



agtech...
so what?



The agtech adoption dilemma: irrigation

Why everything you think you know about irrigation technology is wrong, and what to do about it



Introduction

Irrigation is pivotal to the global agricultural economy. Though only 16% of the world's croplands are irrigated today, those lands produce 36% of the global annual yield. In developing countries, irrigation increases yields for most crops by 100 to 400%. Further, irrigation allows farmers to reap the economic benefits of growing higher-value cash crops.

But though the impact of irrigation is impressive, we haven't done enough to optimize the efficiency of irrigated agriculture. There are several challenges preventing us from unlocking this vital outcome.

Agriculture can be an inefficient user of water, especially in areas where water is scarce. In some cases, as much as 60% of the water withdrawn for irrigation does not reach the crop, as it is lost through canal leakage, spillage, infiltration and unproductive evaporation. What's more, studies show farmers may have up to 20% lower crop yields and income, along with inefficiencies between 20 and 40% due to excessive water applications¹. This not only leads to wasted water, but also increased costs: for example water pumping accounts for 70% of the agricultural energy use in California²

These issues can be further compounded by poor drainage and practices that lead to waterlogging and salinization, which have eroded the productivity of nearly 50% of the world's irrigated lands³.

¹ <https://doi.org/10.1016/j.agwat.2014.07.012>

² <https://caclimatehub.ucdavis.edu/2016/06/17/californias-farmers-save-on-electric-well-pumps/>

³ <http://www.fao.org/3/x0262e/x0262e01.htm>

Beyond productivity impacts, inefficiencies in irrigation have negative consequences for the greater environment. Excessive watering can increase nitrogen leaching, leading to nitrates moving away from the targeted crops and accumulating in water basins. For example, according to the United States government, 60% of the nitrates deposited in the Gulf of Mexico come from agricultural related sources ⁴.

There is growing awareness of the need to improve irrigation efficiency and water stewardship amongst participants in the agrifood supply chain. Irrigating more efficiently will not only have positive environmental and social outcomes, but it will also improve profitability for farmers around the world. However, despite the potential benefits, changing irrigation behavior has proven to be very challenging at scale.

Why is this the case? Some claim we need better technology, but in fact the answer lies in the realm of psychology. Farmers, like most humans, fear loss more than they value gains, and this loss aversion prevents many from maximizing the use of technology to make informed irrigation decisions.

One European Study ⁵ on irrigation decision support systems observed the following:

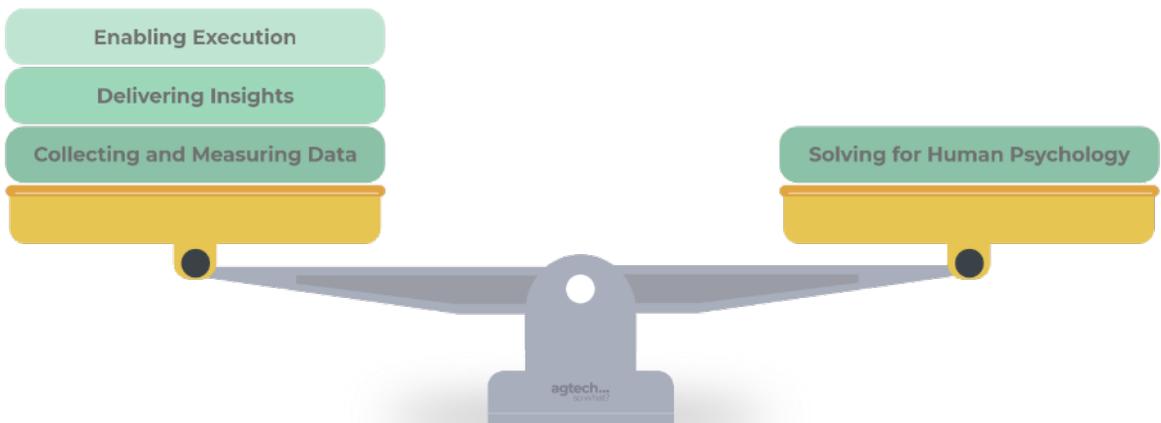
“Most farmers irrigate based on previous experience (74%) and daily weather forecasts (23%), while only one used a soil moisture sensor. The majority had no water consumption records (74%) and only 26% used water meters. Water consumption on-farm was rarely recorded.”

The mindset of the average farmer is that there is a more significant downside to not having enough water on the crop at any given time. So even if there's an incremental cost of turning on the irrigation system, incurring this cost is 'worth it' to avoid losing a bushel (or pound or two). In other words, the incentive is to irrigate 'just in case'. Even though we have the technology and tools to make better decisions, many farmers are not using them at scale to make more informed decisions.

⁴ <https://www.usgs.gov/special-topic/water-science-school/science/nitrogen-and-water>

⁵ Farmers Try to Improve Their Irrigation Practices by Using Daily Irrigation Recommendations—The Vipava Valley Case, Slovenia - MDPI

Outsized Impact of Psychology



Adoption remains low because there has been too much attention given to the technology, and not enough given to the psychology of farmers. It is not the technology that needs to be better. Instead, far more attention must be given to farmer psychology, and the go-to-market strategies, business models, and water policies that can drive the change and impact we need to see.

Is it really a psychology problem?

One possible explanation for the lack of penetration for irrigation technology is that the market is just not big enough to attract serious players who can commit the level of investment needed to create great products. However, we can't rely on this defense - the global irrigation market is large and filled with powerful incumbent firms.

The total irrigation market is worth billions of dollars, and the largest irrigation companies all have more than \$1 billion USD in annual revenue. It logically follows that the market for precision irrigation technology is also large.

However, the reality is that precision irrigation tech is currently <5% of these organization's total sales ⁶. Lindsay, a global provider of irrigation and infrastructure solutions, for example, reported technology sales at 7% of total sales in 2020 ⁶. This was the first small jump in their tech sales in three years, and it included control panels and more traditional technologies that enable basic operations of their pivots.

Outside of agriculture, tech companies know that augmenting product sales with a focus on growing services revenue is key to success. Apple, for example, has increased services business lines such as Apple Music and Apple TV+ from less than 10% of their revenue to 18% in 2019, with goals to expand to 25% of revenue by 2025 ^{7,8}.

Today, services revenue sits in the single digit percentages of total revenue for most irrigation incumbents with slow or stagnant growth. So while the market is currently dominated by large firms, scale alone is not sufficient to guarantee success in the precision irrigation tech market.

If overcoming the adoption challenge does not appear to be simply a matter of scale, perhaps it is a lack of focus on behalf of the existing firms that hinders success? However, the example of John Deere water suggests that this explanation isn't sufficient either. Back in 2008, Deere began acquiring irrigation tech companies and consolidating them under a dedicated John Deere Water division. Six years later, it was sold to Israeli investment firm FIMI Opportunity Funds.

If succeeding in the irrigation tech market was as simple as creating a large organization with market share and marketing spend, John Deere Water would have been wildly successful.

Perhaps, then, the challenge is that the technology itself is not yet powerful enough to deliver impact?

Is the technology good enough to deliver value?

There are many existing and new technologies in the irrigation space. These technologies are promoted as the key to making irrigation more efficient, ultimately leading to better outcomes for farmers and the environment.

⁶ <https://www.lindsay.com/usca/en/investor-relations/investor-information/>

⁷ <https://www.forbes.com/sites/jeffkart/2019/05/08/solar-powered-waterbit-system-irrigates-farms-saves-h2o/?sh=7a42bb47dc39>

⁸ <https://www.forbes.com/sites/greatspeculations/2020/02/25/apples-services-to-top-50-billion-profits-by-2025--beating-iphone/?sh=1dc9d81653db>

And in many cases the technologies are delivering benefits to irrigated agriculture today - performing detailed field measurements to collect data, providing insights and recommendations, and enabling direct execution of those recommendations (see table below).

However, though these capabilities are critical in improving irrigation efficiency and delivering impact, alone they are not enough to significantly increase adoption.

Collecting and Measuring Data	Delivering Insights	Enabling Execution
<p>Technologies are coming to market with the ability to measure key production data (e.g., soil moisture, sap analysis, weather conditions) and help inform a decision.</p> <p>Measurements range from the simple to the complex. For example, the measurement might be the amount of water in the soil and the evapotranspiration rate, combined with a mapping of the soil via satellite imagery. This could be at various points within a field or area.</p> <p>Providing this sort of production data through a combination of directly (e.g., IoT) and remotely sensed information has been the approach taken by many solution providers.</p> <p>This technology and these organizations are primarily focused on informing, but not necessarily around easing, decision making.</p>	<p>Companies are developing technologies that take information acquired through sensors or other sources and make sense of it for the farmer to ease or simplify the decision making process.</p> <p>The large and diverse amount of data acquired today can cause confusion when recommendations for tangible next steps are not provided. Converting the raw data into an insight or specific recommendation addresses the challenge of having to directly interpret large amounts of raw data. These insights could include the amount of water the crop is currently using per day, a variable rate recommendation, a recommendation of the amount of time to run a pivot at a given setting, or a specific amount of water to be applied.</p> <p>Taking multiple sources of information and transforming them into actionable recommendations increases utility, but often doesn't go far enough to significantly increase adoption.</p>	<p>Direct execution of recommendations has often been thought of as the holy grail of irrigation management.</p> <p>Technologies that enable direct execution, or 'close the loop,' are those that can take a recommendation based on analysis of acquired data, and implement the recommendation for the farmer.</p> <p>Some approaches look to combine all of the technology and entirely remove human decision from the process, aiming for optimum outcomes (e.g., automatically turn on or off a pump). However, while full automation is possible and companies are bringing it to market today, it still has not significantly increased the adoption of irrigation technology.</p> <p>In fact, companies taking this approach have struggled to penetrate the market and growers often end up disabling these "closed loop" systems.</p>

Ultimately, the adoption problem goes much deeper than scale, influence, specialization, or technology. It comes down to addressing all the factors that influence farmer behavior change, and the impact of incentives on the psychology of decision making.

So, while just like in other industries we cannot expect that incumbent firms in irrigation will be the only source of new technologies coming to market, neither can we expect that startups with emerging technologies alone will unlock rapid market penetration.

If startups are going to solve for farmer psychology, they will need the right combination of elements: a combination that, thus far, has remained elusive.

The influence of human psychology on adoption of irrigation technology

The key to increasing the adoption of irrigation technology, thereby delivering better profitability and more sustainable environmental outcomes, including lower water usage, is understanding and focusing on the psychology of the farmer.

Psychology is a core influencer of human behavior. This is true in every industry, including farming where entrenched ways of thinking, deepened over decades, can be a significant hurdle to overcome.

Prospect Theory is a behavioral model that shows how people decide between alternatives that involve risk and uncertainty, for example the likelihood of possible gains or losses. It demonstrates that people think in terms of expected utility relative to a reference point, rather than absolute outcomes. Individuals dislike losses more than they like equivalent gains, so under situations where there is more up front investment and uncertainty of expected gain, otherwise rational actors will opt to stay with the current practice rather than risk uncertainty.

This is especially true in irrigation technology adoption: farmers often over irrigated to avoid potential yield losses, rather than optimizing for irrigation efficiency to unlock potential yield gains and/or cost savings

Farmers are smart and savvy business people. They're also human. This means they don't always act rationally and efficiently. Cognitive biases such as risk aversion, fear of uncertainty, lack of process, and ease vs. effort all cloud rational thinking. Without the proper incentives in place, we end up with inferior outcomes, both for farmer profitability and environmental health.

One key factor is the human need for control. We always want to feel like we are in the driver seat when running our lives or our businesses. When a farmer loses their sense of decision making autonomy, for example because they are required to trust an algorithm or machine, it can create a sense of uneasiness and uncertainty. This limits adoption of these technologies.

Another way this need for control and self-determination can play out is with farm staff, external service providers, and reliance on new systems. The need to keep staff trained can provide additional disincentives, and the sense of becoming reliant on external service providers also increases the psychological resistance to adopting new technologies.

Effective irrigation is about increasing what's possible and what's economical, by optimizing the capabilities available while ensuring the farmer remains comfortable and in control. To overcome the above challenges and increase the adoption of impactful irrigation tech solutions, there needs to be a change in how technology companies inform and incentivize farmers to make decisions.



Overcoming the adoption challenge

Having access to better information about irrigation decisions has value, and having access to actionable recommendations will have an impact. Further, the ability to have those recommendations directly executed can also be a powerful solution. And yet, the data still shows that most of the time, even though technologies exist to achieve all of the above, irrigation decision making does not change.

Most change requires alignment of incentives, as well as feedback, or reinforcement, to make changes permanent. One of the challenges with irrigation is how incentives are aligned. Today, the minor incremental cost of over irrigating doesn't cause enough pain to the farmer or the farm bottom line to entice rapid uptake of many technologies. For example, the secondary impacts of over-irrigation are not felt at the production level, as they don't impact production cost or prices received. Although the situation is changing, currently there are few good examples of additional farmer payments for optimized irrigation that reduces run-off and water table infiltration of nitrates.

This is where we see regulation, business model innovation, and consumer sentiment beginning to make an impact.

A Policy Stick

Gradually, the introduction and enforcement of regulation is having an impact on the adoption of irrigation efficiency technologies.

However, at times regulation can be a blunt instrument, and if penalties are not significant, the impact can be limited. Water policies often have complex history and cross over state and federal jurisdictional boundaries, making change difficult and often ending in political rather than technical arguments about reform. Ultimately, the results of trying to place a true value on water and stimulate behaviour change through policy and regulation has had limited success globally to date.

Moving forward, rather than being the carrot or the stick, we see potential for regulations to set up the environment for incentives to emerge that will help drive adoption.

Business Models and Consumer Sentiment

Though its direct impact may vary, increasing global focus on water policy and stewardship has significantly raised awareness of the complex issues around water management and agricultural production.

The increasing importance of good environmental stewardship along the supply chain is creating new ways to incentivize behavior change and create the opportunity for those changes to be recognised and rewarded - a vital ingredient for lasting change. Increasingly we see large, global food brands working directly with farmers and within the supply chain to offer concrete solutions to water use efficiency. Examples include programs that offer access to training, equipment, and innovation, as well as those that provide the information needed to demonstrate tangible improvements and positive environmental outcomes.

Other solutions are emerging as well. For example, there are increasingly ways that farmers can participate in new markets for ecosystem services that support, recognize, and reward improvements in the management of natural capital. Private companies, philanthropic organizations, and government bodies are all recognizing the potential of creating new revenue opportunities for farmers who are prepared to undertake sustainable management practice changes. For real change to occur, these schemes need to deliver direct, near-term economic benefit to farmers.

Rather than relying on the prospect of future savings to justify investment, innovative business models will front-load economic incentives and ensure that both risks and rewards are shared equally. If adoption results in significant water savings and reductions in other farm inputs, innovative companies need to find ways to better match the investment with the result.

Conclusion

We are seeing effective irrigation technology being deployed in the marketplace today that supports farmers and the environment. What will accelerate the adoption of this technology is not more technology itself, but rather an evolution in how the technology is being positioned. This evolution will require thoughtful consideration of farmer psychology and the continued development of incentives and novel business models.

Startups are ideally placed to innovate in these areas, rapidly testing and improving their technologies as they search for business models that align incentives and deliver profitable, rewarding outcomes for farmers who want to place environmental sustainability on equal footing with profitability and regional economic prosperity.



About the Authors

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Upstream Ag Insights is a weekly newsletter written by Shane Thomas, a lifelong agronomist with a passion for the intersection of technology, agriculture and business. Upstream provides essential news and analysis for agribusiness leaders. To subscribe, visit <https://upstreamaginsights.substack.com/>

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