Improving irrigation management in conditions of scarcity: Myth vs Truth

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"Often, myths serve the rhetorical purposes of particular stakeholders. And they persist because our public policy debates are not sufficiently grounded in solid technical and scientific information about how we use and manage water."[1]

Across the developed and developing world, important issues are widely misunderstood, misrepresented or "mythologised" in the irrigation sector. The result is excessive debate (and investment) based on misconceptions—or the hope that different outcomes will be achieved if the same experiment is repeated enough times. To improve analysis, policy, and investments we must understand what science actually reveals about the use and management of water in the irrigation sector. This article will examine five myths that permeate the sector and contribute to misunderstandings about how to tackle water scarcity within agriculture.

Myth 1: *There is an* ***impending*** *water crisis.*

In most places where irrigation is required, the fear of an impending water crisis was accurate some decades ago. Today we are often well beyond the threshold of physical sustainability: current demand exceeds the renewable supply. A global study by Wada et al. concluded that around 18% of current water consumption in irrigation depends on groundwater depletion.[2,3] This means that we need, on average, an 18% reduction in irrigated crop water consumption just to restore the balance between recharge and abstraction from aquifers.[2]

Naturally the exact reduction percentage varies greatly; the Table below shows countries where irrigation depletes groundwater between 5-71%.[3] The results demonstrate that focusing on an impending water crisis is inaccurate; we should acknowledge that the crisis is already here.

Country	Gross Crop Water Demand ($km^3 yr^{-1}$)	Green Water Contribution		Gross Irrigation Water Demand							
				Total		Blue Water Contribution		Nonrenewable Groundwater Abstraction		Nonlocal Water Resources	
		$km^3 yr^{-1}$	Percent	$km^3 yr^{-1}$	Percent	$km^3 yr^{-1}$	Percent	$km^3 yr^{-1}$	Percent	$km^3 yr^{-1}$	Percent
India	600	247	41	353	59 (100)	214	36 (61)	68	11 (19)	71	12 (20)
China	403	267	66	136	34 (100)	105	26 (77)	20	5 (15)	11	3 (8)
United States	204	77	38	127	62 (100)	77	38 (61)	30	14 (23)	20	10 (16)
Pakistan	183	37	20	146	80 (100)	81	44 (55)	35	19 (24)	30	17 (21)
Iran	59	9	15	50	85 (100)	19	32 (38)	20	34 (40)	11	19 (22)
Mexico	71	26	36	45	64 (100)	27	38 (60)	10	14 (22)	8	11 (18)
Saudi Arabia	14	1	7	13	93 (100)	3	22 (23)	10	71 (77)	0	0 (0)
Globe	2510	1172	47	1338	53 (100)	844	34 (63)	234	9 (18)	260	10 (19)

[a]Values in parentheses are the percentage of a water resource contributing to gross irrigation water demand.

Table 1: Contribution of water resources to irrigated crops (Gross crop water demand in irrigated areas) in major groundwater users for the year 2000 (a). Source: Wada et al., 2006.

Truth 1: We are already in a water crisis, and the challenge for irrigation is not about restricting additional future water consumption, but rather reducing current consumption to restore balance and health to rivers and aquifers.

Myth 2: *Large quantities of water can be saved by more "efficient" irrigation.*

Irrigation systems deliver water to projects, farms, and fields. A proportion of that water is "consumed" by crop transpiration and evaporation from wet surfaces, leaving the local hydrological system as water vapour. The rest of the water returns to the environment, percolating into the soil or running off to drains. The FAO Report 43 reveals water "losses" at the local level often reappear as "sources" at the catchment or aquifer level.

The critical test is whether the flows that return to the system can be reused by other users. The groundwater depletion discussed in Myth 1 results from water *consumption* exceeding the renewable recharge. Using surface or groundwater for any purpose (domestic, industrial, irrigation) often has a significant local impact, but only excessive *consumption* across the water system as a whole leads to progressive aquifer depletion and damaged ecosystems.

The purpose of irrigation is to enhance crop transpiration, which converts liquid water to water vapour thereby "consuming" water and not allowing it to return to the system. Improving irrigation efficiency (the ratio of water beneficially transpired to water delivered) increases local crop production through higher yields per hectare and/or expansion of the area irrigated, each of which often involves *increased* transpiration and *reduced* outflows to downstream users and the environment.

Truth 2: More "efficient" irrigation typically increases local water consumption.

Myth 3: *The productivity of irrigation water can be substantially improved.*
This myth is half true, but separating the elements of truth from myth is vital.

It is true that an improved irrigation service (better timing, higher reliability, precise matching to the differentiated needs of a variety of crops, etc.) facilitates conversion to higher value agriculture—more water-sensitive, higher yielding cultivars, or a switch from basic grains to vegetables or fruit.

But the irrigation service is only one constraining factor. Others include risk aversion, access to markets, and the availability of finance, appropriate seeds, labour and chemicals. It should not be *presumed* that radical increases in the value of production per unit of water consumed will automatically follow from a better irrigation service. A better service may begin that transition *provided* other constraints are addressed.

The mythical aspect of increasing water productivity relates to two far more common responses to an improved irrigation service, such as conversion from flood irrigation to modern drip or sprinkler technology.

If a farmer cannot irrigate all his land, and achieves relatively low yields because the water supply is erratic and limited, then an improved service will have two quite immediate impacts. First, yield *per hectare* will increase because the irrigation supply is better matched to crop requirements so that transpiration increases. Second, the farmer may be able to expand the irrigated area.

Each of these changes involves an increase in water consumption (and a commensurate decrease in return flows—see Myth 2, above). Unless the farmer makes other substantial changes to his crop selection and crop husbandry, the research shows[4] that increases in production are linearly related to crop water consumption for typical field crops.

Thus at least in the short run, productivity (expressed as kg/m^3 of water consumed) is essentially constant. Some farmers will be more productive than others (better soils, better skills, more financial resources, better access to markets, etc.) but each will tend to follow the Yield/Evapotranspiration vector they currently occupy *unless* other interventions are included.

The recent Implementation, Completion, and Results report of the Turpan Water Conservation Project[5] is an example of both outcomes—reducing water supplies while improving irrigation technology *and* crop husbandry led to improved farm incomes *and* less water consumption; improved irrigation technology alone resulted in increased consumption (Myth 2) without significant improvements in water productivity.

Truth 3: Increased water productivity depends on multiple factors and does not automatically follow from an improved irrigation service.

Myth 4: *Water demand will fall as irrigation efficiency and water productivity improve.*
Myth 4 is perhaps the most commonly believed.

Value added by irrigated agriculture can be maintained with lower water consumption *if* the multiple interventions required to improve water productivity are introduced. But because these enhancements generally result in higher returns to water delivered to the farmer, water demand and consumption are likely to increase: pumping will become more affordable, marginal land more productive, and so on.

Truth 4: As long as water is scarce, demand tends to increase as irrigation efficiency and water productivity improve.

Myth 5: *Pricing alone can fix water overconsumption issues.*
Broadly, two types of intervention can restrict and reduce water consumption—pricing and some form of rationing.

Irrigation services are often provided at less than the cost of delivery and far less than the value of water to the farmer. Moreover, most water pricing regimes are designed so that the marginal cost is zero, which means that there is no extra cost for each additional unit of water used.

Economists see this as an obvious case for introducing volumetric pricing; however, the issue is complex.

- Faced with an increasing charge for water delivered, farmers may choose to improve on-farm efficiency and perversely *increase* consumption (see Myths 2, 3 & 4) despite *reducing* demand for water deliveries, as was the case in Australia where several cases of increased water consumption following modernisation have been reported.[6]
- In using pricing alone as a mechanism to control demand, it is implicit that the individual user can specify the volume of water required. Very few systems serving small farmers have this flexibility, and it is impossible in field-to-field rice systems. In such situations, the incentive to reduce costs by saving water is absent.
- The price of water required to balance supply and demand is well beyond the politically acceptable range in most countries and thus cannot be set at that rate.

Thus, creating a pricing strategy could have a perverse impact: implementation constrained by technical and political difficulties, while unhappy farmers face high charges and continue to use too much water. A review of over 25 studies found that physical sustainability was never achieved through water pricing alone. Physical controls—rationing—are needed after all.[7]

Truth 5: While positive marginal pricing, if technically and administratively feasible, will induce a reduction in demand, quotas will inevitably be required to ensure that demand is constrained to sustainable levels—which is why no country relies on pricing alone to balance supply and demand in the irrigation sector.

Conclusion

It is clear that popular assumptions about irrigation and water fail to accurately convey the facts about irrigation. So, why do these myths about the potential benefits of hi tech irrigation persist?

1. Farmers approve because the myths increase their (own) income and save labour and chemicals.
2. Engineers approve because they like modern infrastructure and money to spend on it.
3. Equipment suppliers approve because that is what they sell.
4. Politicians approve because they can claim to be saving the environment, helping food security, and pleasing their constituents all in one go.
5. (Some) planners and environmentalists approve because they believe water will be released from irrigation to other uses, including restoration of ecosystems.
6. "Experts" approve because they can recommend something and give optimistic presentations with upward trending graphs at conferences.
7. Donors like it because they can fund something: policy reform is cheap, hard, and slow. Modern equipment is expensive, easy, and quick.
8. Environmentalists often approve because they are told that water will be released for ecosystems and sustainability improved.

Thus, those who deny the myths have trouble gaining a foothold among these groups.

References:

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