DU Journal of Undergraduate Research and Innovation

Socio-Economic Aspects of Agronomics in India

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ABSTRACT

This report is based on an ongoing inter-disciplinary research project titled “Potential of Organic Farming in Combating Salt-Stress and its Socio-Economic Aspects” and will focus on the socio-economic aspects of cultivation of Black Gram. In the following sections we attempt to understand the economics of cultivation of this crop and in particular focus on understanding the major concerns and difficulties faced by farmers in the context of soil salinity. The specific costs and benefits that farmers need to account for in the context of soil salinity given the existing institutional and technological arrangements are covered in the review. From the standpoint of the economy too the productivity gaps across regions in the cultivation of black gram as highlighted from secondary data suggest that there exists a vast potential for self sufficiency in this crop and the possibility of eliminating demand supply imbalances. The need for ensuring soil sustainability also leads us to consider and evaluate the role of organic farming in promoting sustainable farming. Secondary data as well as our field visit to Jodhpur in Rajasthan suggest that organic techniques have a major role to play in enhancing productivity. Therefore, there is reason to be optimistic if we are able to capitalize on work of various research institutes in India, and deliver cost-effective cropping techniques to farmers. The field trip strongly reinforces our understanding of diversity of agronomics in India and the need for local-level research endeavours to tackle issues at a micro level and ensure viability and sustainability of farming practices.

Keywords: Food Sustainability, Salinity, Organic Farming, Soil Health, Black Gram, Socio-economic issues.

I

INTRODUCTION

The aim of agriculture is to produce high quality, safe and affordable food for an ever-increasing worldwide population. Since prehistoric times, the various methods used in conventional agriculture have improved crop yield. At the same time, it has resulted in serious environmental pollution (1,2) The environment related problems appear to be increasing globally and has adversely affected surface water quality, soil organic matter, aeration and soil structure leading to increased salt concentration in soil. Excessive use of phosphorus fertilizers result in increased salt concentration in water used for irrigation and nutrient loading in aquatic ecosystems (3, 4, 5). Plants growing under field conditions are exposed to various environmental factors and any deviation in these factors from the optimum levels is deleterious to plants and leads to stress (6)
Amongst the various abiotic stresses, salinity has emerged as one of the major challenge and is considered as one of the most serious environmental problems which influences crop growth (7, 8, 10) Together with drought, it continues to be one of the world's most serious environmental problems for agriculture (11). The loss of agricultural land due to salinization is in direct conflict with the increasing population posing even a serious challenge for maintaining world food supplies (9). This problem is particularly severe in arid and semi-arid regions of the world where most of the developing countries happen to fall (12, 13).

Thus, there is a deliberate need to raise plants that can, not only withstand high levels of salt, but can also maintain optimum yield levels. However, efforts to improve crop performance under salinity have been elusive owing to its multi-genic and quantitative nature along with removing salinity stress in arid and semi-arid regions of the world to ensure agricultural sustainability.

Thus, our project seeks to understand the potential of alternative techniques of farming that are sustainable yet scalable and to understand the socio-economic aspects that motivate and dictate the decisions made by farmers. The focus is on understanding the agronomics of cultivation of Black Gram - the crop which has been chosen for our project. As part of the project, in order to understand the effects of salinity, the crop has been tested with various treatments under saline conditions. The results from the laboratory experiments are reported separately. In this report we focus on the socio economic aspects and cropping patterns in the context of salinity. This also brings us to the problem of the adverse impact of soil conditions on yield and the yield gaps emerging due to these constraints. Lastly, we discuss our findings from the fieldwork done in Rajasthan concerning organic farming and less-arable soils.

METHODOLOGY

Choice of Crop

In this section we look at the major issues which influence farmers regarding the choice of crop for cultivation. Clearly the decisions with respect to choice of crops and cropping systems are influenced by a variety of factors operating interactively at the lowest level. The most important factor is of course the agro climatic conditions which dictate the suitability of crops for different regions. In addition the existing institutional and technological arrangements also influence the cropping pattern. Finally at the micro level farmers make rational decisions about the crop to cultivate based on their understanding of the economic costs of cultivation and the returns or net profitability from it. Understanding the complex interplay of all these factors would help us to better understand the agronomics of cultivation in India.

The agricultural sector in India still has a large population dependent on this sector for a livelihood. The increasing pressure of population on land has led to a situation where average land-ownership is relatively small, and there is immense pressure on resources due to this rapid population growth. Currently, out of the 97.15 million holdings in operation, 90 % of them are marginal (less than 1 ha), small (1-2 ha) and semi-medium (2-4 ha) farm holdings (56.2 million, 17.9 million, 13.3 million respectively). Thus cultivation of crops thus remains a subsistence rather than commercial activity, since the economics of scale does not take place. Management of holdings is done like that of a household and cannot be commercially competitive. In subsistence farming, crops are grown to meet household requirements. The existing land distribution patterns as well as the diversity of agro climatic regions in India have contributed to a multiplicity of cropping patterns. It is estimated that there are more than 250 double cropping patterns of which there are 30 major cropping systems. Some common cropping patterns are rice-gram, rice-wheat, rice-groundnut, pearl millet-sorghum etc.

The specific factors which impact decisions about cropping patterns can be classified into infrastructural factors and technological factors. Infrastructure is the key to any production process and comes in various forms; the types of irrigation facilities available to farmers; transportation modes available to farmers; storage and post-harvest handling and processing systems; marketing facilities including grading and standardising procedures etc. Another key factor is access of farmers to formal credit mechanisms. The extent to which individual farmers can avail or make use of the above-mentioned infrastructure requirements depends on a variety of socio-economic factors that come into play at the micro level. The size of the land holding by and large determines the financial resource base of the farmers and is crucial as it determines their decisions regarding input usage in land, labor and credit markets. Household needs such as food, fodder, fuel and labor availability also affect the type of cropping patterns farmers undertake. In addition technological factors which impact farmer’s decisions include the availability of high-grade varieties of seeds, fertilizers and various mechanization possibilities, plant protection mechanisms and most importantly, the extent to which the farmers can access relevant information and put them in practice.

In lieu of our project goals, we are more interested in pulse crops as they are popular for their suitability in different cropping systems. Recent advances in the development of a large number of varieties of pulse and oilseed crops with varying maturity duration have made it possible to include them in irrigated crop sequences. Pigeon pea-wheat in Madhya Pradesh and groundnut-wheat in Gujarat, Maharashtra and Madhya Pradesh and groundnut-sorghum in Andhra Pradesh and Karnataka are popular combinations.

The problems faced by legume based cropping systems particularly that of black gram is summarized in the following: Technological breakthroughs particularly for arid and saline soils have yet to be found for boosting yields; susceptibility to aberrant weather conditions and diseases/pests makes them highly unstable in performance and low harvest indices, flower drop, and poor response to fertilizers and water is prevalent in most of the grain legumes (14).

In addition there are many serious problems in marketing the crop-incorrect and faulty weighing, extraordinary commission charges, and delays in all forms of transportation such as unloading, weighing, loading etc. Lastly, the existence of large chains of middlemen reduces farmers' shares of the consumer's price(16).

After procedures of grading, packaging, storaging, and transporting, marketability of black gram can still be affected by the following problems: Many farmers are in financial troubles, they are forced to sell their crops right after harvesting thus getting lower prices than normal. And even if they are sold through normal channels, due to the unpredictability of prices profits are never assured. Lack of marketing information and incorrect grading of produce can lead to low prices for farmers. There is also the possibility of post-harvest losses during different operations like threshing, winnowing, transportation, and storage at the rural stage.

Crop chosen for project SVC-209

Vigna mungo (L.) (Black gram) belongs to family Leguminoseae. The general plant height is 30 to 100 centimeters, with hairy and lightly ridged stem densely branched at base. The large hairy trifoliate leaves are purple in color. The long and cylindrical pods are 4 to 6 centimeters in length and each pod contains about four to ten seeds, which are generally black or very dark brown. Due to its economic and biological significance (reviewed in the following paragraphs), it was the crop of choice for our project. It is one of the most important pulse crops grown throughout the country in very diverse afro-climatic conditions. According to a report, black gram produces 22.10 Kg of Nitrogen/ha, which is equivalent to 59 thousand tons of urea annually. Black gram supplements the cereal-based diet and contains about 26% vegetable protein, which is three times that of cereals. It is well known that a diet deficient in protein intake can cause Protein Energy Malnutrition. The National Food Security Mission (NFSM) of the government thus aims to provide for measures to increase pulse production and consumption in the country.

Black Gram has various uses: It is normally consumed as black gram dal, which is an important part of diet of Indians. Farmers use it for the sowing purpose in the next season. The fodder for milch animals can be prepared with a by-product of seed coats, broken bits and powder from dal mills. Furthermore, it helps in fixing atmospheric nitrogen in symbiotic association with the rhizobium bacteria that is present on the root nodules and hence maintains the soil fertility.

In the sections below we highlight the significance of black gram cultivation in terms of area, production, yields and trends in consumption and imports.

Figutre 1.The area, production and yield trends of black gram from 1964-69 to 2011-12 are depicted below:

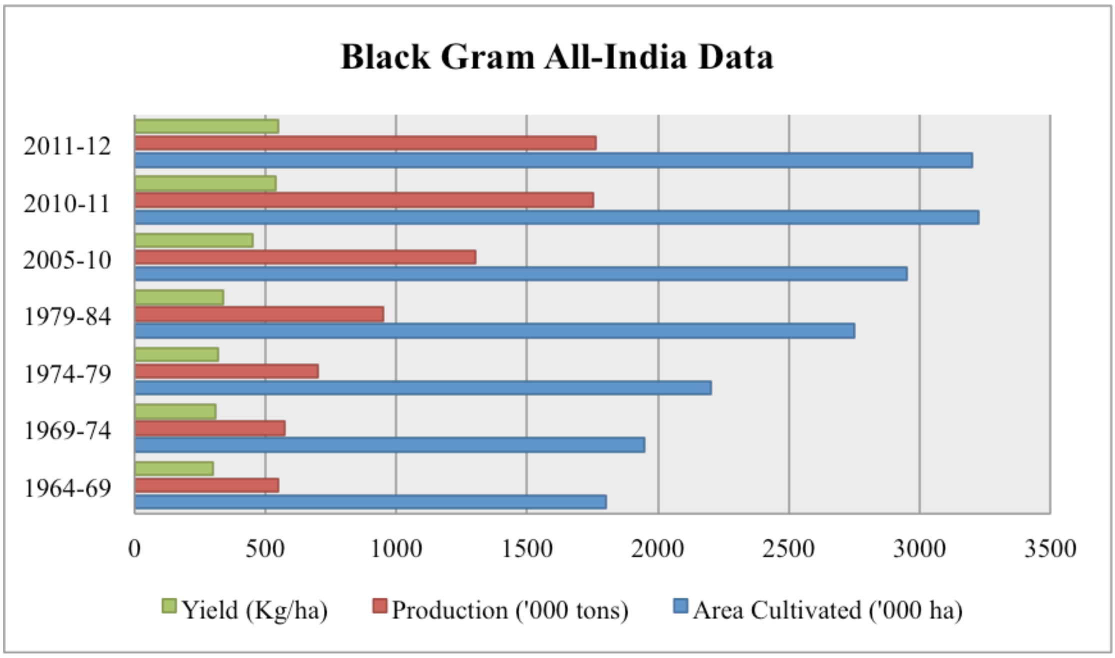


Figure 1.The above chart depicts the increasing trends in Black Gram cultivation, with significant increases in area as well as production. The trends for production of black gram show anincreasing trend with an almost doubling of production especially during the period from 1979-84 to 2011-12. However, the gains from productivity increase as seen from the trends in yield have not been so impressive. This highlights the possibility of the gains that can be obtained from measures to increase productivity.

Table 1.The following table shows more recent trends in production, imports, domestic supply and consumption of Black Gram.

Black Gram Trends	Production	Imports	Supply	Consumption
2009-10	1.23	0.47	1.76	1.65
2010-11	1.76	0.40	2.27	1.80
2011-12	1.81	0.25	2.53	1.90
2012-13	1.90	0.20	2.73	2.00

Trends in Trade and Supply of Black Gram in India (million tons)
Source: India Pulses and Grains Association, trade and industry sources

RESULTS

Yield Gaps

As a part of the research for this project we were looking for secondary data sources which reported the specialised efforts for enhancement in the yields of black gram. This led us to the work of the Accelerated Pulses Production Program (A3P) of the Ministry of Agriculture. The A3P program initiated in 2010-11, identified farmers in different agro-climatic regions across the country where black gram was cultivated in both khalif and rabi seasons. The program is based on the use of intensive measures to increase yield. These included a package of measures like soil adjustments, fertilisers, seed treating chemicals, pesticides, the use of agricultural machinery and supports well as water harvesting measures etc. The farmers identified in 16 states across the country were covered under this program in order to promote available technologies conceived in 2010-11. Under this program, farmers were provided with incentivized supply of kits of critical inputs containing seeds, plant nutrients and pesticides etc. We now discuss their findings for Black Gram cultivation in India and certain yield gaps that we see in some identified states. The program covered 2493 villages of 97 blocks in 29 districts of 11 states, covering an area of 0.86 lakh hectares and engaging 0.816 lakh farmers during Kharif Season-2010.

Following figures and table shows the state specific area and production configurations:

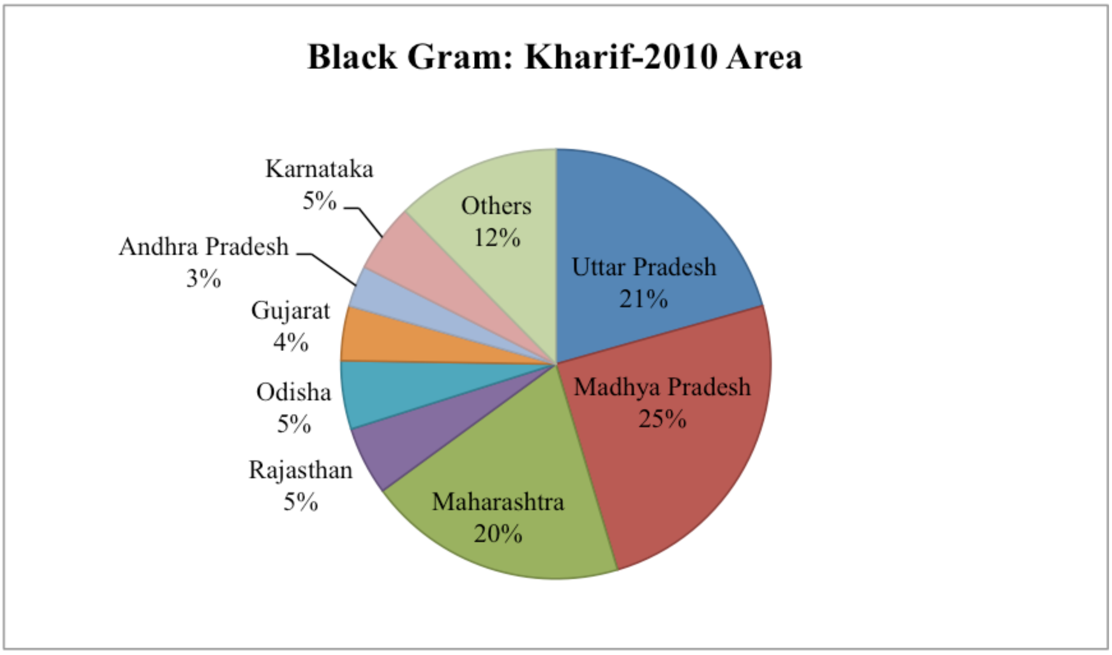


Figure 2 Shows the state specific area and production configurations

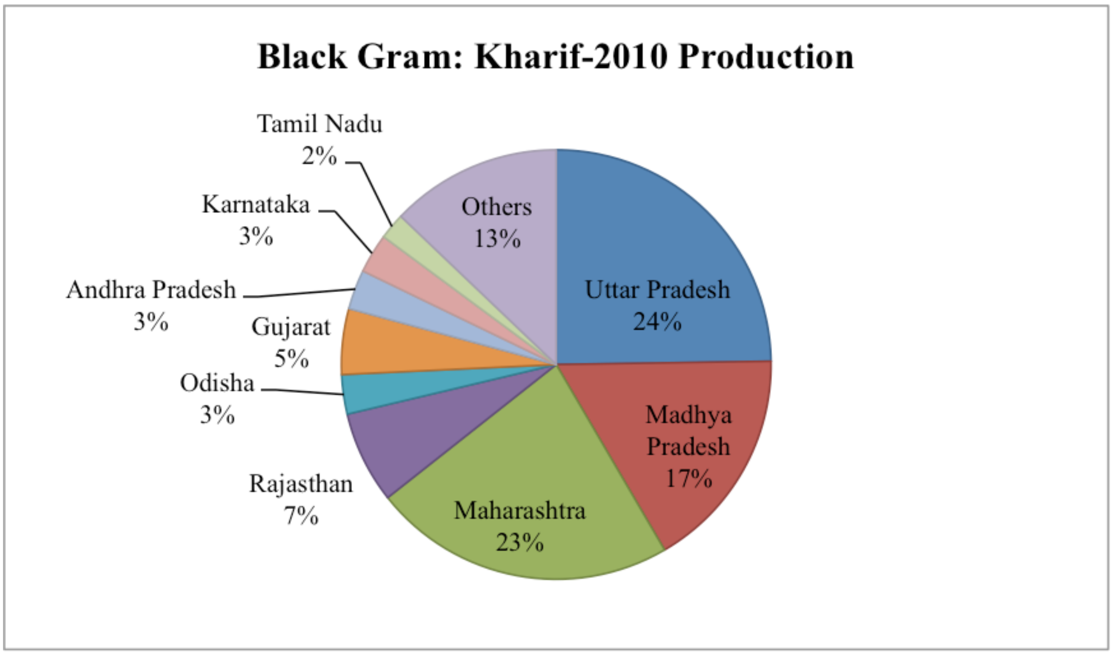
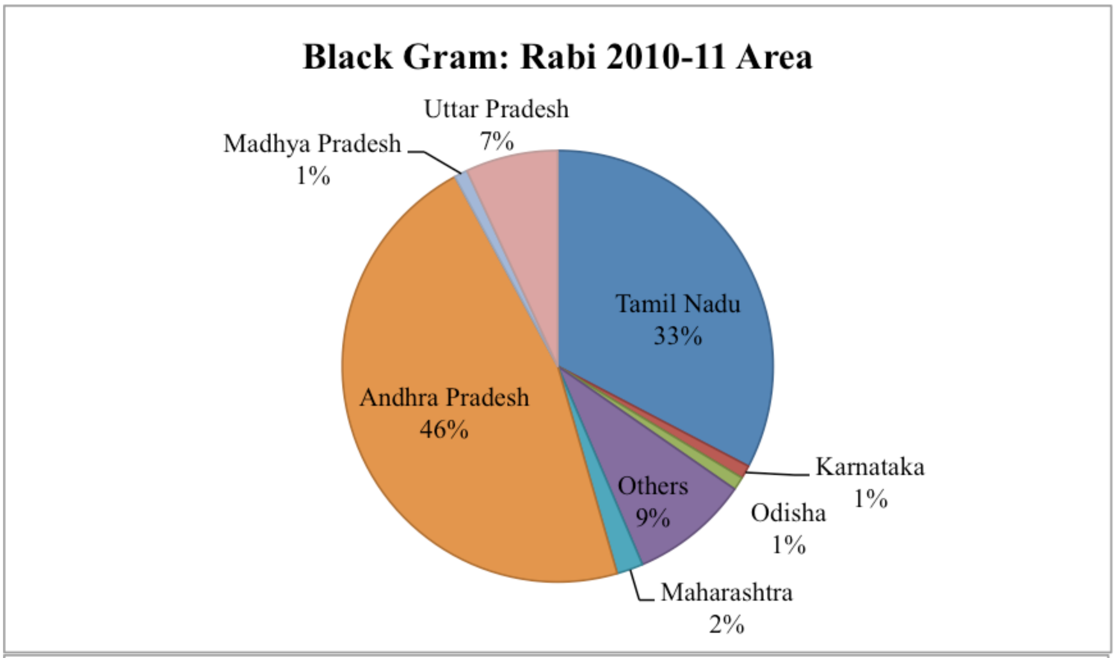


Figure 2 Shows the state specific area and production configurations

Table 2 :The findings from the A3P report on Black Gram during the Kharif Season in 2010.

State	Increase over state average		Increase of national average	
	Demonstration	**Main Plot**	**Demonstration**	**Main plot**
Andhra Pradesh	39%	At par	40%	1%
Chhattisgarh	47%	(-) 10%	(-) 25%	(-) 54%
Gujarat	13%	21%	36%	24%
Karnataka	89%	131%	17%	44%
Madhya Pradesh	21%	3%	(-) 15%	(-) 32%
Maharashtra	43%	15%	74%	41%
Odisha	117%	111%	13%	10%
Rajasthan	**(-) 48%**	**(-) 31%**	**(-) 31%**	**(-) 9%**
Tamil Nadu	69%	44%	60%	36%
Uttar Pradesh	2%	(-) 13%	22%	4%
West Bengal	53%	24%	74%	40%

Here we have a table of the findings from the A3P report on Black Gram during the Kharif Season in 2010. We focus on the state Rajasthan, since there was no increase in yield in any of the demonstrations or actual cultivation. From the report comments we find that this variety of crop is not suited to soil conditions and we hypothesize it is due the arid and saline conditions. Next take a look at the Rabi Season from the A3P report: 178 villages of 30 blocks in 10 districts of 3 states were taken into consideration, covering an area of 0.272 lakhs and engaging 0.289 lakh farmers during Rabi-summer 2010-11.



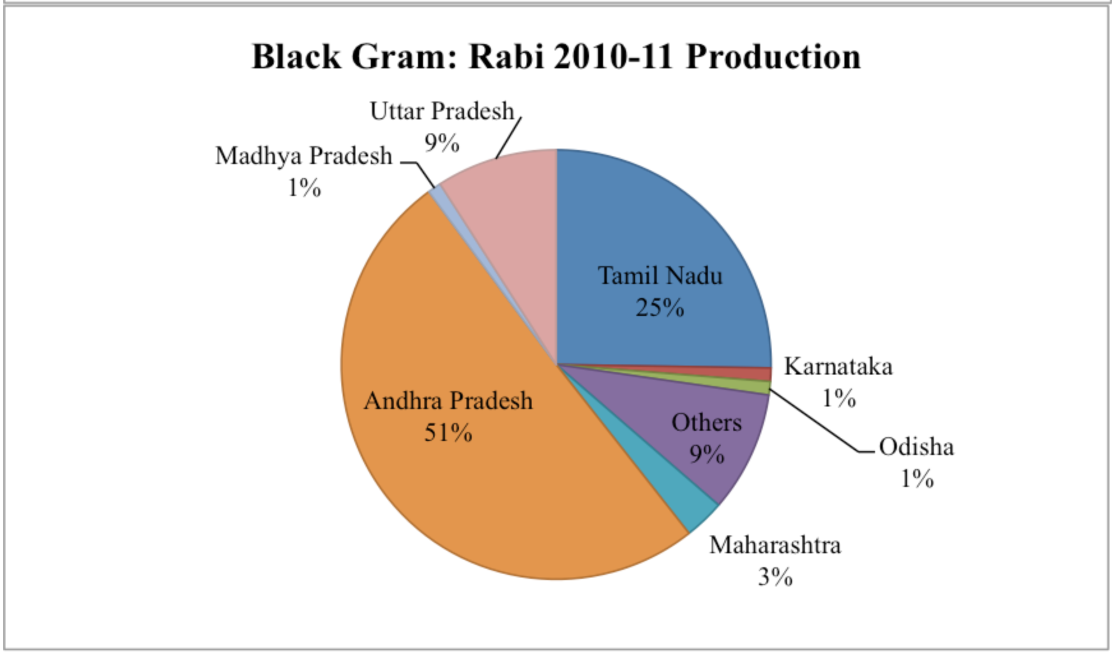


Figure 3, 4:Shows the state specific area and production configurations

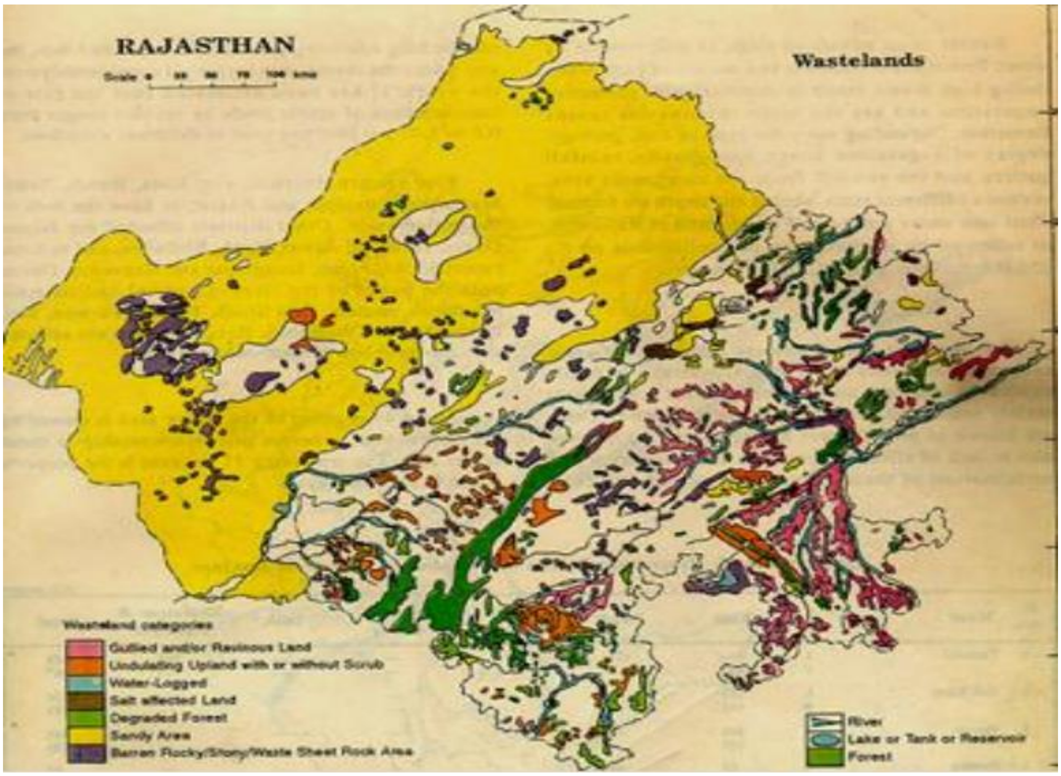
In this seasons finding, only three states (Andhra Pradesh, Odisha, Tamil Nadu) were tested and all showed an increase in yield, thus solidifying the claim that such varieties and better management practices are helpful at the ground level. But regarding the yield gap we found in Rajasthan in the Kharif season, we concluded that a better understanding of salinity and ground conditions was necessary [Ministry of Agriculture, 2012].

Salinity and Organic Farming

This section covers the formal definition of Salinity and its impacts on agriculture, and potential of organic farming in combating these effects. Lastly, we share the findings from a field visit to Jodhpur, Rajasthan.

Salinity

Salinization is a process that results in an increased concentration of soluble salts (such as sodium chloride) in soil and water. Salinity is the state of soils that have a high concentration of such salts (8, 18,19, 20). It can be classified in two categories: [1] primary salinization, when salts accumulate in the soil and groundwater of an area over a long period of time due to natural processes, and [2] secondary salinization, an aftereffect of primary salinization, in which evaporation draws rising groundwater to the soil surface through capillary action, then concentrates the salts at or near the surface, affecting the root zone of native and introduced vegetation (30).



Salinity negatively impacts crop yields and degrades the value of land (20). It increases costs faced by landholders in protecting land and surface waters from salinization or by forcing them to switch to alternative practices. Saline conditions damage regional infrastructure by eroding bricks, mortar and concrete, saline water corrodes materials used in construction of pipes and maintenance equipment, and it sometimes results in the loss of local water supplies (21). It can cause a general reduction of income and expenditure of rural families and communities, with significant social and economic implications for regions as a whole (22). These impacts are more notable in small rural towns, where opportunities for adjustment of the local economic base are limited. Rajasthan in particular has an area of 82 thousand hectares under salinity, mostly confined to Hanumangarh, Nagaur, Jaipur, Jodhpur, and Jaisalmer districts [Govt. of Rajasthan].

Organic Farming

Soil quality is the foundation on which organic farming is based. Organic farming is based on multi-cropping, crop rotations and organic manures and pesticides (29). Minimum tillage allows for lower bulk density in soil, higher water holding capacity and higher soil respiration activities. This leads to higher productivity and keeps maintenance costs low (27). Organic farming is labor intensive year round, thus mitigating underemployment and seasonal fluctuations in unemployment (32). Indirect benefits include consumers getting healthier products, farmers maintaining healthier soils/environment, boosted eco-tourism and protection of the ecosystem.

However, proper training is required for compost making and using bio-fertilizers, and needs the willingness and motivation to adopt these techniques on the part of the farming community. Marketability of organic products remains a concern since recognized green markets and trade channels are yet to form and verification and certification of farms is also inadequate. Furthermore, there is lack of financial support and absence of an appropriate agricultural policy (23, 24).

Organic farming has considerable potential in improving plants performance by providing varied macro-nutrients as well as micro-nutrients required for healthy growth in an environment friendly approach. For example, Sonamukhi (*Cassiaangustifolia*) is planted at the circumference of field to prevent rodent attack. Its roots are poisonous for rats. Its leaves purify blood and restore the metabolic imbalance lost due to indigestion. These techniques promote a less polluting agricultural system, which combats the hidden costs of resource degradation and in turn is far less detrimental to society as a whole. For example, fermentation is done using dhatura, kaachra, cow dung and akdaa to kill pests. Organic farming can provide rural development benefits through enhanced employment by meeting the needs and concerns of farmers (28). In conclusion, the public utility of organic farming can be divided into the following: productive/quality advantages over conventional farming, prevention of environment degradation to a larger extent, and inculcating a sustainable approach for long lasting human consumption.

Field Visit Findings

In order to understand the effects of salinity and to gauge the potential of organic methods first hand we conducted a field visit to Jodhpur, Rajasthan. We found various techniques used by the local inhabitants to counter the less arable nature of soils there; they have evolved suitable land use and management systems of farming, pastoralism and animal husbandry. However lately, these local survival systems have become inadequate to fulfil the ever-increasing needs. This has resulted in over-exploitation of the resources causing rapid and widespread land degradation and decline in productivity.

To arrest this degradation process and for scientific and sustainable management of the resources, Desert Afforestation Station was established in 1952 at Jodhpur. This was later expanded into Desert Afforestation and Soil Conservation Station in 1957, and finally upgraded to Central Arid Zone Research Institute (CAZRI) in 1959 under Indian Council of Agricultural Research, New Delhi. The CAZRI operates through Six Divisions, located at the headquarters in Jodhpur. There are four Regional Research Stations located in different agro-climatic zones to work on location-specific problems.

Water scarcity and soil infertility are major concerns in this area resulting in lower production. Farmers used only traditional seeds (from previous production) and were dependent only on rainfall and their luck. Scientists at CAZRI analyzed the local soil and climatic conditions of Rajasthan and developed new varieties of seeds suitable to these conditions and which could be sown even with scanty rainfall, especially during the Kharif season and yet gave higher yield. The demonstration farms at CAZRI also educated the farmers on sowing these modified seeds and also distributed the seeds initially free of cost to farmers interested in adopting them. Gradually, farmers accepted the scientifically modified seeds and today the seeds are sold at a reasonable price by CAZRI. After the harvest, farmers had no work and were unemployed and therefore had no source of income. The scientists at CAZRI successfully developed and improved dozens of traditional and non-traditional crops/fruits, such as Ber trees (like plums) that produce much larger fruits than before (lemon-size) and can thrive with minimal rainfall. These trees became a profitable option for farmers. One example from a case study of horticulture showed that in situation of budding in 35 plants of Ber and Guar (Gola, Seb and Mundia variety developed in CAZRI), using only one hectare of land, yielded 10,000 Kg. ofBer and 250 Kg. of Guar, which translates into double or even triple profit.

CONCLUSION

In order to tackle the problem of self-sufficiency in crops, we need scalable techniques for enhancing production whilst increasing the reliability of these yields such that we are not constrained by environmental factors. After the in-depth review into the crop Black Gram, we should reinforce the fact that there is much need of enhancing productivity of crops and pulses in particular.

However, one proposal is not enough as we are tackling a host of local and very specific constrains at the ground level such as the ones we witnessed through our fieldwork. In the economics of cultivation, there is no one solution fits-all situations and a combined effort from a management/marketability and research oriented approach is necessary. Generalizing our findings to pulses alone, the projected pulse requirement for India in 2030 is 32 million tons at an anticipated required growth rate of 4.2%. India needs to produce more not only for consumption but also to remain competitive in the world market to protect indigenous pulse production [Gowda et al. 2013]. Therefore, an accommodative agriculture policy needs to be considered to improve the socio-economic conditions of famers enabling much required growths in agronomics of India.

As a continuation of our project work, we are in the process of conducting a questionnaire-based survey with local farmers of Haryana, with the objective of collecting primary data for a better understanding of the major issues highlighted in this report. Creating local repositories of data that can enumerate the problems and unique solutions already in place become crucial to organize and implement policy and scientific measures.

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