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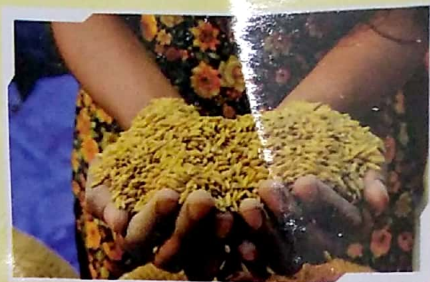

CROP PROTECTION

Protecting Crops, Protecting Food Security

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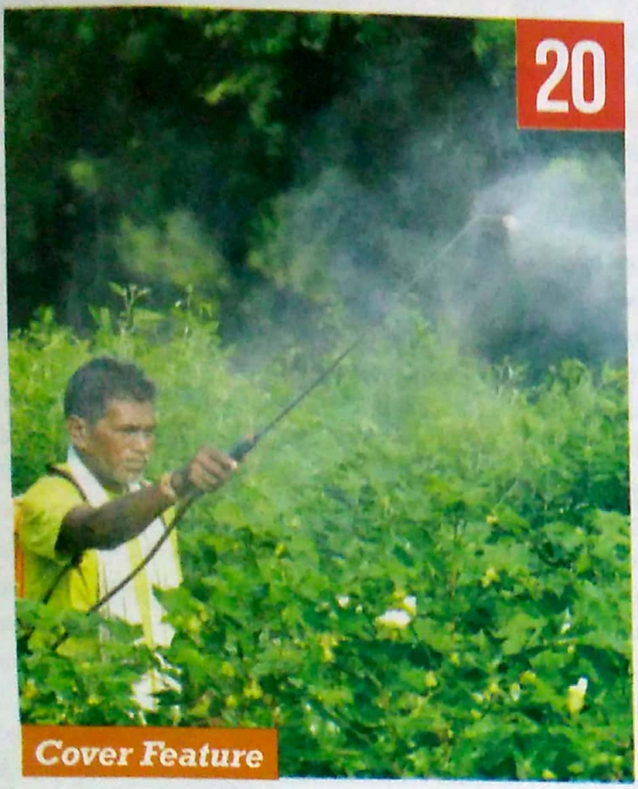
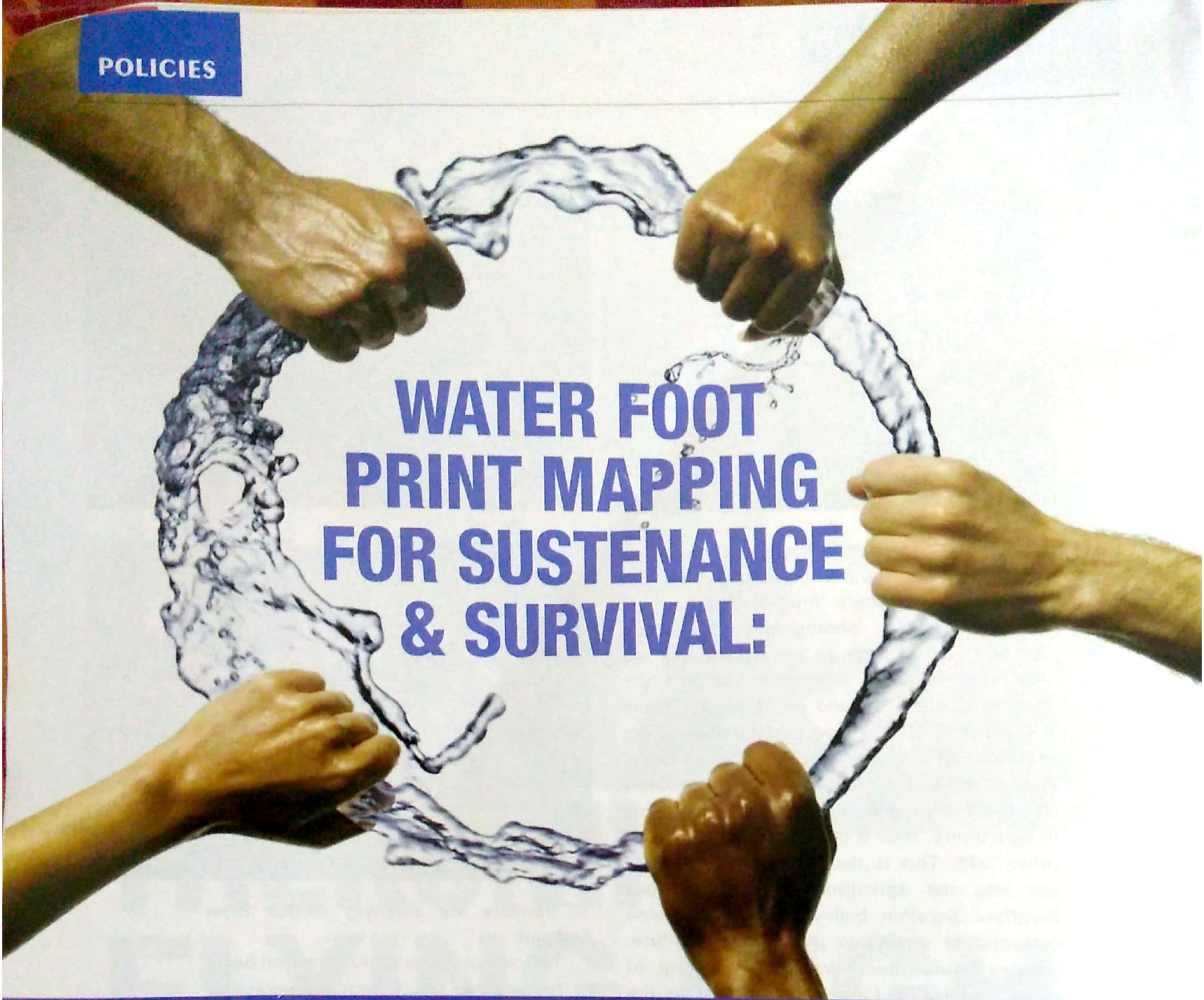


CROP PROTECTION:
PROTECTING CROPS, PROTECTING FOOD SECURITY

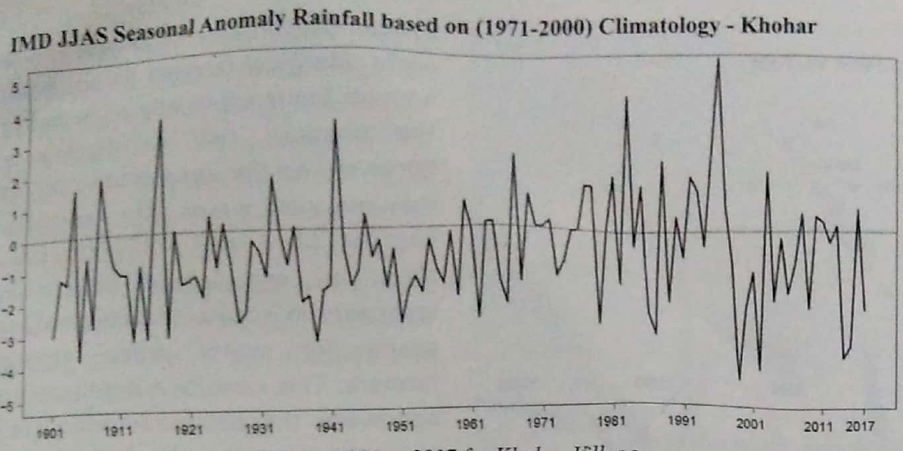
TROPICAL TUBER CROPS FOR RAINBOW DIET



WATER FOOT PRINT MAPPING FOR SUSTENANCE & SURVIVAL:

THE CASE OF KHOHAR, RAJASTHAN

Humans are the principal consumers and polluters of water. An analysis of water scarcity challenges in Haryana- Rajasthan region advocates that water security is one among the main problems that hinder economic development and food security in the area. Linking gaps arising out of the uneven distribution of water and maximising water productivity remain primary challenges to water security. Unlike carbon footprint, a global attempt to reduce water footprint has not been successful as it is itemized in time and location. Water footprint can only be an effective tool for policymakers by developing bottom-up approach or awareness building at grass root and by system based holistic development.



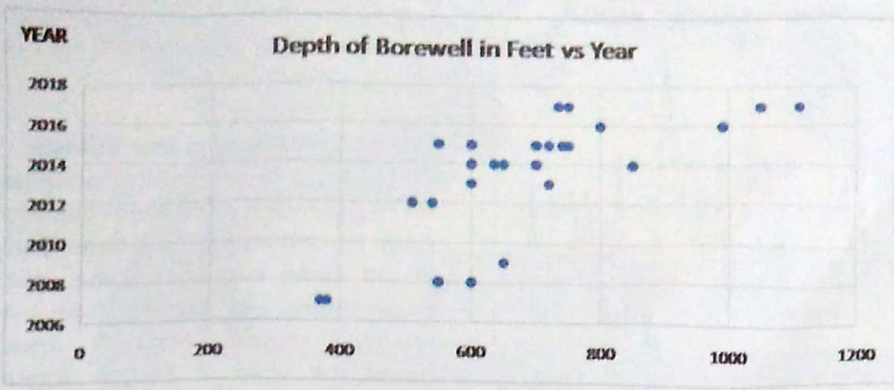
JJAS annual rainfall anomaly from 1901 to 2017 for Khohar Village

Water Foot Print (WFP) in agriculture helps one understand the amount of water consumed for agricultural purposes. It includes the water used directly, that is supplied to plant as irrigation water and the water used indirectly, the water plants absorb from soil and atmosphere. India's water footprint is 980 cubic meters per capita that positions beneath the global average of 1,243 cubic meters but its 1.2 billion people together add to a substantial 12% of the world's total water footprint. The International Water Management Institute forecasts that by 2025 in India alone, one-third population will live below "scarce water" situations.

India is one of the top cultivators and exporters of food grains and also the largest consumer of groundwater. Conventional irrigation techniques cause maximum water loss due to evaporation, drainage, percolation, water conveyance, and excess use of groundwater. As more areas come under unscientific irrigation techniques, the pressure for water available for other purposes will continue. One such water-scarce area is Khohar village (area of 5 squarekm) situated at the foothills of Aravalli bordering the states of Haryana and Rajasthan. Water is a threatening resource in Khohar. Khohar faces arid to semi-arid climate with short spells of showers brought by the southwest monsoon. The climate of the region has been classified as semi-arid with scorching summers experiencing temperatures rising to 47°C, followed by cold winters. The potential evapotranspiration rates are quite high, especially during May and June. The IMD (India Meteorological Department) JJAS (June, July, August, September) seasonal rainfall anomaly shows a decline in trend heightened by magnified excessive groundwater exploitation by the villagers. The soil is mostly alluvial, and the village has no access to any perennial stream or canal. A seasonal stream fed by the rainwater flows through the village and deposits silt in the village agricultural fields.

Water Situation in the Village

Water scarcity is a critical problem for a monsoon-dependent country such as India, since a large part of its farm output, income, and employment emanates from a relatively small irrigated area. So is the case of Khohar where inhabitants have been traditionally migrating out of the village to earn their livelihood owing to non-remunerative nature of agriculture and ever depleting ground water. Women and children drudging to and fro for fetching water for domestic consumption is a common sight in the village. How farmers survive such water scarcity at the micro-level is as important, if not more, as is for how policy-makers' pact with it at the macro-level. Local water scarcity does motivate farmers not only to improve on-farm water-use efficiency but also to develop new approaches for inter-farm water sharing. The villagers cite that this was not something they witnessed ten years ago when the water level was 200 feet or above and it is only since the year 2000, the



Trend in the depth of bore well from 2006 to 2018 for Khohar and Patan village

conventional wells got replaced by tube wells and eventually turned to bore wells.

Agriculture is the primary source of lithe livelihood for more than 80 percent of the population of Khohar. The only source of water for farmers is borewells, and since time immemorial they have been extracting water from aquifers that are now firmly dry. Last year, the community bore well connected to two community tanks that provided piped water to most of the households, dried up leaving most of the villagers dependent on the individual bore well owners for their water needs from drinking to irrigation. Borewell was first introduced in the village in the year 2005. At present, there are 13 bore wells in the village, of which around, 10/11 are functional. When a borewell was first dug in an already existing well, its initial depth was 415ft (250 ft well + 165 ft bore well). This worked for first five years and thereafter dried up. Several other bore wells were dugpost-2005. Ever since 2005, there have been several instances of increasing the depth of borewells. The most recent increase in depth has been 1100 ft. Around 50% agricultural land of the village is owned by few households, who also own majority of bore wells in the village. Farmers with large landholdings are capable of spending money on digging bore wells. Marginal farmers do not have enough funds especially considering the financial risk in digging a borewell, as the excavation may or may not yield water. The excessive cost of bore well including fuel, electricity and labour results in inequality in access thereby making space for water trade among farmers. This condition continues to aggravate the economic inequality preventing improvement of quality of life of the marginalised population in the village.

Agricultural Situation in the village

Major crops grown in the village are Wheat and Mustard in Rabi season and Cotton and Bajra in Kharif season. Cotton was introduced in the village after year 2000 and became widely accepted as it is an intermediary crop permitting production of wheat in the following season. Onion is the most favoured crop of the farmers in the village as it fetches high returns. However, due to scarcity of water and onion's water-intensive nature, only those owning a bore well can cultivate onions. Though being an exhaustive water crop, wheat is preferred and widely cultivated in Khohar because of its high yield and market linkages. Mustard is another crop widely grown that requires less water and is preferably chosen by farmers who do not have means to irrigate their farms and need to buy water to irrigate.

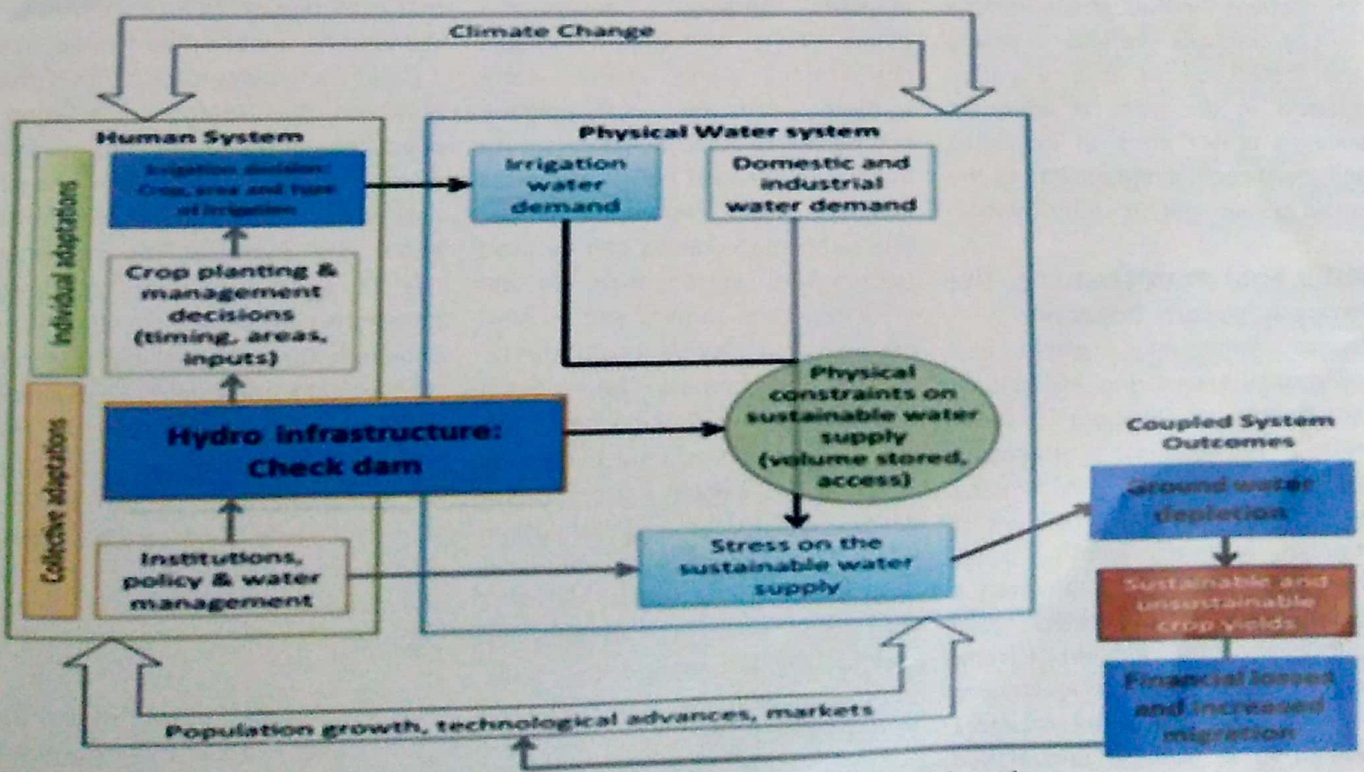
The terms of water trade in the village involve giving a third of the total wheat production instead of five irrigations, 4000 rupees for two mustard irrigations, one-fourth of the produce for two cotton irrigations and one-fifth of the crop for seven onion irrigations. However, this is not beneficial to recipient farmers as access to purchased water is only feasible once the borewell owner has provided essential irrigation to his/her field. This often results in untimely and scarce irrigation according to the crop cycle that diminishes the productivity of the crop, and consequently its fiscal realisation. Resultantly, the farmer enters into the vicious trap to depend on farmers having bore wells, local money lenders, banks etc. eventually forcing them to remain trapped into a liability ploy.

Khohar's Water Foot Print and Implications

Even though, water conservation methods have been introduced into the village such as hydro infrastructures like check dam, drip irrigations and laser levelling, low rainfall coupled with an excessive area under water-intensive crop has been causing a steep decline in the groundwater levels. From 2014 to 2018, bore wells have been dug deeper than 1000 feet. Agriculture is leaving a considerable water footprint in Khohar, it poses a severe threat to agricultural sustainability. This implies that there is an urgent need to set a water footprint cap that sets a maximum to the water volume that can be allocated for various human purposes, accounting for environmental water needs. WFP needs to be measured as a multi-dimensional indicator, showing water consumption volumes by sources and polluted water volume by the amount of pollution.

Low recharge along with excessive exploitation is the primary cause of rapid depletion of groundwater, therefore planned recharging of groundwater along with judicious irrigation could be a promising solution to reduce WFP. Farmers need to control their water use in keeping with what is available by altering their cropping pattern and swapping to more efficient irrigation systems. Irrigation scheduling involves managing the soil reservoir so that water is made available when the plants need it. Soil moisture and weather monitoring are used to determine when to irrigate, and soil capacity and crop type are used to determine how much water should be used during irrigation.

Climate change, population growth, technological advances, and markets (including agricultural product prices, trade, and GDP) directly impact multiple components



The conceptual framework for a coupled human-physical water system modelling of the regions' groundwater future

of both the human and physical water systems. Components within these systems respond individually to external changes, but also tend to impact each other. Check dam constructed to conserve ground water is a key component of both the systems. Individual adaptations include practices like laser levelling and installation of drip irrigation systems in the field. If adequate planning is not done at individual and group level, sustainability of the whole system will be under threat.

Water Foot Print Mapping, the Policy Advocacy Solution

Precise water measurement and soil moisture checking are critical components of efficient on-farm water management practices. Irrigation flow meters can be used to help calculate the efficiency of irrigation systems, identify water loss from leaks in conveyance systems, and to accurately apply only the necessary amount of water based on soil moisture levels and weather conditions. Soil moisture monitoring is used in conjunction with weather data and crop evapotranspiration requirements to schedule irrigation. Fields need to be designed for efficient water use by grading land with laser equipment, creating furrow dykes to conserve rainwater, and by retaining soil moisture through conservation tillage. WFP benchmarks will enable actors along supply chains – from farmers through intermediate companies to final consumers – to compare the actual WFP of products against certain reference levels. The benchmark values can be used to measure performance, to set WFP reduction targets and monitor progress in achieving these targets.

Majority farmers face credit constraints, incomplete markets, lack of information, and low levels of human capital. They have limited ability to quickly adopt new technologies orto improve upon existing ones. Now, it is used for water management decision-making. Since irrigation is a short-term adaptation response by farmers in the face of inter-annual monsoon variation, WFP calculations made year to year helps to conserve groundwater with increased efficiency. So far, the role of water footprints in water policy has been limited to a few examples in research experiments and corporate perspectives. It is accomplished that evolution of WFP concept from elementary quantitative studies to a potent advocacy tool can aid the provision of strategy formulation, policy making and agricultural risk awareness for sustainable water use. WFP raises a lot of questions about the sustainability of water use in agriculture. Solving these questions will be the most significant challenge for policymakers. It's time that we take cognizance of the truth of Khohar being waterless, and take steps to make people aware, fix infrastructural issues, harvest rainwater, reclaim bore wells, and endorse concepts for making the best use of prevailing water supplies.

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