



Farmer showing his pomegranate plot in summer 2012

Adapting to climate variation through crop diversification

Eshwer Kale and Marcella D'souza

While farmers everywhere are struggling to cope with the changing agro-climatic conditions, a few farmers in Kumbharwadi village in Maharashtra are adapting to the situation by diversifying their cropping systems. The diversified cropping systems have not only minimized the climatic and market risks, but has also resulted in providing diverse and nutritious food at the household level.

Weather aberrations are being experienced by farmers more frequently in the recent years. This is manifested in different forms like delayed and untimely rainfall, floods, increase in temperature etc., resulting in crop losses. For example, in villages of the Akole block in Ahmednagar district, for instance, most of the wheat and chickpea seed sown in *rabi* season were lost due to water logging conditions, owing to unseasonal heavy rains late in November 2010. Resowing during the month of December resulted in 50% reduction in *rabi* harvest. Similarly, heavy rains in the last week of May 2011 coinciding with the harvest time of pearl millet and groundnut, caused an approximate 50% crop destruction. Again on the 9th February 2012, the unseasonal frost damaged crops like groundnut, the seeds of which had just started sprouting. Farmers are therefore finding it increasingly difficult to cope with uncertain monsoon behaviour which has become more frequent.

During 1996-2001, WOTR, an NGO implemented the Indo-German Watershed Development Program (IGWDP) in many parts of Maharashtra including Kumbharwadi village. In 2012, WOTR conducted a GIS based study in the village to assess the change in vegetation and cropping pattern after completion of watershed development project (WSD). Despite low rainfall in that year, diversity in crops was observed. This stimulated WOTR to probe further to understand reasons for crops diversification in the villages. We used comparative method of crop-data in village at various periods. We tabulated the crop data in three phases 1996 (Pre-WSD), 2011, and 2012.

To understand high diversification of crops in the year 2012, we adopted a survey method. In the survey, we included farmers who have shifted to cash crops, horticulture crops, fodder crops, and vegetable crops. Also included selected representative sample farmers for understanding changes in cultivation of pulses and food grains. Additionally, we conducted group discussions with village farmers to understand their experiences and perceptions on shifting cropping patterns.

Water conservation brings in crop diversity

Kumbharwadi village is situated about 45 kms southwest of Sangmaner taluk of Ahmednagar district in Western Maharashtra. The village has 145 households, distributed in various hamlets. Although agriculture is the primary occupation in the village, a significant number of households are in dairy business; therefore the livestock rearing (cross breed cows) is the major subsidiary occupation. Kumbharwadi is located in the rain scarcity zone

(average 500mm per annum) of Maharashtra, with drought being a regular phenomenon.

Before implementation of the Indo-German Watershed Development programme in 1996, the annual cropping pattern in the village included only two main crops - pearl millet (*kharif*) and sorghum (*rabi*) - with a little of moth bean, green gram, horse gram and sugarcane for fodder. A total of 325.5 hectares was cultivated under rainfed conditions, while a substantial area (66 hectares) lay fallow. Pearl millet (168 ha) in the *kharif* season, and sorghum (149 ha) in *rabi*, were the main crops. These were grown for household consumption (food and fodder) only. Cultivation of wheat was unheard of.

Post WSD, from 2002 onwards, owing to increased water levels, farmers started cultivating cash crops, like wheat, tomato and onion. During our study we found that in 2011 the annual rainfall was near normal with good amount of rainfall being received in the first and second week of June (sowing period in *kharif*) and mid of September (sowing period in *rabi*).

Owing to good amount of rainfall, a total area of 414.75 ha was cultivated. Farmers cultivated 15 different crops. In *kharif* pearl millet (40 ha) onion, tomato and soya were taken in large areas, while in *rabi* wheat (80 ha), sorghum (60 ha), onion and tomato were the major crops. In summer, farmers grew tomato (10 ha) and forage (25 ha). Besides these, during the 3 seasons, they grew around 4 varieties of pulses and some vegetables. A couple of farmers had initiated pomegranate cultivation, too.

Adapting to low rainfall conditions

Rainfall in 2012 (287mm) was considerably less than in 2011 (450mm). Besides, the total annual rainfall, there was a drop in the number of rainfall days - from 60 days in 2012 to 86 days in 2011, with high variations and gaps between two rainy days. In 2012, the arrival of good rainfall for sowing in *kharif* season was late, as it occurred in first week of July, and even for *rabi* season it was late i.e towards September end and October first week.

Owing to changes in rainfall pattern, the response of farmers to crop selection was also different. In spite of low rainfall received, farmers were still able to grow a number of crops. While the cultivated area was less at 318 hectares, farmers practised extensive diversification of crops across all three seasons. Around 24 types of crops were cultivated. These included coarse cereals, pulses, vegetables, fodder crops, fruit trees and even fibre (cotton and sun hemp). Sorghum was the main crop cultivated on 142 ha, almost double that of 2011.

In *kharif* 2012, because of the low rainfall and delayed monsoons the familiar pearl millet (*bajra*) was cultivated on almost twice the area as compared to 2011. Being unsure about the possibility

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of growing two crops (*kharif and rabi*), farmers wanted at least an assured *kharif* crop. They wanted crops for household needs, besides income. Hence, together with bajra, they grew small amounts of moth bean, moong, soya, tomato and green peas. Farmers associate moong with the '*bevad*' (crop rotation) system, for as they quoted, "following its cultivation in the *kharif*" the *rabi* sorghum crop yield greatly increases". A couple of farmers experimented with growing cotton and sun hemp. Sun hemp was cultivated by one farmer for green manure to enhance the water holding capacity of the soil. According to him, due to lack of timely rains, it was not ready for mulching, so he grew it for seed.

In *Rabi* 2012, sorghum was cultivated only for household consumption, as a little water was available. Sorghum in 2012 would provide people with their staple food and fodder for livestock. Farmers said, "*fakt ek paus padla tari jwariche pik hamkhas, aani jar paus nahich padala tari janavarana chara hotoch*" (If there is just one rain after sowing, there will be some production of sorghum. In case the rains fail later, the production will be low, but it will provide fodder). Crop residue has a good market, too. With regard to wheat farmers shared, "*panyachi ek pali jari kami padali tari gavhache pik hatache jate* (If we miss irrigation even once, wheat production is seriously affected). Minor changes in the temperature also affect wheat production.

Farmers had greatly reduced the area under tomato and onion cultivation, replacing these with pulses and oil seeds, besides sorghum. They shared, that pigeon pea has a low water requirement, high market value and the residue is useful as fodder. Some farmers said that pigeon pea benefits from higher temperature as there are less pest attacks. Chickpea was cultivated on almost 8 hectares solely for home consumption. This also has a low water requirement. Where wheat requires 7-8 irrigations, only 1-2 is required for a relatively good chickpea yield. A few vegetable crops were introduced in small proportions, such as cabbage, lady finger and chillies, besides a little of onion and tomato. These were for home use as well as for the market.

The higher cash income from summer crops attracted a couple of progressive farmers. A few other farmers followed them. However, as onion and tomato are water intensive, the area under cultivation was minimal. Instead they grew forage and fodder (maize, carrot and sugarcane). Maize cultivation was greatly increased from 10 ha. to 23 ha. Horticulture which was completely absent in the pre-WSD period has been initiated. The area of pomegranate plantation was increased to 10 ha in 2012, despite the low rainfall. The reason given is that in addition to its high market demand, when drip irrigated, it requires less water and is also more temperature tolerant. Besides, cultivation of pomegranate is less labour intensive as compared to other crops, which is important for farmers. Mango plantation was introduced on 0.33 ha. Between the 3 farmers who have horticulture and summer agriculture, during March-May (2012) they invested Rs 80,000/- in total, to obtain water (50 tankers) for the fruiting pomegranate plantation.

Livestock population in the village is around 156 comprising of cross-bred cows, with a daily milk production of an average 500 litres per day. This summer, due to the drought conditions,

production had reduced to approximately 350 litres per day. As farmers believed that milk yield is reduced in higher temperatures, they bathed the cows more frequently to keep them cool, which helped increase milk production. To meet the green fodder needs for livestock, maize and *Kadaval* a local variety of sorghum, which requires less amount of water were cultivated. Farmers also started feeding the livestock with sugarcane and carrot stalks which they believe increases milk production.

Biodiversity fulfils diverse needs

Household food security was given priority in view of the uncertainties in production. All the farmers who cultivated cereals, did so solely for home consumption. Of those who grew pulses like pigeon pea and moth bean, used primarily for home consumption while selling the little excess they had. The total soya bean produce was for the market, whereas all the groundnut produce was for home consumption.

Farmers who cultivated vegetables or edible cash crops in 2012, retained sufficient quantities for home consumption. While sale of sun hemp seed brought in some income, those who grew cotton on experimental basis, earned around Rs.4000/- per quintal. Thus crop diversification during this drought year ensured food and nutritional security and also brought income into the village (see Table 1).

Conclusion

Water availability in this scarcity zone since WSD, has built the confidence of the farmers and encouraged them to 'experiment',

in judiciously using the resources to meet their diverse needs. During the drought year too, farmers reverted to the traditionally known crops. Food security and household needs (fodder) were given priority while not ignoring the income needs.

The watershed development besides increasing water availability and land productivity, contributes greatly towards enhancing the risk taking ability of farmers. The eagerness of the Kumbharwadi farmers to learn and experiment even in a drought year has shown their ability to make calculated decisions. When agro-advisories and guidance in sustainable agriculture methodologies is provided, these would contribute greatly to building farmers resilience in the face of extreme weather variations, preparing them to adapt to climate change

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Eshwer Kale (eshwer.kale@wotr.org.in) is Senior Researcher in Watershed Organisation Trust (WOTR), Pune and doctoral student at Tata Institute of Social Sciences, Mumbai. **Dr. Marcella D'souza** (exec.director@wotr.org) is Executive Director of WOTR.

Table 1: Distribution of farm produce for home consumption and market

Crop	Farmers (No.)	Area (ha.)	Total Production (Kg)	Home consumption & kept as seed (Kg)	Market (Kg)
Cereals					
Pearl millet	13	1.58	5800	5800	0
Sorghum	14	2.04	440	440	0
Wheat	5	0.88	400	400	0
Pulses and Oil seeds					
Moth bean	4	0.60	25	25	0
Moong	5	0.50	400	200	200
Soya bean	1	0.10	80	0	80
Pigeon pea	18	3.63	3370	860	2510
Groundnut	3	1.45	200(nuts)	200	0
Chickpea	5	1.09	175	175	0
Cash crops and Vegetables					
Cabbage	1	0.29	100	10	90
Lady Finger	4	0.10	200	5	195
Onion	11	1.83	2100	340	1760
Tomato	10	2.33	44400	100	44300
Greens peas	3	0.40	125	0	125
Chillies	9	0.90	310	60	250
Cotton	5	0.89	1280	0	1280
Sun hemp	1	0.19	400	25	375