Agriculture market price fluctuations, changing livestock systems and Vulnerability Connect – a case of *Mhaswandi* watershed, Ahmednagar district, Maharashtra

K. Bhavana Rao

Watershed Organisation Trust

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'The Forum', 2nd Floor, S.No. 63/2B,
Padmavati Corner, Pune Satara Road, Parvati,
Pune 411009, India.
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Fax: +91-241-2451134
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Foreword

Adaptation to climate change demands that vulnerable and resource-poor communities have the ability to tide over the shocks during the time of seasonal stress (during summer months) in a manner that not only provides relief from stress, but at the same time helps rejuvenate the ecosystems, upon which they depend.

Livestock – particularly small ruminants – when managed sustainably could and do act as an effective shock absorber for significant number of vulnerable communities during times of seasonal stress. However, the livestock systems challenge the governments, development professionals and the communities due to intricate interactions and interdependence with numerous subsystems and stakeholders – be they forests, grasslands, extension services and markets

The apparent quick gains in productivity often blind us to hidden negative externalities which erode the medium and long-term adaptive capacities of the communities because of the stress they create on the ecosystems which are vital to their sustained well-being. The white-revolution, while increasing milk production, has also posed serious ecological challenges. In many instances it has weakened the natural systems and increased vulnerability to climate change.

The case study takes a close look at the changes in livestock systems in Mhaswandi village and explores its linkages with markets and adaptive capacity *aka* vulnerability.

Systems such as these are complex to start. With increasing influence of globalization and changing patterns in weather variations the situation is only getting more complex. It demands that immediate attention be paid to this often neglected sector, while defying attempts to understand the situation through use of popular paradigm of reductionist and empirical research. It calls for a fresh approach – an examination of multiple subsystems and linkages together over a period of time – in order to understand the dynamics that is unfolding and to be able to respond to these changes on the run. Livestock systems necessarily demand both reactive adaptation that dovetails

into pro-active adaption leading to interventions which then form a part of bigger effort we call adaptive sustainable development.

This paper is a brave attempt in that direction. I hope more studies will follow and some of them would move in the direction of "sensing the impending changes" rather than "understanding the changes"; for the system is so complex that it challenges conventional attempts at understanding it.

Furthermore the ecosystems that support the production system of the livestock are already degraded and stressed beyond their carrying capacity. The real danger comes from continued erosion of carrying capacity and impending collapse of a shock absorber which is essential for adaptation to climate change. We are running against time and the wisdom possibly lies in "sensing" the system rather than analyzing it.

Sushil Bajpai
Director - WOTR

Agriculture market price fluctuations, changing livestock systems and Vulnerability Connect – a case of *Mhaswandi* watershed, Ahmednagar district, Maharashtra

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Abstract

The concern for many today is to have an improved understanding on vulnerability of the communities and the ecosystems in the face of climate change. The present paper illustrates the study findings on shifts/ changes in livestock systems in Mhaswandi watershed located in Ahmednagar district, of Maharashtra, India.

This paper is part-1[1] of WOTR's working paper series on livestock development and climate change adaptation as the study is still in progress. The paper

1 And Part 2 of the study will attempt to Identify key indicators to project the impact on watershed and identify possible interventions that can reduce vulnerability of communities that depended on these production systems by improving the resilience of the ecosystem using "Future DPSIR framework".

K. Bhavana Rao – has a post graduate degree in Agriculture Sciences form G.B. Pant University of Agriculture & Technology. She has been working in the development sector since 1999 with various reputed NGOs.
Her core area of work has been developing innovative livelihood alternatives for rural poor focussing on ecosystem maintenance and regeneration; Micro Enterprise Creation; Market Access Development. She strongly believes that working through multi-stakeholder partnership is the key to sustainable livelihoods. She has keen interest in livestock production systems and pastoralism in particular.
She is presently Regional Coordinator for WOTR, Andhra Pradesh unit and can be contacted bhavana.rao@wotr.org.in

illustrates the improved understanding of current livestock systems being followed by communities in watersheds; the drivers and pressures that have induced these changes; impact on the environment (watershed) due to these changes; and the consequences on the environment (watershed) and the communities. It also brings out what the responses of the communities in the face of climate variability and the risks being experienced by them currently.

The study is being done by applying the DPSIR (Drivers-Pressure-State-Impact-Response) framework a process of the GEO approach to Integrated Environmental Assessment. By using this framework an attempt has been made to assess the degree of vulnerability of the communities to climate risks due to changes that have occurred in livestock production systems.

Introduction

Majority of the rural poor in India depend on livestock rearing as a means of livelihood. In resource fragile regions, semi-arid and arid regions in particular, livestock plays a critical role in ensuring sustainability of agricultural production systems and increasing the resilience of food supply systems. It makes a significant contribution to rural food and nutritional security, particularly in case of women and children.

For small-scale livestock keepers[2], who are the majority in rural India, the importance of livestock goes beyond its food production function. It plays a vital role in supporting livelihoods by providing transport and valuable draught power and their wastes are used as manure and fuel. Most importantly, in rural economies livestock act as cash, are considered potential savings and an insurance against crop failures

2 According to FAO, "small-scale livestock keepers" include mixed crop-livestock farmers, pastoralists, and landless livestock keepers (FAO, 2009).

(India Country Report 2003)[3]. Due to this, farmers and pastoralists have, over time, developed and managed diverse local breeds that are adapted to the environment and the local feed resources they live in (RLN Vision document 2010)[4]. Centuries of efforts by India's pastoralists and livestock-keepers in rising livestock on natural vegetation has led to a large diversity of breeds that are adapted to very specific eco-systems. These breeds have the impulse to forage for themselves, and have learnt how to access the various feed resources in their territory (Saverio 2009)[5]. Over centuries, these breeds have developed certain traits in order to utilise the sparse vegetation and harsh environmental conditions in resource fragile areas. These special traits are ability to walk long distances, drought resistance, natural resistance to diseases and parasites, ability to ingest and digest roughage, thermoregulation, fertility and good mothering instincts, (Köhler-Rollefson and Mathias, 2010)[6].

It is this diversity in animal genetic resources and the specific traits and traditional livestock rearing systems that demonstrate a resilience and adaptability to climate change and weather variations, offering stability to livelihoods in resource fragile regions of the country. In a year of drought, livestock can account for as much as 80% of household incomes in these regions. Despite this, policy environments show an inherent bias against small-scale livestock systems, and especially against pastoralist systems. Research, extension, conservation, breeding development programmes, infrastructures and markets, and, in many cases, subsidies currently favour high-output large-scale livestock systems. These trends are contributing to the

3 Country Report on Animal Genetic Resources of India, Department of Animal Husbandry & Dairying Ministry of Agriculture Government of India, 2003.

4 Köhler-Rollefson. I and Kamal Kishore 2010, Shaping policies to Support Socially and Ecologically Sustainable Livestock Development in India's Rain-fed Areas, Vision Paper of the Rain-fed Livestock Network.

5 Krätli (2008) on how the ability of livestock to ingest a wide variety of vegetation is learnt behaviour, passed on in the herd from generation to generation, and also selected for by pastoralists.

6 Köhler-Rollefson, I. and Mathias, E. 2010. Animating Diversity. Supporting endogenous development of livestock keepers. Development, 53(3), (425-428).

disappearance of valuable local breeds, knowledge and ecosystems. (Learning Agricultures 2010)[7].

The paper illustrates the improved understanding on current livestock systems being followed by communities in watersheds; the drivers and pressures that have induced these changes; impact on the environment (watershed) due to these changes; and the consequences on the environment (watershed) and communities. It also attempts to bring out what responses are being taken by communities in the face of climate variability and risks being experienced currently. Lastly, it tests the hypothesis that adoption of high input-output livestock systems[8] in fragile environments and reduction in indigenous cattle breeds and non-dairy livestock increases the vulnerability of the communities and their ability to cope with climate risks.

About the research framework and methodology used

The study was done by applying the drivers-pressures-state-impacts-responses (DPSIR) framework. This framework is used in GEO reports, including the fourth *Global Environment Outlook: Environment for Development (GEO-4)* for Integrated Environmental Assessment (IEA). Integrated analysis of environmental trends and policies is one of the core elements of IEA. It analyses environment and human well-being trends and dynamics based on the DPSIR framework. (Figure 1)

1. What is happening to the environment and why?
2. What are the consequences for the environment and humanity?
3. What is being done, and how effective is it?

Using this framework, the assessment identifies the drivers of human development and associated pressures that, along with natural processes, affect the state and trends of the environment. Changes in

7 Lucy Maarse and Mundie Salm 2010 Learning agriculture, module 4 livestock systems, Published by ileia, Amersfoort, the Netherlands.

8 Here means livestock production systems that are generally focusing on a single species, rely on commercial inputs and trade and may include concentration of large numbers in one unit.

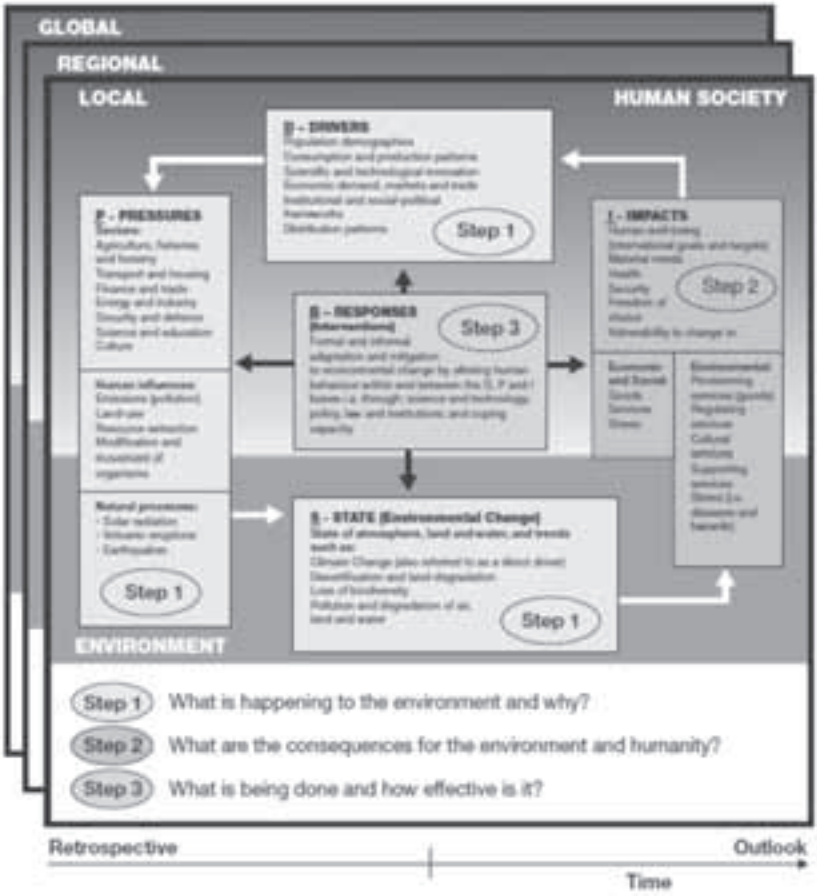


Figure 1:

the state of the environment have impacts on ecosystem services and aspects of human well-being. It also analyses policies directed at the mitigation and conservation of the environment, as well as adaptation by people to the environmental impacts. Integrated assessment of the state of the environment identifies priority environmental and sustainability issues, specific indicators, and policy targets for a given issue. Such a process could also be used to identify linkages to human well-being.

In context of climate change adaptation, the IEA module 6 modifies the generic DPSIR into a "current" DPSIR in which the responses (R) will focus only on capacities to cope or to adapt (vulnerability assessment) and a "future" DPSI will be developed (impact assessment) in which the R will focus only on needed capacities. These are then analyzed alongside proposed "Responses" to the form of adaptation options. Integrating principles of vulnerability assessment with available information on current and future climate change into the DPSIR framework helps to develop adaptation responses that are relevant to other social, economic and environmental challenges.

Part-1[9] of this paper only describes the findings using "current" DPSIR in which the responses (R) focuses only on capacities to cope or to adapt (vulnerability assessment).

Spatial, temporal and thematic context

The study jurisdiction is a non-political boundary taking a watershed[10] as the unit of analysis. The watershed is not only considered as a geographical area, but more as a "living space/ecosystem" i.e area of survival in which a communities are living and drawing their sustenance from. Within this unit, the study focuses on livestock systems that communities have practiced since 1980's and how it has changed over time.

9 And Part 2 of the study will attempt to Identify key indicators to project the impact on watershed and identify possible interventions that can reduce vulnerability of communities that depended on these production systems by improving the resilience of the ecosystem using "Future DPSIR framework".

10 A watershed is defined as a geo-hydrological unit comprised of all land and water within the confines of a drainage divide. It refers to the area above any point on a stream/river which feeds water into it. A watershed may vary from a few hectares to several thousands of hectares.

Methodology used for data collection

As the study is still in progress, findings of only one watershed village have been detailed out in this paper. The watershed was selected after classifying all 25 watershed villages in WOTR's climate change adaptation (CCA) project area in Ahmednagar district. It was based on extent of changes in crop-livestock systems being practiced by communities in the area. Care was taken that the selected watershed brings out maximum issues to the forefront in the same agro-ecological zone and project area.

The qualitative data was collected through focus group discussions with Village Development Committee and Village Watershed Committee members, the members from the Gram Panchayat, women SHGs and the milk society. It was further supported by specific interviews with two livestock rearers/farmers from all land holding categories[11] including landless villagers – to understand the drivers that brought changes in the livestock production systems. This was then cross checked with 10 randomly selected households falling in the same category and practicing similar crop-livestock farming systems to ensure consistency of data and information. The numerical data presented in the paper are from the baseline reports, internal project monitoring, project completion reports and recent field surveys.

Study Findings

State of Environment: *Mhaswandi* watershed (Box 1) falls in the rain shadow/scarcity zone of the *Sahayadris* and agro-ecological zone (AEZ) 6 i.e hot moist semi-arid eco region. Within this AEZ, *Ahmednagar* district falls under AESR 6.2. This sub region is drought-prone and is characterised by severe drought spells repeating approximately once in three years. The moisture availability also mostly remains as sub marginal, and length of growing period extends to slightly over 90 days or less at places leading to severe crop failure. Other constraints in the region are prolonged dry spells that adversely affect the crop

11 Land holding categories are landless, 0-1ha, 1-2 ha, 2-4 ha, 4-8ha and above 8 ha.

Box 1: About Mhaswandi watershed village

Watershed Village Mhaswandi is located in the foothills of the Sahayadri ranges of Western Maharashtra in the Sangamner taluka of Ahmednagar district. It is a home to 220 households living in 9 hamlets spread across the village. Sixty per cent of these families are Marathas and other sub-castes such as *Chambhar*, *Navhi*, and *Sutar*. The remaining 40 percent are *Thakkar Adivasis*. The topography of the watershed is undulating with over half the total area coming under forestlands, with steep slopes of over twenty five per cent. The area of the watershed is 1145 ha of which 377.49 ha is arable land, 20.75 ha is cultivable wasteland and 231.50 ha is uncultivable waste land. Government forest land in the watershed is 502.10 ha and Panchayat land comprises of 13.16 ha.

growth; high runoff during stormy cloud bursts in the rainy season resulting in heavy soil loss and deficiency of nitrogen, phosphorus and zinc leading to nutrient imbalance in soils.

The climate is hot in the summers and there is a general dryness during major part of the year, except during the southwest monsoon season. In the cold season which lasts from November to February the air is dry and invigorating. The period from March to the first week of June is the hot season. It is followed by the southwest monsoon season which lasts till the end of September. October and November constitute the post monsoon or the retreating south west monsoon season. In this region, the early rains are often scanty and the late rains capricious, so that droughts appear to form the rule and good year. The average annual rainfall in the district is 578.8 mm. (22.79'')[12] however; the average annual rainfall is area where *Mhaswandi* is located is 399 mm.

Changes observed in the state and current trends (exposures)
The main exposures currently being felt by communities in the area are increase in unpredictable rainfall pattern, increase in intensity of rainfall or sudden prolonged rainfall (year 2010). In the recent 15 years, heat spells and droughts have increased in the region (1997,

12 http://www.maharashtra.gov.in/english/gazetteer/Ahmadnagar/gen_climate.html and http://ahmednagar.nic.in/html_docs/RAINFALL%20AND%20CLIMATE.htm, Jan 10 2010.

2003). The region is also experiencing frequent changes in temperature and precipitation patterns. (See Graph 1)

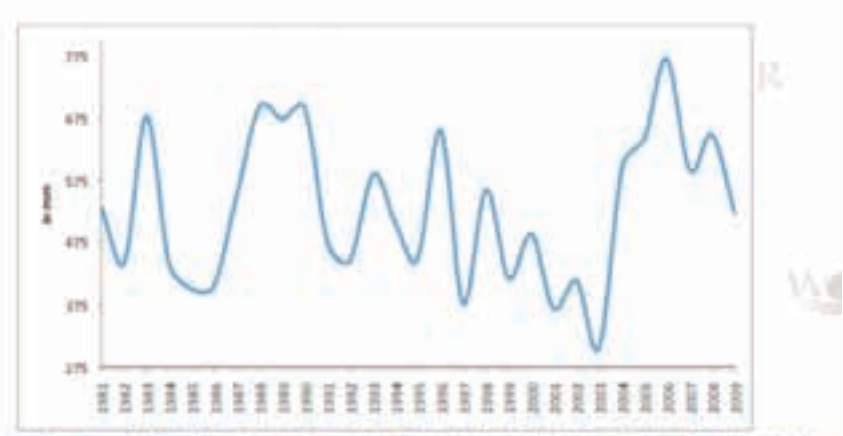
Step 1: What is happening to the environment and why?

Drivers (in-direct)
Two levels of drivers have been identified responsible for the changes in the state of environment since 1980's:

At the national level: The key drivers of change are the growing needs of ever increasing population and growing market demand for livestock products. This has led to agriculture and animal husbandry policies that promote adoption of high input-out production systems, animal breeding programmes focused on increasing breed productivity (single productive trait). In addition to this, natural resource conservation and management programmes such as watershed development and Joint Forest Management (JFM) and rural literacy programmes have added to these changes.

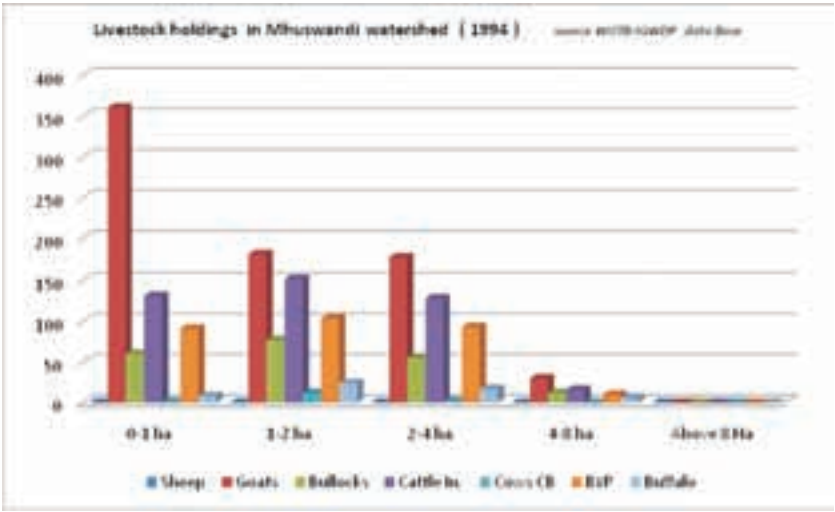
At the farmer level: All farmers expressed the need for food and financial security and want for better education and quality of life were found to be the key drivers of inducing change in crop-livestock production system.

Pressures (direct)
Livestock – Agriculture systems: Farmers revealed that mixed livestock farming was practiced earlier and number of livestock per household decreased as land holdings increased. Indigenous cattle, goats and back yard poultry played a critical role in sustaining livelihoods especially as agriculture productivity was very low (only rain-fed) (Ref. Graph 2). Farmers reported that natural resource conservation and management programmes such as watershed development initiated in 1994 and Joint Forest Management in 1996 (JFM) have been the main pressure for communities to reduce rearing indigenous cattle and other non-dairy livestock. The reason being, conservation and management of these resources puts a direct restriction on grazing which is essential for the rearing of these animals. On the flip side, development, conservation and management of the common property



Data Source : http://ahmednagar.nic.in/html_docs/rainfall_information_of_district.htm, http://www.imd.gov.in/section/hydro/distrainfall/webrain/maharashtra/ahmednagar.txt

Graph 1



Graph 2

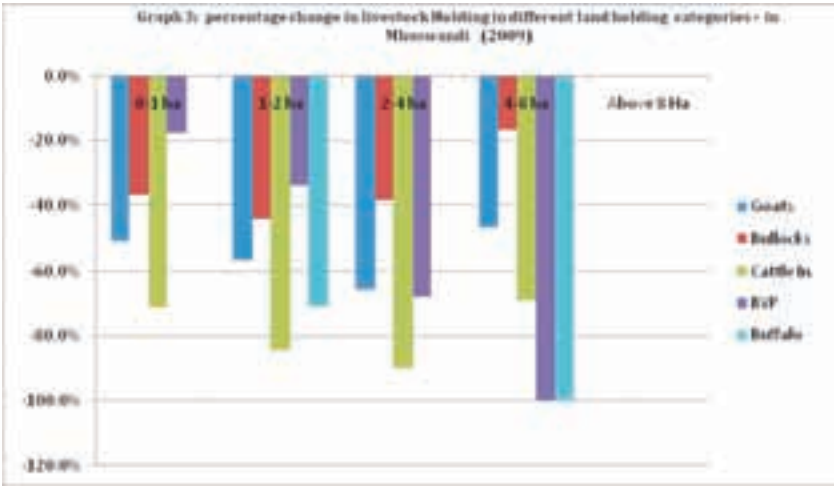
resources (CPR) lead to increased availability of water and fodder resources in the area – bringing large tracts of barren land under agriculture production.

During the past decade and a half, Ahmednagar district has risen to be largest producer of onion, tomato and other horticulture produce. The study revealed that due to this, the farmers' decisions on growing crops are highly influenced by the market demand. This is more in the case of small and medium farmers due to the need for regular cash flow. Farmers shared, that even though their land benefits from growing wheat, millets and other crops in rotation basis there is absolutely no demand for the produce and often the cost of cultivation is higher than the return. Hence these practices are not taken up and the need for continuous cash flow forces them to cultivate cash crops year after year. The cropping pattern have changed from earlier groundnut, bajra (pearl millet) and sorghum, to potato, tomato, onion, groundnut, wheat, soya bean, floriculture, and fodder crops like maize, and green fodder (*WOTR Voices – Mhaswandi*). Groundnut, bajra (pearl millet), and sorghum are still planted but in small areas just for household consumption.

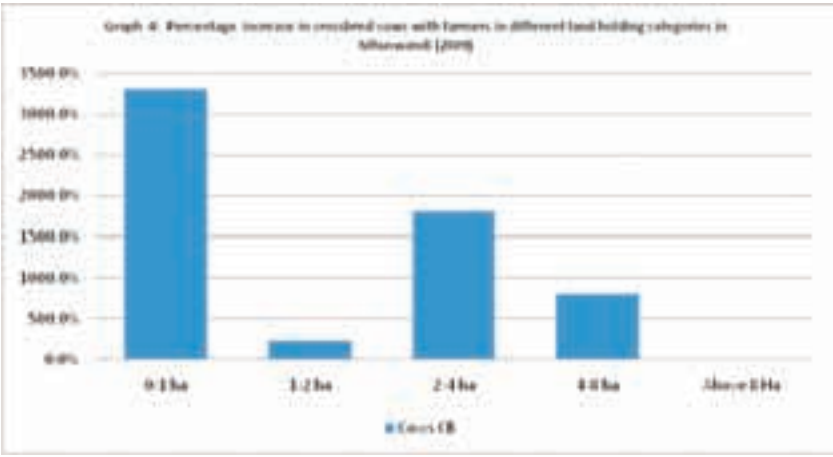
As elsewhere, the farmers here also are greatly susceptible to market price fluctuations. For example a crate of tomato (approx. 10 kg) can sell for ₹600 or drop down to a minimum of ₹60/- within short periods. In times of climate related disasters the fluctuations are even more rapid. To safeguard themselves farmers have switched to rearing crossbreds taking advantage of the increase demand for liquid milk and the continuous water availability in the watershed. Currently for many households rearing crossbred cows for milk production, has become a key secondary source of income – as there is no fluctuation in milk market prices and is an assured income. A clear shift[13] from the rearing of non-descript/indigenous *Deoni* cattle to 75% high grade *Holstein Friesian* crossbred cows is observed. (Graph 3 and 4).

Simultaneously, developments in village infrastructure (roads, transport services), dairy cooperatives, subsidies, poverty alleviation

13 Approx. 12-15 indigenous cattle are replaced by 2 crossbred cows per household.



Graph 3



Graph 4

programmes and animal husbandry schemes/programmes that promote crossbred cattle for improving economic returns through 'increased production' have accelerated this change.

Environment related: The cash crop and dairy based farming systems (high input-output) have increased use of chemical pesticides and fertilizers. Shift to crossbred cattle has increased the utilization of water for growing green fodder throughout the year and for animal maintenance and milk production activities. Conversion of common lands to private agricultural land and infrastructure development has resulted in further reduction of Common Property Resources (CPRs) at village level. And policies directed at the mitigation and conservation of the environment is bringing larger tracts of forest/ common land enclosed conservation.

Social changes: Cash crop agriculture and dairy based animal husbandry have raised household level incomes considerably. Rise in incomes, developments in rural education systems along with infrastructure development in villages has led to better educated youth in villages. These young educated youth aspire for better jobs and expressed less interest in agriculture and animal husbandry activities – livestock rearing in particular. Most of the households in the village now have only the parents and less educated brothers managing the agriculture and animals and the well educated youth either were in nearby cities or have migrated to Mumbai for better job opportunities.

Step 2: Impacts – What are the consequences for the environment and humanity?

Livestock – agriculture production systems: The major impacts noticed due to the drivers and pressures described above is the significant reduction in indigenous cattle numbers and rearing of non-dairy livestock by poor households in particular. This has resulted in heavy shortages in farm yard manure and bullock power at village level. Investigations revealed that farmers now have to invest heavily for cattle dung and is available only every alternate year. The price of a pair of bullocks has shot up from just ₹10,000/- to ₹70,000/- a pair in

the last few years. Lack of manure and bullock power has increased dependency of farmers on tractors and transport vehicles for farm operations and heavy usage of chemical fertilisers and pesticides for maintaining crop productivity. Increase in agriculture production in own lands has led to shortage of availability of labour to manage livestock further reducing rearing of non-dairy species and indigenous cattle. Reduced bullock power has led use of tractors and transport vehicles for agricultural operations.

Impact on Environment (ecosystem, ecosystem services)

High input-output crop-livestock productions systems are highly water intensive as farmers have reported that the 75% high grade *Holstein Friesian* is being fed at least 90-110Kg of fresh forage/day and clean water ranging between 60-80 lts/day per cow. Such production systems are unsuitable for the agro-ecological region which is drought-prone. These systems have resulted in reduction in soil quality and water availability and quality. This is due to excessive use of chemical fertilizers and pesticides; reduction in beneficial agricultural practices; increasing green fodder production and use of feed concentrates. As the region has black soil, under irrigated agriculture, injudicious use of irrigation water coupled with imperfect drainage conditions can result in high groundwater table leading to subsoil salinity and sodicity (increase in sodium deposits)[14] leading to decreased agriculture productivity.

As crossbred dairy farming is a critical source of income for all the farmers of *Muhswandi*, continuous fodder availability and storage of milk is essential. To reduce fodder deficit, the forest protection committee (FPC), village development committee (VDC) and the Gram Panchayat (GP) of *Mhaswandi* in collaboration with the State Forest Department have enclosed and protect 502.10 ha of forest land and 13.16 ha of revenue land (Gyran) to produce fodder for the dairy livestock. The mechanism involves the division of the CPRs into plots ranging from 15 to 30 ha which are then auctioned in the

14 This is being further investigated through WOTR's agriculture and technical project component in CCA project villages.

village in the presence of GP, FPC, VDC and Forest department officer in charge of that area. Once a patch of land has been allotted to a particular household, they are in-charge of the plot and collect fodder from it through the cut and carry system only. The money generated from the auctioning of the CPRs is deposited in to the FPC account and managed by the VDC for village development activities. The increase in high grade crossbred cows in the village increased the milk production in the village tremendously. But improper storage facilities due to the climate were resulting in a daily loss of over 150 litres of milk. This prompted the VDC to establish a bulk chilling unit in the village with a storage capacity of 500-800 liters a day in the year 2004. Both these strategies are definitely supporting both rich and poor farmers with dairy cattle but have triggered unfavourable changes/loss in biodiversity[15] and high fossil fuel consumption due to the bulk milk chilling unit.

Study also revealed that only farmers with four acres and above land holdings are able to produce adequate quantities of green fodder as well as invest in higher amounts of concentrate feed and better health care. Rest of the farmers with smaller landholdings depend on fodder harvested from the CPR, which is stored and fed through the year. It was obvious that majority of farmers feed inadequate quantities of green fodder and feed concentrates to the animals and large component of fodder is from the CPR which is if low quality (more cellulose content). As various studies indicate that high-grade crossbreds are known to have less capacity to ingest and digest low quality feeds and enteric emissions from livestock depends

15 The changes in biodiversity is attributed to both over grazing in limited grazing resources and loss of symbiotic relationship between livestock (through grazing) and germination of certain plant species in enclosed areas. This has been reported by small ruminant rearers as they say that enclosing the area and adoption of cut and carry system has definitely increased biomass production but there is decrease in species composition in area. This is being studied further by WOTR through the preparation of people's biodiversity registers and other support studies in all CCA project villages. Literature also reports that seeds of some plant species cannot germinate unless it passes through the gut of the animal and hence grazing restriction in enclosed areas may not be a beneficial conservation strategy in the long run.

on the interactions between varieties of factors[16] of which the feed characteristics and feed rate have the most influence. Hence one can conclude that methane emissions in livestock production systems in *Mhaswandi* maybe definitely high. However, further research is required to prove this accurately.

Impact on Social and Economical (human well being) factors

Social: Changing crop-livestock production systems have made the lives of rural women more difficult – as these production systems are highly labour intensive. Reduction in small stock, especially goats and backyard poultry, has led to reduced nutritional and financial security for women and children. There is also a significant decrease in intake of animal products (curd, ghee, milk, eggs and chicken meat) by villagers as practically all villagers strongly claimed to prefer animal products from indigenous livestock than crossbred cows and broilers. They state it to be tasteless, less nutritive and unhealthy and are reared only for financial security. Discussions revealed that the rural education system is not good enough for rural youth to compete with urban youth and feelings of dejection and unwillingness to take up traditional occupation prevail among the youth who have not been able to succeed.

Economical: Farmers shared that input cost in agriculture and animal husbandry has been rising every year. Some small and marginal farmers are unable to get out of the debt cycle – as rearing small stock that acts as cash/potential savings against any risk have reduced. Farmers also claimed that the crossbreds particularly *Holstein Friesian are* less resistant to disease and have heat related stress problems resulting in increased input costs. Secondary literature also state that decrease in fertility in subsequent generations is observed in high grade *Holstein Friesian* animals. Hence it can be concluded that crossbred based milk production maybe a highly risky option with increasing climate variability.

16 Such as the physical and chemical characteristics of the feed (feed quality), the feeding level and schedule, the use of feed additives to promote production efficiency, and the activity and health of the animal etc.

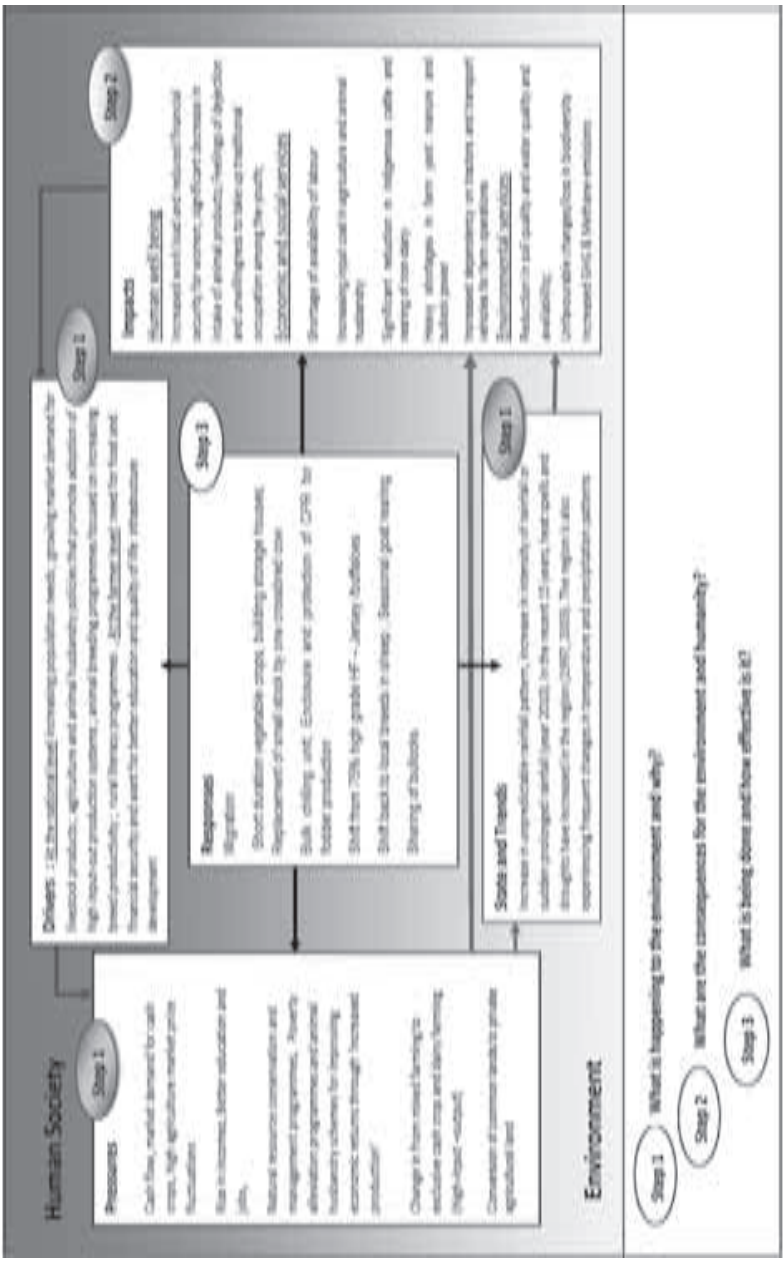


Figure 2: Diagram of framework with findings

Step 3: Responses – What is being done and how effective is it?

The current section describes the responses taken up by the communities due to the exposures in the region (refer to section 3 state and trends). It also illustrates the effectiveness of these responses and the effect on the ecosystem and vulnerability status of the communities living in the region. As per the study, the effectiveness of the response determines the sensitivity of both the communities and the watershed, which is directly proportional to the degree of vulnerability. Sensitivity in this context means degree to which a system responds to change which can be either be beneficial (reduces) or harmful (increase). The systems here are the watershed (ecosystem) and the communities that live in it. Table 1 makes an attempt to analyse the same.

Table 1:

Response	Effectiveness	Impact on ecosystem	Vulnerability of communities
Goat rearing	Response is effective temporarily as it provides instant cash in times of stress or a planned need	Increases sensitivity of the ecosystem especially if number of animals increase suddenly as grazing resources are both low in quantity and quantity in the given area	Reduces vulnerability of the community towards the risk temporarily
Seasonal rearing of goats	More effective – it gives option to make management plans	Reduces sensitivity of ecosystem	Reduces vulnerability of communities in long run
Migrate for work	Effective	Reduces sensitivity of ecosystem	Reduces vulnerability of communities temporarily
Short duration vegetable crops	Not effective even temporarily – due to high market price fluctuations; increases input costs; increasing debt for small and marginal farmers	Increases ecosystems sensitivity as these are high input crops	Provides cash flow but increases vulnerability
Storage houses	Very effective, reduces loss, provides option to make profit when market prices are high	Reduces sensitivity of ecosystem	Reduces vulnerability of communities

Table 1: continued...

Response	Effectiveness	Impact on ecosystem	Vulnerability of communities
Crossbred cow farming as strategy to safe guard against loss due to market price fluctuations	Proving effective currently but only till the time watershed can continue to provide its services. Also high yielding crossbreds will only be useful if management practices such as improved feeding (as they have low capacity to ingest and digest low quality roughage), plenty of fresh water availability, and a reliable source of veterinary drugs are available. Without these conditions the survival rate and productivity of these cross breeds is likely to be low.	Increasing sensitivity of ecosystem – 1. is no limit to high water usage 2. low quality fodder consumption 3. inadequate health care. 4. improper feed management	Currently reduces vulnerability of communities. However, profit from this option is likely to decrease with increasing climate variability as the breed is not suitable for local conditions and health service delivery system is poor.
Replacement of small stock by one crossbred cow by small and marginal farmers	Currently proving effective as other support system are in place; as milk prices are constant and demand for liquid milk is high	Increases sensitivity of ecosystem – if number of cows keep increasing	Highly vulnerable.
Bulk chilling unit	Currently proving effective	Increases sensitivity of ecosystem – high consumption of fuel as power cuts are high in rural area	Currently reduces vulnerability of communities as milk spoilage has be totally reduced

Table 1: continued...

Response	Effectiveness	Impact on ecosystem	Vulnerability of communities
Enclosure and protection of CPR for fodder by leasing system with cut and carry system of extraction of fodder	Effective for farmers with large ruminants only in terms of reducing fodder deficit but not in terms of feed quality. But not effective for communities that cannot maintain crossbred cows and who have small ruminants.	To some extent it reduces the sensitivity of ecosystem by maintaining green cover etc. Also crossbreds cannot ingest and digest feed which is of low quality; hence contribute to higher methane emissions – increasing sensitivity of ecosystem. The fund generated by leasing CPR land, is used for various village development activities and gatherings during festivals etc and not maintenance and management of the CPRs – increasing sensitivity of system as it is only in an protection and extraction mode.	Currently reduces vulnerability of communities with large ruminants. However in the long run it will increase vulnerability of communities due to reduction in palatable species in the area.
Tying wet gunny bags around shed, watering the cow regularly	Effective to some extent	Increases ecosystem's sensitivity as this is injudicious use of water	

Table 1: continued...

Response	Effectiveness	Impact on ecosystem	Vulnerability of communities
Shift from 75% high grade Holstein Friesian cross to Jersey cross.	Effective	Reduces sensitivity of ecosystem – reduces pressure with respect to water consumption and fodder intake; more suitable for dry areas	Reduces vulnerability of communities – as Jersey crosses have lesser health, fertility problems, more heat tolerance and adaptation capacity; more disease resistant
Shift from crossbreds to buffaloes	More Effective	Reduces sensitivity of ecosystem – have capacity to ingest and digest lower quality feeds/fodder	Reduces vulnerability of communities – more suitable to local climate and can be used in farming operations; Milk sells at higher price
1-2 crossbreds per household versus more numbers or larger animal units	1-2 crossbreds per house hold is more effective – as economic analysis[17] revels increasing the number of crossbreds beyond 2 per household is not profitable beyond a point as the net income per crossbred cow does not result in incremental gains or higher profitability per cow	Reduces sensitivity of ecosystem	Reduces vulnerability of communities
Shift to local sheep breeds	Very effective	Reduces sensitivity of ecosystem	Reduces vulnerability of communities
Sharing bullocks	Very effective	Reduces sensitivity of ecosystem – keeps number of animal within limit, increase in manure	Reduces vulnerability of communities – reduces maintenance costs for rearing bullocks, inpur costs in farming decreases.

17 Preliminary analysis has revealed this and further in-depth analysis is under progress.

Vulnerability of the area – statements of conclusion

The adaptation responses in the above table do show that communities over time are finding better options continuously to reduce their vulnerability to climate change. Few responses decrease the sensitivity of the system they live in, however, majority of them are short-term fixes that reduce their vulnerability temporarily but decreases the resilience of the ecosystem towards changing climate patterns. This will increase the community's vulnerability in the long term.

Changes in livestock composition and rearing systems have definitely increased the vulnerability of both communities and the ecosystems. However, due to successful watershed development the ecosystem is still able to provide adequate water resources and support the shift in production systems adopted by farmers due to external drivers, pressures and developments. The most vulnerable groups in this context are identified as landless, small and marginal farmers and women, the old and children in particular. The reasons being:

1. Dependence on only high grade crossbred cows farming and significant reduction on small stock that an act as a buffer in times of emergency.
2. Increasing investment costs in farming due to loss of multiple advantages provided by indigenous cattle (manure, drought power etc.)
3. Loss of financial and nutritional security for women and children is lost due to reduction in small stock back yard poultry and goats in particular.
4. No regulation of resources usage and maintenance within limits is operational.

Preliminary leads for making livelihoods climate smart

1. Literature states that there is enough genetic variability in the indigenous breeds hence there is a need to collaborate with the state Animal Husbandry department on identification of those breed lines, support breed up-gradation through selective breeding and maintain superior breeding stock with *in situ* community-based conservation and promotion approach.
2. Promotion of farmer's cooperatives that have solar powered cold storage units to store perishable produce. This will manage market price fluctuations and reduce loss through spoilage of produce. It will also support and strengthen the animal health delivery systems by providing space to store much needed vaccines/ medicines.
3. Improve livestock management practices and better health care service delivery.
4. Promote backyard poultry and organic manure/vermin compost units women and youth in villages.
5. Regulated use of water and resource management planning to support small ruminant rearing.
6. Promote labour association at village level to manage labour related issues.

Watershed Organization Trust (WOTR)

The Watershed Organization Trust (WOTR) is a not-for-profit NGO founded in 1993. Its operations presently span five Indian states – Maharashtra, Andhra Pradesh, Madhya Pradesh, Rajasthan and Jharkhand.

WOTR's mandate is reflected in its vision *"communities, especially the poor within, are empowered and secure their livelihood and well being in sustainable ecosystem."*

Since its inception WOTR has been working in resource-fragile semi-arid rain-fed regions through participatory watershed development. Now, WOTR has moved from "regenerating the degraded lands through in-situ harvesting of rainwater" to a holistic integrated and systemic ecosystems based model of community development that aims to address climate variation and climate change.

WOTR mobilises the communities to tap into their capacities to help them move on the path of equitable sustainable development – and along the way – reduce poverty, through regenerating the eco-space and watersheds they live in. It helps the rural communities in resource fragile rain-fed and drought-prone regions, to organise themselves, to respond to, emerging climate variations while enhancing their adaptive capacities, to address the climate change.

Watershed Organisation Trust (WOTR)
'The Forum', 2nd Floor, S.No. 63/2B, Padmavati Corner,
Pune Satara Road, Parvati, Pune 411009, India.
Phone: +91-20-24226211 • Fax: +91-241-2451134
Email: info@wotr.org • Website: www.wotr.org

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