the next generation. Almost all farmers said they will teach their children the value of these crops and why they are important for sustainable farming systems. This could be extended upon by researching case studies where conservation practices have been maintained after the farm has been handed down to the next generation and how such efforts could be implemented in the Medak district.

CONCLUSIONS

This case study in the Medak district of Telangana, southern India contributes to the accumulative work done on *in situ* conservation efforts of important crop genetic resources. The region being of landrace crop origins makes it a valuable area of study for research on climate change adaptation. The crop genetic resources conserved in the region are necessary for plant breeding programs that exploit the germplasm of LR crops to develop modern varieties used in agriculture around the world. Smallholder farmers of the Medak are directly exploiting the genetic resources of local LR crops to adapt to conditions of water scarcity and poor soil conditions. One third of farmers in the world farm on marginal lands such is the semi-arid tract of the Deccan Plateau that encompasses the Medak, research on *in situ* conservation done in this region will potentially contribute to strategies on climate change adaptation in agricultural regions elsewhere.

The greatest threats to *in situ* conservation efforts are some of the specific effects of modern agriculture: homogenous cropping systems (monocrop), limited markets favouring modern varieties, and biological proprietary. Modern varieties are genetically more homogenous than landraces. Therefore, when modern agriculture exclusively uses MV, it is a type of agriculture that can potentially render LR crops extinct. This realisation has initiated a world-wide response against what the FAO calls *genetic erosion,* with the FAO's conception of the Convention of Biological Diversity's (CBD) second Plan of Action, and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). *In situ* conservation efforts must therefore focus on farmers who do still grow and conserve LR crops such as the traditional smallholder peasant farmers in the Medak district of Telangana.

This research investigated two major questions: 1) what type of farmers are conserving traditional, LR crop varieties on their farms? 2) Under what unique conditions of the Medak are farmers able and willing to conserve landrace crops where modern alternatives are available? The results of this work show that there are two points of departure when considering a farmer's use of traditional

varieties over modern breeds. There are those who choose to use traditional varieties instead of MV because of some specific preferable traits traditional varieties carry. There are also those who must grow traditional varieties by default because they simply lack the means to invest in MV, even if they are willing to try.

The ecological and socio-economic environments intimately affect what farmers are able to grow in the Medak district. The results show that the Medak's geographical region renders MV unusable without expensive external inputs. The genetic resources forgone in MV, such as drought tolerance and disease resistance are supplemented with synthetic pesticides and fertilizers, and underground irrigation. A farmer that grows MV must have access to a bore well and pest management strategies that include synthetic chemical inputs. The results show that traditional variety crops require less synthetic inputs and less water that MV. Therefore, the conditions for growing MV in the given geographical environment are directly affected by a farmer's socio-economic status because their ability to invest in MV requires constant financial maintenance. This has meant that *in situ* conservation efforts in the region are often sustained as a consequence of farmers being economically excluded from agricultural modernisation.

The **smallholder peasant** farmer identified in this study is conserving the most overall landrace crops. This type of farmer is identified in the work by several specific characteristics. Land size is generally small, averaging around 3.5 acres, though larger farmers are also conserving some LR crops. Smallholder peasant farmers grow crops predominately for direct on-farm household consumption and are therefore only moderately affected by the market. Any crops sold by these farmers are surpluses left after they have satisfied their own household food needs; these farmers do not generally grow crops exclusively for a market. Many large farmers may grow traditional crops alongside their MV cash crops for their own household consumption. Crops grown for direct household consumption is the most strongly associated impetus for farmers to choose to grow traditional varieties. The smallholder peasant farmer in the Medak generally has little financial means and minimal market integration; therefore their access to modern variety crops is limited by default. A farmer of this sort will generally belong to a farming community, which is an essential component of *in situ* conservation efforts. The results show that not only does it act as a space for farmers to solve common problems, collectively it is an important network for the free exchange of traditional crop seeds. The diverse crop genetic resources existing in Medak's LR varieties is an emergent property of sprawled, functioning village seed exchange that embody Medak's village communities.

The results show that a functioning market in the Medak district exists for local, traditional food crops, which significantly contributes to *in situ* conservation efforts. The results show that farmers felt membership in the Deccan Development Society makes it easier for them to sell their crops.

DDS has extended the traditional, organic crop market to Hyderabad and Zaheerabad. This supports Brush's (1999) observation that some institutional support is necessary for sustained *in situ* conservation efforts.

This research illustrates that *in situ* conservation strategies are not an effort to reverse the framework of modern agriculture. They are rather an effort to support farmers who are already growing and conserving important LR crops. *In situ* efforts are fragile because of the transient and sprawled nature of farming systems. *In situ* conservation efforts are impossible to centrally control and therefore the longevity of these efforts are in the hands of many diverse farmers themselves. It is not a perfect system, but it is no less an essential one for climate change adaptation. Although the Medak district is a case study of a functioning and important area of *in situ* conservation, its sustained success will depend on the economic status of smallholder peasant farmers, their values, their children' values and the rate at which climate change affects the region. The results show that the younger generation is becoming increasingly educated which will undoubtedly affect their values and worldviews. There is some evidence showing that some LR crops are not adapting fast enough to climate change, such as in the case of yellow sorghum. *In situ* conservation efforts must focus on the values that farmers already give to LR crops. A crop must meet the household demands of a farm to ensure its continued cultivation. The ecological and socio-economic conditions of the Medak are currently conducive to LR crop cultivation. Those involved in *in situ* conservation efforts should support the positive values farmers give to LR. No one can force a farmer to grow LR crops, but efforts through local organisations and institutions can help preserve the conditions that allow farmers to choose and be able to grow, and **re-grow** these local, landrace crops.

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Appendix

Appendix 1a

Biodiversity vs. High Output

There is an observable pattern in the modernisation of food production and the loss of on farm biodiversity. An extensive study done by M. Giampietro suggested that whenever changes in socio-economic and demographic circumstances result in a higher opportunity cost of labour, land and capital the agricultural sector has no other option but to convert labour, land and capital specifically to making a profitable return on the capital investments (1997). This is because there is less available labour for farm work. Also, the available labour that does exist will expect higher wages. A farmer must therefore increase the per hour, per hectare outputs of the farm into a commodity market to make a profit. Giampietro (1997) observed that up to a certain point, the typical natural cycling of matter that characterises traditional agro-ecosystems (see his work on far East and South East Asia) becomes insufficient and, therefore, the incumbent use of fossil fuel energy and monoculture farming takes over. Economically, this means a farmer must produce more food commodities to pay for their investments which equates to high input, high yielding, economies of scale, specialised mechanized, monocultures (*ibid*). In ecological terms, this means a direct decrease in on farm biodiversity, including the genetic diversity that makes up the plethora of crop varieties used by smallholder peasant farmers. The few high yielding modern varieties tend to displace traditional varieties because they are likely to provide a higher return by supplying to the limited demands of large commodity markets.

Appendix 1b

Qualitative Interview Questions

1. How many acres of land do you grow crops on?
2. How many different crops do you grow on your land approximately each year?
3. How many people does your farm have to feed?
4. How much of the crops you grow come from seed you have saved?
5. Do you exchange seed? If so, why? How far are your seeds exchanged (local)?
6. Have you always saved seed? If not, then what compelled you to change?
7. Do you grow any cash crops? If not, why? If so, which ones? Would you like to grow more? What is stopping you from doing this?
8. What does being food secure mean to you? Is it being able to grow enough food for you and your family each year, or is it having enough money to buy food each week? Please elaborate..

9. In your experience, what do you feel are some of the biggest differences between modern variety seeds an locally saved seeds? – In regards to yield, drought, pest resistance, taste etc?
10. Do you sell crops from the traditional, local seeds you grow? Is this challenging?
11. What are the biggest challenges for you in regards to this type of seed saving and exchange system?
12. How do you feel this type of seed saving and conservation can be preserved to the following generations? What are you **doing** (as a group of women) to ensure the continuity of this type of conservation?
13. Do you feel any laws, institutions, or companies make it more difficult for you to save and exchange seed? (Please elaborate).
14. Do you use local seed banks for access to seeds?
15. Have you ever had trouble accessing the seed varieties that you want? If you want a certain variety; how do you get it?
16. Does your diet ever change because of the availability of seeds?
17. Do you ever use modern variety seeds because of the unique characteristics they may have?
18. Do you use synthetic pesticides and fertilizers on your farm?

Quantitative Results

Original tables generated with STATA from quantitative results chapter

- **Appendix 0**

```
. ologit TradSeedG FCropG Land SynChemG

Iteration 0:   log likelihood = -90.009624
Iteration 1:   log likelihood =  -82.77043
Iteration 2:   log likelihood = -82.625484
Iteration 3:   log likelihood = -82.625142
Iteration 4:   log likelihood = -82.625142

Ordered logistic regression                     Number of obs   =         80
                                                LR chi2(3)      =      14.77
                                                Prob > chi2     =     0.0020
Log likelihood = -82.625142                     Pseudo R2       =     0.0820
```

TradSeedG	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
FCropG	.0093706	.0088453	1.06	0.289	-.0079659	.0267071
Land	-.0697458	.0618671	-1.13	0.260	-.1910032	.0515115
SynChemG	-1.412011	.4767094	-2.96	0.003	-2.346344	-.4776777
/cut1	-4.25308	1.026779			-6.265529	-2.24063
/cut2	-3.535733	.8956044			-5.291086	-1.780381
/cut3	-2.128097	.7822834			-3.661344	-.5948498
/cut4	-.3590526	.7364796			-1.802526	1.084421

- **Appendix 1**

```
. ologit TradSeedG FCropG Land

Iteration 0:   log likelihood =  -113.9133
Iteration 1:   log likelihood = -109.04292
Iteration 2:   log likelihood = -108.97588
Iteration 3:   log likelihood = -108.97584
Iteration 4:   log likelihood = -108.97584

Ordered logistic regression                     Number of obs   =         96
                                                LR chi2(2)      =       9.87
                                                Prob > chi2     =     0.0072
Log likelihood = -108.97584                     Pseudo R2       =     0.0433

------------------------------------------------------------------------------
    TradSeedG |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
       FCropG |   .0143352   .0081539     1.76   0.079    -.0016462    .0303166
         Land |  -.1291867   .0574833    -2.25   0.025     -.241852   -.0165214
--------------+---------------------------------------------------------------
        /cut1 |  -3.100978   .8632642                     -4.792945   -1.409011
        /cut2 |  -2.377126   .7620875                     -3.87079    -.8834624
        /cut3 |  -1.062289   .6831896                     -2.401316    .2767379
        /cut4 |   .5574523   .6728779                     -.7613641    1.876269
------------------------------------------------------------------------------
```

- **Appendix 2**

```
. xi: ologit TradSeedG i.SynChemG Land
i.SynChemG        _ISynChemG_0-1      (naturally coded; _ISynChemG_0 omitted)

Iteration 0:   log likelihood = -90.009624
Iteration 1:   log likelihood = -83.312389
Iteration 2:   log likelihood = -83.184462
Iteration 3:   log likelihood = -83.184234
Iteration 4:   log likelihood = -83.184234

Ordered logistic regression                     Number of obs   =         80
                                                LR chi2(2)      =      13.65
                                                Prob > chi2     =     0.0011
Log likelihood = -83.184234                     Pseudo R2       =     0.0758

------------------------------------------------------------------------------
    TradSeedG |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
_ISynChemG_1  |  -1.442805   .4754176    -3.03   0.002    -2.374606   -.5110034
         Land |   -.074284   .0621223    -1.20   0.232    -.1960414    .0474735
--------------+---------------------------------------------------------------
        /cut1 |  -4.913879   .8313261                     -6.543248   -3.284509
        /cut2 |  -4.193591   .6642307                     -5.495459   -2.891722
        /cut3 |  -2.790047   .4914741                     -3.753318   -1.826775
        /cut4 |  -1.045029   .3681018                     -1.766496   -.3235632
------------------------------------------------------------------------------
```

➢ Appendix 3

```
. logit DiffcltSellG TradSeedG DDSMKTG FCropG

Iteration 0:   log likelihood =  -41.85406
Iteration 1:   log likelihood = -32.662141
Iteration 2:   log likelihood = -31.220861
Iteration 3:   log likelihood = -31.168329
Iteration 4:   log likelihood = -31.168242
Iteration 5:   log likelihood = -31.168242

Logistic regression                             Number of obs   =         73
                                                LR chi2(3)      =      21.37
                                                Prob > chi2     =     0.0001
Log likelihood = -31.168242                     Pseudo R2       =     0.2553

------------------------------------------------------------------------------
  DiffcltSellG |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
    TradSeedG |  -.0296995    .012675    -2.34   0.019    -.054542   -.004857
     DDSMKTG |  -.0404479    .016286    -2.48   0.013   -.0723678   -.008528
      FCropG |  -.0177182   .0124934    -1.42   0.156   -.0422048   .0067684
       _cons |   3.640947    1.44188     2.53   0.012    .8149149    6.46698
------------------------------------------------------------------------------
```

➢ Appendix 4

```
. regress DiffcltSell FCropG TradSeedG

      Source |       SS       df       MS              Number of obs =      91
-------------+------------------------------           F(  2,    88) =    4.13
       Model |  1.66184037     2  .830920187           Prob > F      =  0.0194
    Residual |   17.722775    88  .201395171           R-squared     =  0.0857
-------------+------------------------------           Adj R-squared =  0.0650
       Total |  19.3846154    90  .215384615           Root MSE      =  .44877

------------------------------------------------------------------------------
  DiffcltSell |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
      FCropG |  -.0024388   .0019859    -1.23   0.223    -.0063854    .0015077
    TradSeedG |  -.0045132    .001898    -2.38   0.020     -.008285   -.0007414
        _cons |   .8465246   .1982224     4.27   0.000     .4525992    1.24045
------------------------------------------------------------------------------
```

➢ Appendix 5

```
. logit DiffcltSellG TradSeedG DDSMKTG

Iteration 0:   log likelihood =  -41.85406
Iteration 1:   log likelihood = -33.371051
Iteration 2:   log likelihood = -32.244381
Iteration 3:   log likelihood = -32.205509
Iteration 4:   log likelihood = -32.205481
Iteration 5:   log likelihood = -32.205481

Logistic regression                             Number of obs   =         73
                                                LR chi2(2)      =      19.30
                                                Prob > chi2     =     0.0001
Log likelihood = -32.205481                     Pseudo R2       =     0.2305

------------------------------------------------------------------------------
  DiffcltSellG |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
    TradSeedG |  -.0295348   .0126552    -2.33   0.020    -.0543385    -.004731
     DDSMKTG |  -.0391973   .0157436    -2.49   0.013    -.0700542   -.0083404
       _cons |   2.418693   1.094794     2.21   0.027     .272937    4.564449
------------------------------------------------------------------------------
```