Is there a science behind local knowledge in weather forecasting and crop planning?

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Introduction

"On a hot summer day, walking from one dhani (hamlet) to another in the Ranjitpura area in Bikaner district of Rajasthan, Dhanji stopped and asked me to look down and describe what I saw. I could only see lots and lots of sand! I was asked to look more carefully. I squatted and peered closely and finally noticed ants carrying grain. Ants carrying grain out of their homes! My first lesson in traditional weather forecasting. If in the month of Ashad ants carry their food out of their homes, it is likely to rain shortly and the ants are moving their food to safety!",writes VK Madhavan, Livemint, 2012.

In the desert, if the *ker* flowers first, there will be a drought. If the *khejri* flowers first, there will be a *zamana* (a good harvest). *Akha Teej* is also the time for farmers to plan their agricultural season. In Kumaun, the festival of *Harela* is preceded by sowing of seeds of five or seven different crops. Many families still believe that this helps establishing which crops should be sown. Every region of this country has similar customs (Madhavan, 2012).

Today, farmers are loath to talk about traditional weather forecasting practices. Education has led to them questioning traditional wisdom based on generations of observations. Traditional wisdom and local knowledge, in their view, does not have a scientific basis and relevance today. But is that so?

Local, Traditional and Indigenous Knowledge

Local knowledge is a collection of facts and relates to the entire system of concepts, beliefs and perceptions that people hold about the world around them. This includes the way people observe and measure their surroundings, how they solve problems and validate new information. It includes the processes whereby knowledge is generated, stored, applied and transmitted to others.

The concept of **traditional knowledge** implies that people living in rural areas are isolated from the rest of the world and that their knowledge systems are static and do not interact with other knowledge systems.

Indigenous knowledge systems are often associated with indigenous people thus rather limiting for policies, projects and programmes seeking to work with rural farmers in general. Furthermore, in some countries, the term indigenous has a negative connotation, as it is associated with backwardness or has an ethnic and political connotation.

Sources: (Warburton & Martin, 1999) and (FAO, 2004)

1. The attraction of local knowledge in weather forecasting

The main advantage of weather forecast based on local knowledge is its simplicity and timeliness; a person can make an independent observation without use of complicated instruments and make use of the information when needed without resorting to complex analysis of the collected information.

There is no need for consultation with experts and in fact the indicators observed by people in their immediate environment provide more accurate information than forecasts interpolated from data of the weather stations located at distant places.

Remoteness of the places also hinders the accessibility of the people to scientific weather forecasts through television, newspapers or radio. This is important because before the onslaught of modern scientific methods for weather forecasting and climate prediction, farming and other livelihood pursuits were sustained by this traditional local knowledge. Local knowledge can thus be used in conjunction with scientific weather forecasting information from meteorological department specially to improve the timing of agro-horticultural activities and for disaster risk reduction.

For possible integration of scientific weather forecasting and local knowledge, there is need for extended research to correlate local indicators used for weather prediction with meteorological parameters. In areas where traditionally grown crops are cultivated, agricultural decisions like sowing, planting, harvesting are still made according to traditional knowledge and understanding of local environmental conditions. Understanding peoples' perceptions of weather and climate is an important step in facilitating and promoting research on modern science – powered local agro-hydrological knowledge.

2. Field notes from WOTR's project villages in Jalna and Ahmednagar districts, Maharashtra

Is local knowledge much different from modern scientific approaches to crop planning?

WOTR's concept of localization is rooted in the belief that a localized economy is more likely be able to adapt to Climate Change (Watershed Organisation Trust, 2010). Localisation also requires accurate real-time locale-specific information on rain, soil moisture, water availability, etc. And it is in this context that it has gone about documenting traditional and localized agricultural practices, to understand the 'what' and the 'how' of farmers practices regarding water availability and crop planning, while also noting the relations to modern, scientific approaches.

WOTR carried out the study in about 11 villages of Parner and Pathardi blocks (Ahmednagar district) and 17 villages of Ambad, Jafrabad and Bhokardan blocks (Jalna district). About 130 farmers were interviewed through a mix of group discussions, and facilitated group discussions. These areas consist of people from the Maratha, Vanjari, Dhangar, Mali, Rajput, SC, ST and OBC communities.

Our observations from project villages in Maharashtra have shown **eight** commonly used indicators for water-budgeting and crop planning by farmers. These practices, based on local knowledge, were not taught to them by any outside agency, government department or agriculture research centre. They have developed it from their own experiences and rely on them regularly over the years for making decisions during the cropping season.

1. **High temperatures in summer** and some pre-monsoon showers are indicators of a good monsoon during the Kharif season.

2. Depending on the **timing of the first showers**, decisions such as those in table below are taken:

Hydro-climatic conditions	**Crop planning decision**
Rains start by 15th June or latest by 21st June	Cotton (in Jalna district)
Rains delayed beyond 21st June	Soybean, Maize, *Jowar* (Sorghum), etc. (in Jalna district)
Rains delayed beyond 21st June	In Parner block of Ahmednagar district, land is left fallow. In Chandavad village Parner, onion in October
Rains for 2-3 days on श्रावण बैलपोळा event i.e. in August	Good crop harvest possible, else losses in production

3. **Signals from nature:** singing by the cuckoo bird, croaking of the frog, place of the nest of the Crow (middle or top of tree) on Neem tree, abundance of fruits on Mango trees, etc are all signs of good rainfall. Apart from these, there are also some rituals carried out by the community. Like things to be done on Akshay Trutiya and observing colour of sky for 12 days beginning from May 24th, etc.

4. **Quantity of rabi rainfall:** at least 2-4 showers of the return monsoon in the month of September and October are very critical to give confidence to the farmers that they would have good water availability for Rabi crops.

Hydro-climatic conditions	**Crop planning decision**
Major Water harvesting structures (WHSs) filled up to 10-30% of capacity	*Tur (*pigeon pea), *math* (moth bean) , *hulaga* (horse gram)
Major WHSs filled up to about 30% of capacity	Onion, *Watana* (green pea) Groundnut/ Vegetable
At least 2 big showers, filling up most of the WHS structures[1]. Such showers would also indicate that the total rainfall would above 60-80% of normal	If there are good rains, then farmers go in for - Wheat crop. If not then: Fodder is grown (in Pathardi block, Ahmednagar); *Jowar* or Vegetables (in Parner block, Ahmednagar); and Gram (chick pea) (in Jalna District)
All the WHSs are full of water throughout September and October, indicating 90-100% of expected rainfall	Such an abundant water resource presence would lead farmers to grow Sugarcane (in Parner block, Ahmednagar)

5. **Pattern of the rainfall:** It is important to understand the pattern of the rainfall during the entire season while deciding the possibility of water availability for irrigation of crops. The farmers opined that they need both types of rains i.e. high as well as low intensity rainfall so that the runoff is generated as well as soil moisture is deepened. Some of the beliefs of the farmers when it comes to rainfall patterns are:

   a. low intensity rains continuously at least for 3 to 4 hours in a day (भीज पाऊस/ झड)

   b. farmers also expressed the need of having high intensity rain for half or one hour occasionally. Such rains generate volume of runoff which in turn increases the water storage volumes in existing WHSs.

6. **Soil Moisture**: When the soil releases moisture in the form of seepage and water appears in the streams, the farmer assumes that the rain and hence the water is good enough for growing the rabbi crops (**काळे पाणी मातीतून निघाले तर चांगले**).

   a. Depth of moist soil after 2-4 days of major rain events must be recorded

   b. Specific notes on period and time of seepages from these soils must also be taken.

Soil moisture conditions	**Crop planning decision**
100-125 mm rainfall over few consecutive days or 12-15 cm deep soil moisture **बैलाच्या पावलात पाणी**	*Mung* (green gram), *bajara* (pearl millet) & pulses
15-22 cm deep soil moisture	*Bajara / Mung / Math/ Hulaga*

[1] WHS: Water harvesting structures generally constructed as part of watershed development structures

7. **Groundwater levels (GWL) in wells**: Rabi crops, combination of wheat and gram is possible only if the GWL in the well is up to 20 feet below the ground level in the months of Sept and October. If the GWL goes below this level, then possibility of getting wheat crops or sometimes entire rabi crop season is lost. If the GWL in the wells is only 5 feet deep in Sep-Oct then along with wheat, vegetables, onion, etc. are possible crops. If the well shows GWL of 5-10 feet below ground level in January or February then the farmer decides to go for summer crop mostly the groundnut.

Groundwater level (GWL)	**Crop planning decision**
GWL at 5 feet deep (70% of the well is full) in Sept & Oct	Wheat, Vegetables, Onion is planned in Rabi
GWL at 10-20 feet deep in wells in Sept-Oct; represents good rain.	Wheat, *harbhara* (chick pea) and other irrigated crops or combination in rabbi planned
GWL regained (to original level before draft) in 24 hours in January	Wheat can sustain with good production
Daily 1-2 hour pumping possibility of the well in Sep/ Oct	Area under wheat/ *harbhara* is decided. Normally 2 hour pumping suggests 1 acre irrigated crop
GWL at 5-10 feet deep in the well in Jan/Feb	Groundnut in summer planned

8. **Water Level in the Water Harvesting Structures:** It is expected that the small WHSs must be filled at least 2-3 times before Rabi starts so as to guarantee a good harvest. If the structures are filled less than half then rabi possibility becomes blur and risky. Various stages of filling of WHS make the farmer to change the type of crops as well as the area under those crops. Normally the farmer refers to the WHS adjoining or near to his farm/ well. If the big percolation tanks (PTs) are located on the stream then the water levels in the PTs are referred by the respective downstream farmers. Water levels in WHS has direct link with the yield of the adjoining wells and bore wells

Level in Water Harvesting Structure (WHS)	**Crop planning decision**
50% filling of WHS in Sep-Oct	Wheat, *Jowar (Sorghum)*, Gram (chick pea), Fodder
70% filling of WHS in Sep-Oct	Wheat, Vegetable, Fodder
100% filling of WHS in Sep-Oct	Sugarcane is possible
Less than 80% filling of WHSs from the hilly terrain in October	No water security even for Rabbi
MI Tank (Kalu dharan) is 50% filled by October	Wheat, fodder is assured
75% Water storage in Jan-Feb	Tomato/ Groundnut/ Onion in Summer
MI Tank (Kalu dharan in case of Bhalwani) is 50% filled in October	Flower *Zandu* (Marigold), *Methi* (fenugreek) in Summer

It is not just important to fill the water harvesting structures, but also to have a waste-weir/ spillway of the WHS overflows. This overflow takes place at least for 15 days in a month of good rains specifically in Sep-Oct. Overflow of surplus water hints at full saturation of soils with water across the village and assurance of inflow of sub-surface runoff into the WHS for longer time.

3. Discussions

3.1 Water availability and crop planning

India is one of the most water-challenged countries in the world, with 16 per cent of the world's population and access to only 4 per cent of the world's water resources. About 90 per cent of the fresh water withdrawals go to agriculture in India, which is well above the global average of about 70 percent (Food and Agriculture Organization, 2016).

On top of this is the recurrence of droughts – there have been 23 major droughts in the country between 1871 and 2015. The drought prone area in the country has increased by 57% since 1997 leading to extensive crop losses and tragedies, including farmer suicides (Mahapatra, 2016). Heightened weather variability, increasing frequency of extreme weather events and other indicators of climate change only exacerbate this crisis. Longer dry spells and heavier precipitation events projected for South Asia are going to increase run off and hamper ground water recharge (Singh, et al., 2014)

The National Water Policy (Ministry of Water Resources, 2012) made several recommendations for conservation, development and improved management of water resources in the country. NWP stresses that "low consciousness about the overall scarcity and economic value of water results in the wastage and inefficient uses".

In this context, water-budgeting and crop planning have emerged as key strategies in the dryland areas of Maharashtra. While WOTR has directly implemented soil and water conservation measures in 461 villages in the state, it has specifically targeted 100 villages in Maharashtra, covering three districts – Ahmednagar, Jalna and Dhule – for its work on Water Stewardship. The Water Stewardship initiative consists of components such as water harvesting plans, water budgeting plans, plans for increasing water use efficiencies, ensuring water for drinking water, and institutional mechanisms (stakeholder participation) for water resource management by communities.

Two well-known examples of water management in the state are Ralegan Siddhi and Hiware Bazar in the Ahmednagar district. They faced severe water shortage in the late 1970s and 1980s and their fightback was even hailed by the government. But in the summer of 2016, when the region was facing severe drought, Ralegan Siddhi had to again seek government help and ask for a supply of water tankers. Hiware Bazar, on the other hand, did just fine (Sengupta, 2017).

The difference between these two locally driven initiatives was the emphasis on water-budgeting and crop planning. "Hiware Bazar always regulated extraction of water and crops sown", says Popatrao Pawar, sarpanch and the key motivator and mobilizer of Hiware Bazar. This has helped maintain ground water at 11-12 mbgl since 1995 compared to Ralegan Siddhi which started drilling borewells to 150 mbgl (Sengupta, 2017)

3.2 Community mobilisation through local knowledge

Why did Hiware Bazar succeed where Ralegan Siddhi failed? The answer to that lies in the strength of community mobilisation and understanding about the need to conserve water and use it sustainably. In Ralegan Siddhi, the abundance of water brought about by the early efforts in watershed development led to intensive agriculture with water intensive crops like sugarcane and the sinking of around 200 borewells (Sengupta, 2017).

On the other hand in Hiware Bazar, "depending on the water available, the gram sabha advises farmers about the crops suitable for planting in that season in a meeting held every October. For instance, in 2016, we grew millets instead of wheat because the rainfall was low," says Pawar. Cultivation of water-guzzling crops, such as sugarcane and cotton, is completely banned in the village. Even in 2015, when Hiware Bazar received around 50 per cent deficit rainfall, there was no drop in crop production. Open wells in the village have water at 3-4 mbgl, says Vishwanath Thangi, a resident of Hiware Bazar (Sengupta, 2017)

As mentioned in the opening section, local knowledge is fast being replaced by 'modern scientific' knowledge that comes in standardized packages. The richness and diversity of local knowledge is losing out in the race to stay relevant. Coupled with these are a number of other factors that emerging as new challenges to these traditional practices and local knowledge.

- Introduction of new crops not always suited for local eco-system
- Weather patterns are not predictable as before and affects decision making
- Levels of water in dams falling due to excessive lifting
- Changes in tree cover destroying livelihood support systems
- Recent appearance of farm ponds on a large scale for storage of water and inefficient use of it
- Vulnerability to pest attacks and crop failures due to new varieties and climatic conditions

4. Concluding thoughts – people's participation key to conserving local knowledge

There is an urgent need to conserve the local knowledge and practices, especially those related to water conservation and adaptation to changes in climatic conditions. This need has been highlighted even in the Paris Agreement of United Nations Framework Convention on Climate Change, "recognizes the need to strengthen knowledge, technologies, practices and efforts of local communities and indigenous peoples related to addressing and responding to climate change, and establishes a platform for the exchange of experiences and sharing of best practices on mitigation and adaptation in a holistic and integrated manner." (IFAD, 2016)

Peoples' participation is the core strength of social mobilization; for water budgeting to be successful it is essential to bring maximum number of people to have consensus about the scheme. This requires not just innovative communication methods, but also a connect to the traditional practices and local knowledge communities.

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WOTR-CENTRE FOR RESILIENCE STUDIES (W-CReS)

As a learning organisation, the WOTR Centre for Resilience Studies (W-CReS) was set up in December 2016 to undertake application-focussed, transdisciplinary research in the area of water, agriculture, ecosystems, biodiversity and livelihoods in the context of climate change adaption and mitigation. W-CReS is envisaged to be a centre of excellence in knowledge and applied research that aims to bridge the gap between science, practice and policy. It facilitates stakeholder engagement at all levels through collaborative partnerships, rigorous on-ground trans-disciplinary research and capacity building of stakeholders that leads to behavioral change.

Knowledge generated at the centre is envisaged to enhance resilience and promote adaptive responses across scales in order to effectively address the impacts of climate change on ecosystems, communities and local institutions, people and livelihoods, for example agriculture, at implementation and policy / programmatic levels.
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