Energy Efficient, Economically Viable Drip Irrigation Systems

Hydraulic design of inline drippers

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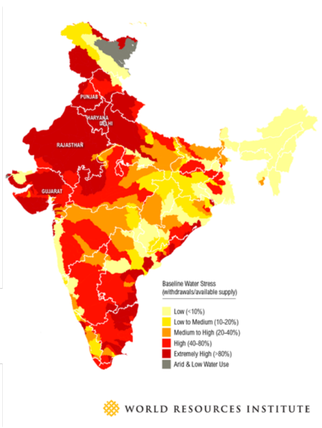
Abstract

Redesigning the hydraulics of drip irrigation systems can drastically reduce water consumption for irrigation and increase crop yield.

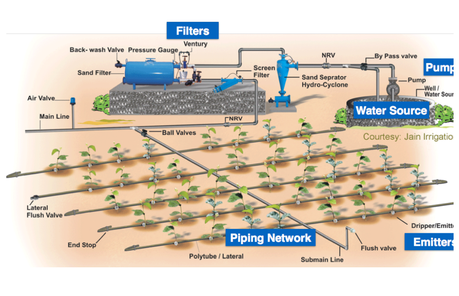
Opportunity

As global population and consumption increases, dwindling water and food supplies makes **effective farming techniques** increasingly important for **alleviating poverty**.



Proposed Solution

- Improved irrigation techniques that save water (by up to 70%) and boost yield (by up to 50%), like **drip irrigation**, have been **inaccessible** to smallholder farmers because they require a high initial investment
- The performance of commercial irrigation systems can be **improved while reducing costs** by applying rigorous analytical to optimize the system



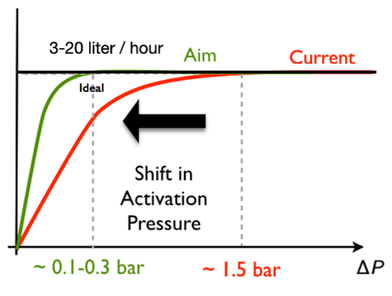
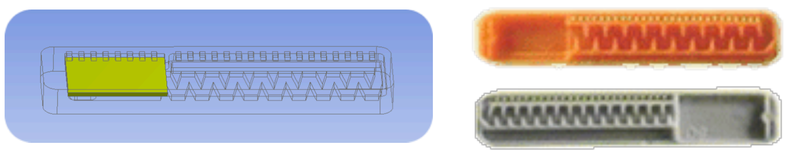


Image from Pulkit Shamshery

Reducing the activation pressure, or minimum functional pressure of drippers allows for smaller pump and smaller systems, and can **halve system costs**

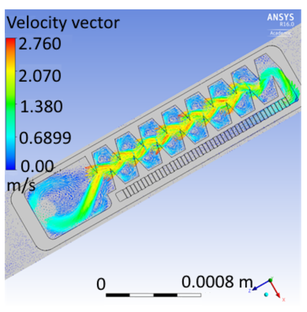
Preliminary Results

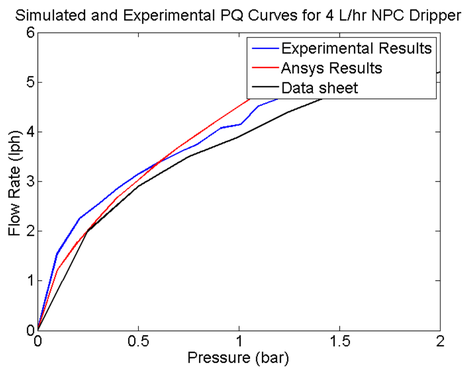
CFD and analytical methods are being used to **analyze and optimize inline drippers**

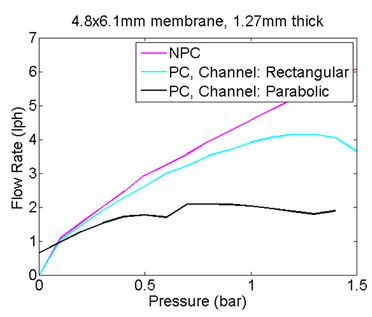


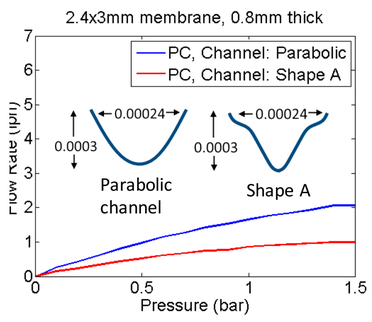
Inline drippers are plastically welded into irrigation tubes and can be **pressure compensating (PC)** or non-pressure compensating (NPC)

CFD models have shown good agreement with experimental results for NPC drippers and are being used to understand and **design new tortuous paths**









With a modified channel shape, the membrane **volume was reduced by over 80 percent** with good hydraulic performance

Optimizing the channel cross-section can **reduce the size of the silicone membrane** while lowering the activation pressure, reducing costs while improving performance

Conclusion

- Optimizing the hydraulics of inline drippers will allow for **reduced production and operational costs**

Next Steps

- Optimize and innovate channel shapes and turbulent path designs to control flow
- Evaluate the socio-economic value of drip irrigation on a regional basis

Acknowledgments

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References

[1] Taylor et al. (IDETC 2015)- A Mathematical Model for Pressure Compensating Emitters.
[2] http://publications.iwmi.org/pdf/H041798.pdf

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