Farmponds for Horticulture: Boon or Curse?

Analyzing Impact on Farm Profitability, Resource Sustainability and Social Welfare

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Organization

- Introduction: Context and the problem statement
- Conceptual model
- Model setup, baseline calibration and scenario details
- Results
- Conclusion

Indian agriculture: the emerging situation

- >50% population in farming; but agricultural output is 15% of GDP
- Government push to increase farm incomes by promoting horticulture
  - High value fruit and vegetable crops; water intensive with need for assured water
- Rising uncertainty in water availability
  - Erratic rainfall, frequent droughts and depleting ground water levels
- Farmponds for water assurance
  - Tremendous popularity in the past decade
  - "*Miracle drought-proofing tool*"; "*game-changer in Indian agriculture*", "*response to climate change*" [Ansari 2016, Pawar 2012]
  - State Government has announced "*Magel tyala shettale*" (Farm pond for anyone who demands it)

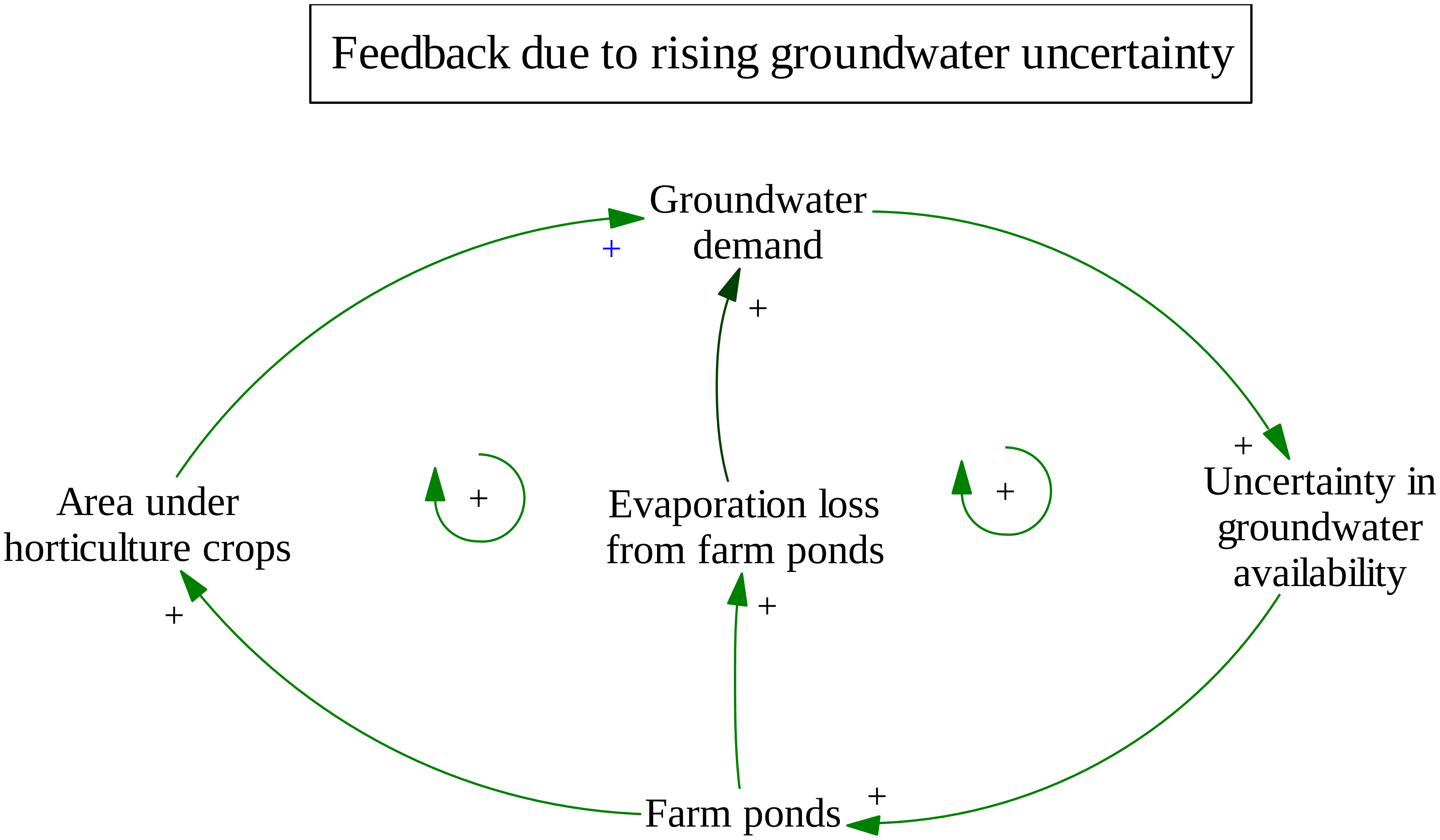
Farm ponds

- Large plastic lined ponds: Not rainwater harvesting but groundwater storage
- Built in areas with groundwater (GW) uncertainty
- Filled with groundwater during monsoon, used in summer months *large evaporation losses*
- Owned by economically better off farmers with larger landholding
- Considered by many as exploitative and environmentally unsustainable [Kale 2017]

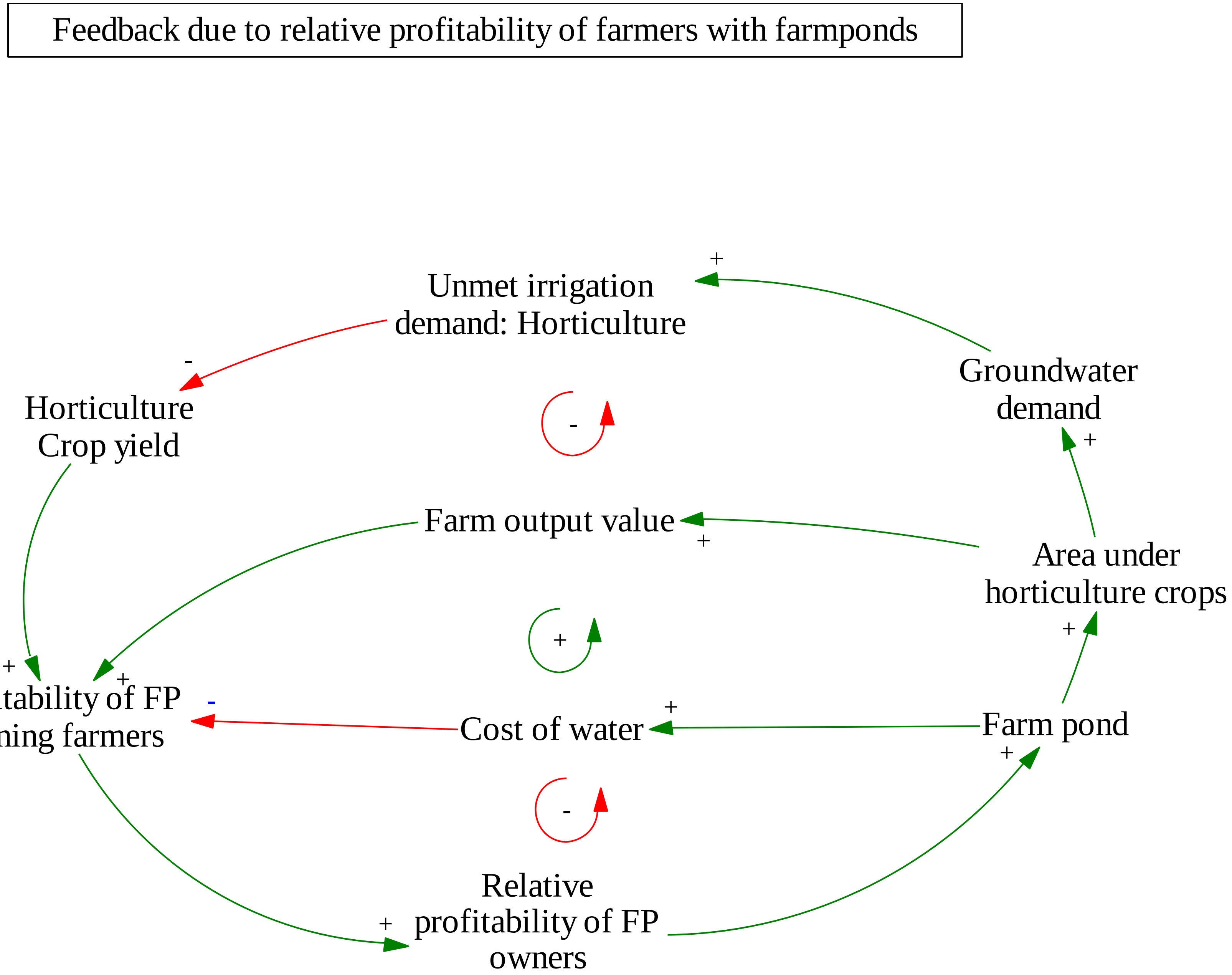
Objective: Farmponds - Boon or curse?

- To assess the impact of ground water filled farm ponds
  - Multiple dimensions: hydrological, economic and social
  - Multiple stakeholders: Farmers, state agencies, politicians, economists, environmentalists, policy makers
  - Multiple goals: to raise farm incomes, to be drought-resilient, judicious use of a scare resource, maintain social welfare
  - Dynamic analysis is crucial because agents adapt and respond
- Model based on extensive data gathering and field observations in different parts of Maharashtra state

Conceptual model: Feedback due to GW uncertainty



Conceptual Model: Feedback due to profitability



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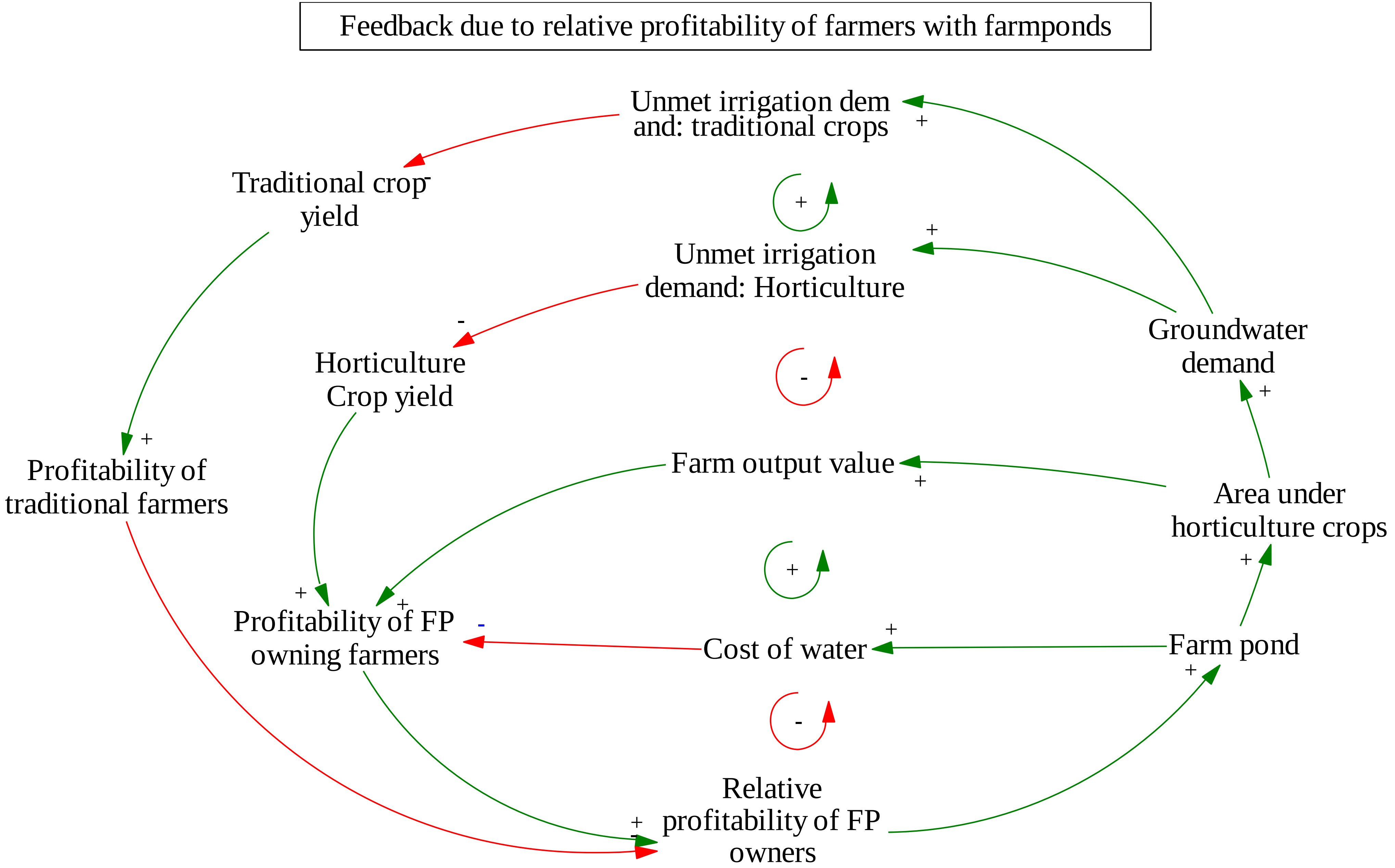
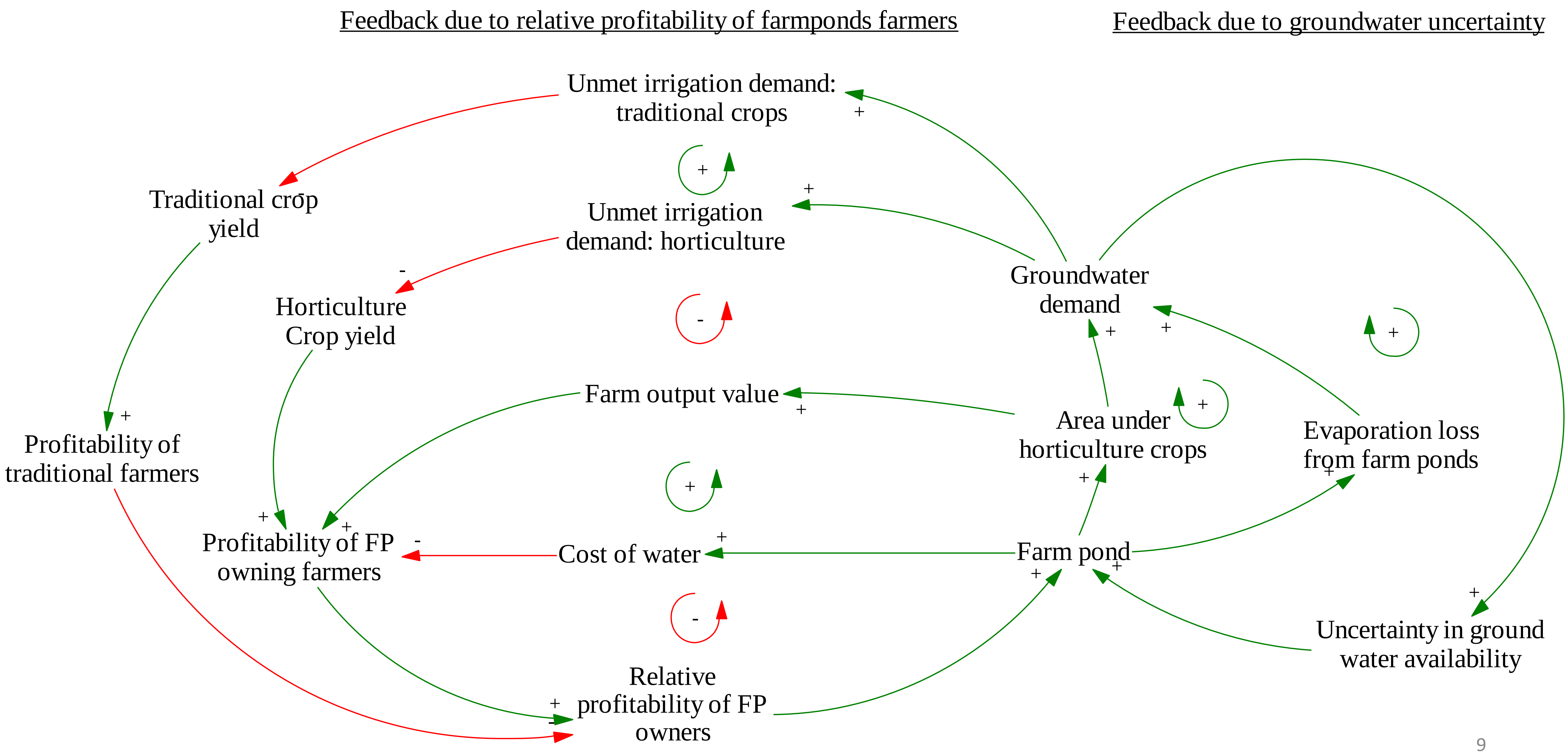
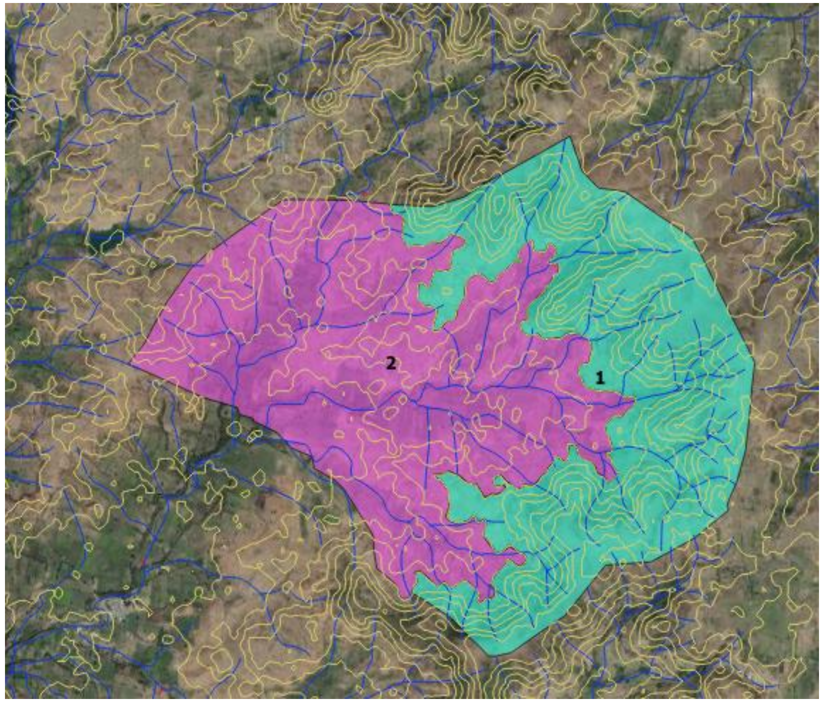


Conceptual Model: Putting it together



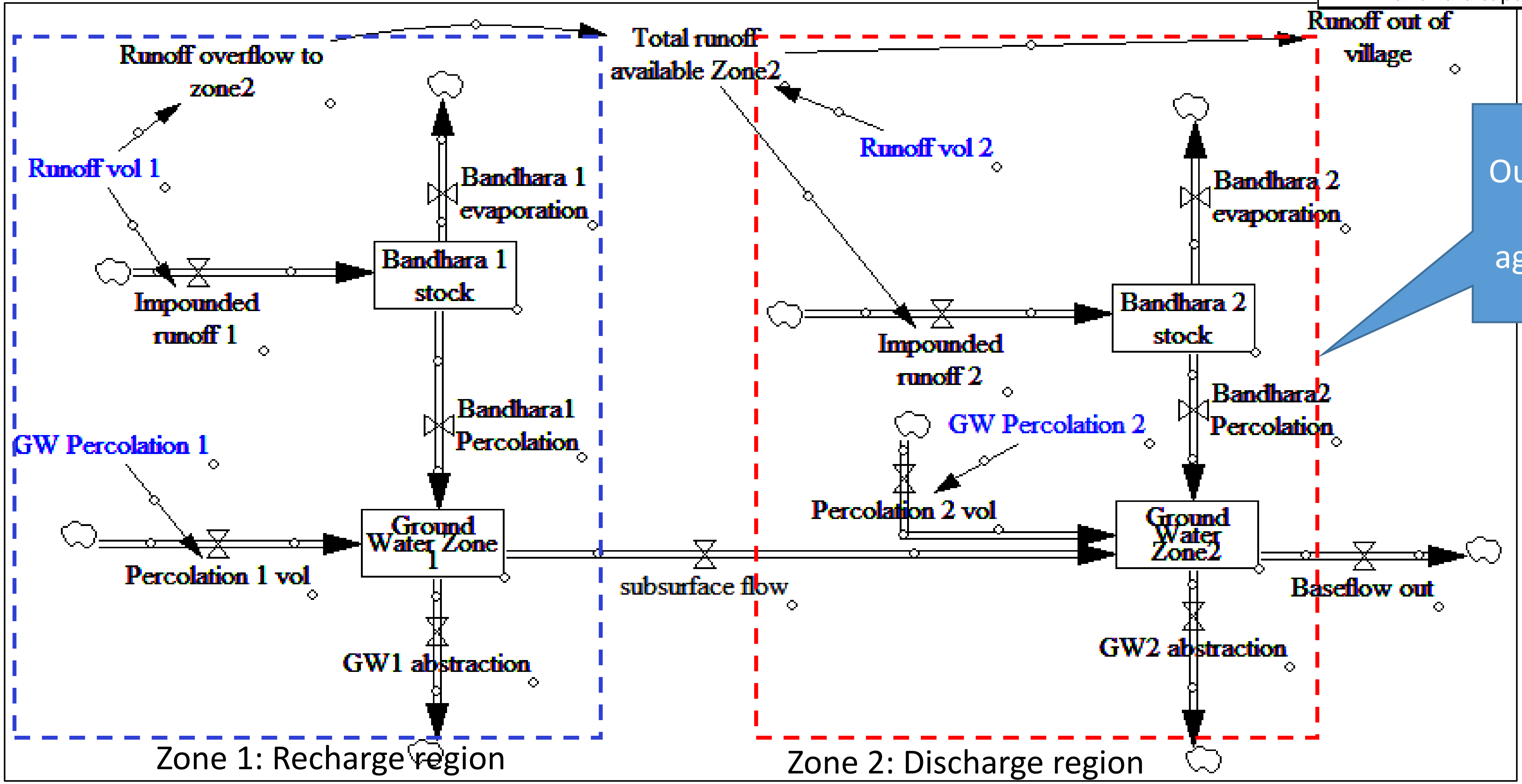
Model Setup

- Biophysical attributes based on attributes of Gondala village, Hingoli district
  - Geomorphology, soil properties, cropping patterns etc.
- Generalized approach: Watershed divided in 2 zones
  - Zone 1: recharge zone – hilly, poor quality shallow soil causing high runoff
  - Zone 2 discharge zone – better soils, comparatively water rich, primarily agricultural land
- Objective: to study the impact of creating farm ponds in zone 2. System boundary includes both zones to capture stream and ground water flows



Hydrological Model

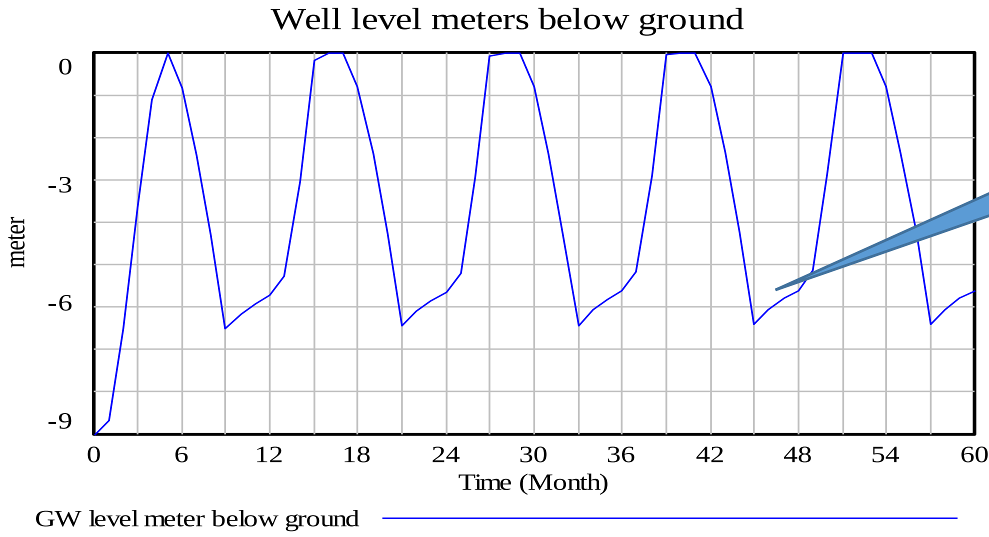
Parameters	Zone 1	Zone 2
Area (ha)	481.63 ha	565.15 ha
Ground elevation (m)	510 m	465 m
Average Well depth (m)	7 m	9 m
Baseline Rabi sown area	200 ha	250 ha
Baseline Rabi GW demand	200 mm	250 mm
Bandhara capacity	50 TCM	300 TCM



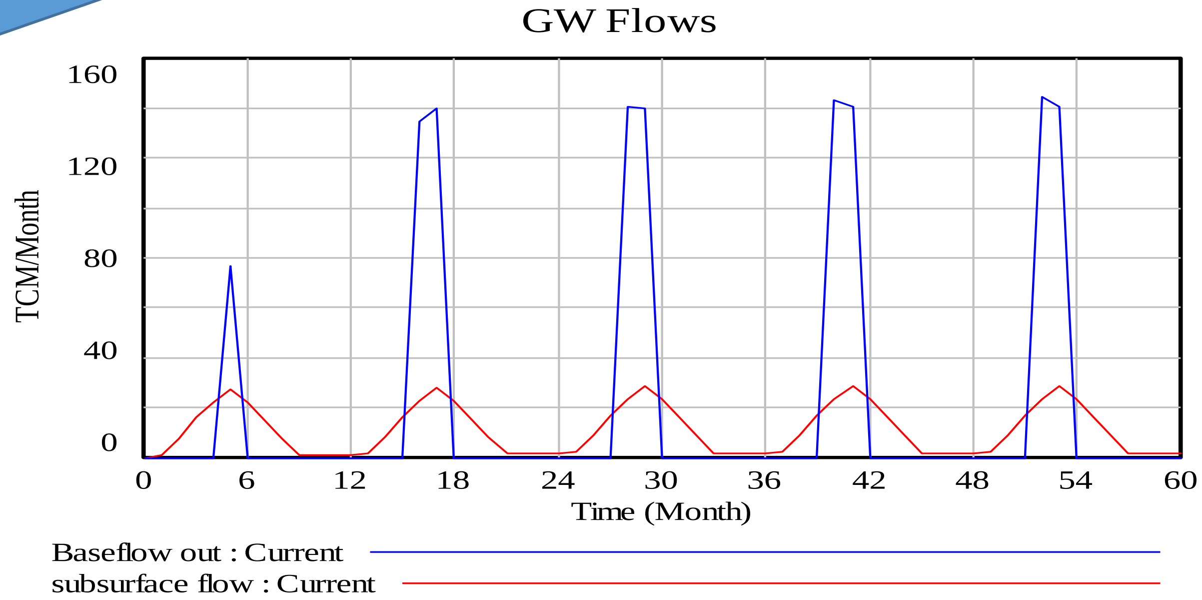
Our focus is creation of farm ponds in agriculture rich zone 2

Baseline Calibration

- Monthly time-step (t=0 is June 1st); monsoon rains (t = 0 to 4); winter crop or *Rabi* extraction (t=5 to 8)
- Model run for 5 years



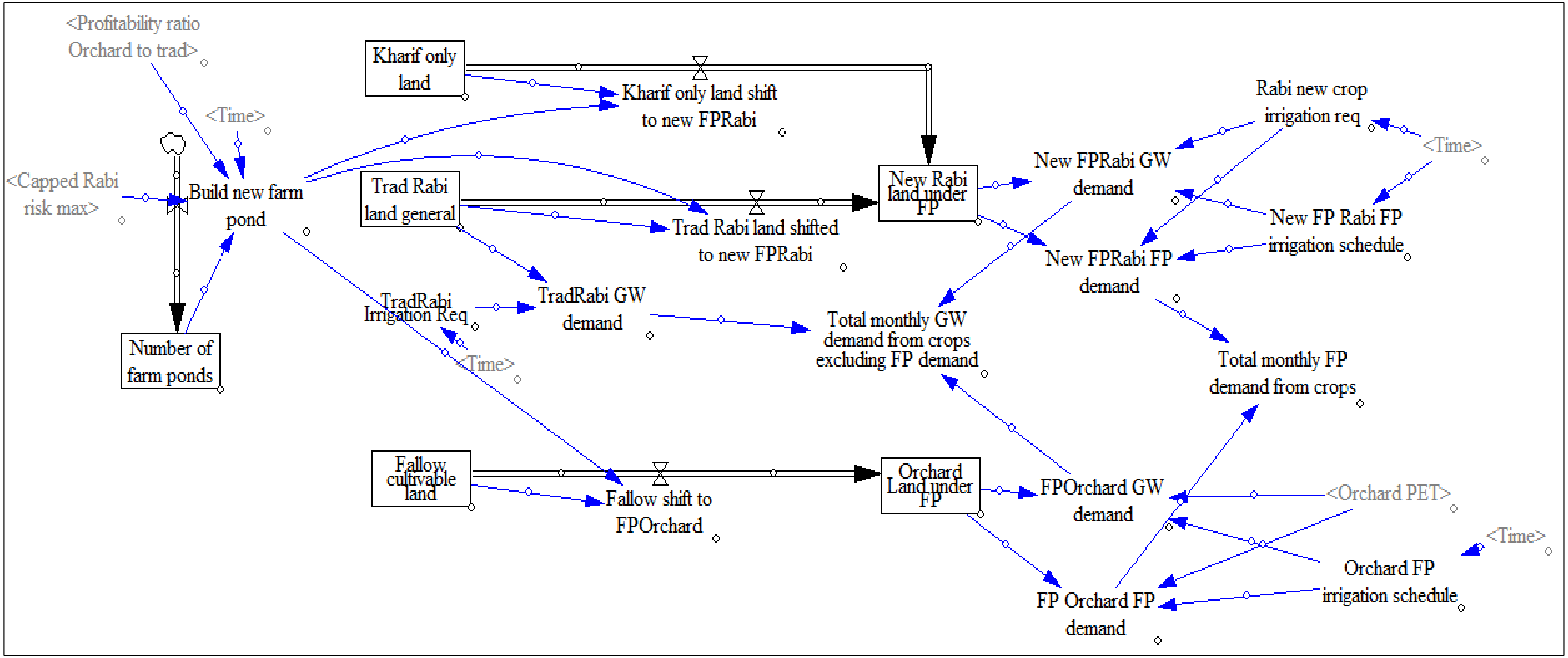
Farmponds created to tide over this scarcity period



Well behavior and GW flows consistent with field observations

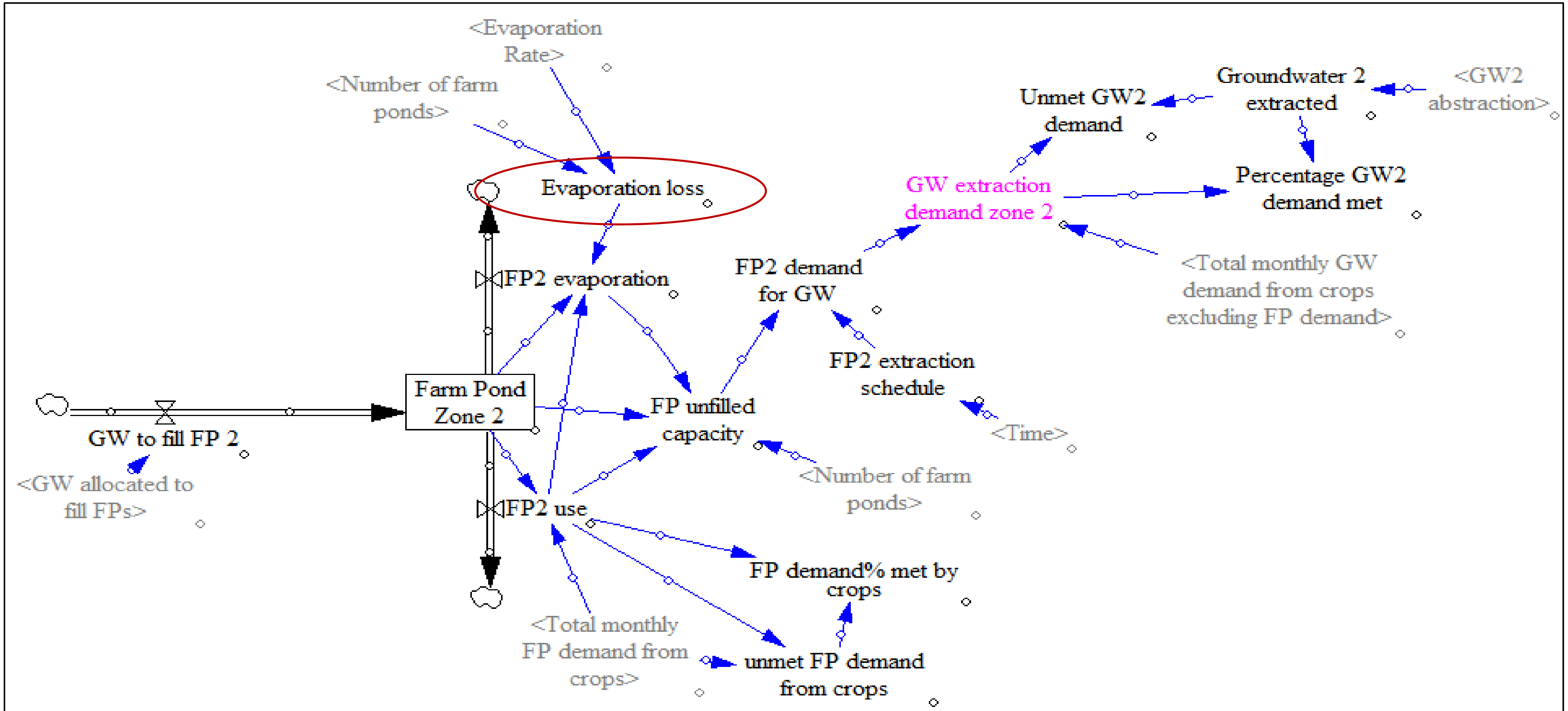
Change in cropping pattern

- New FP triggers shift in cropping pattern and change in ground water demand



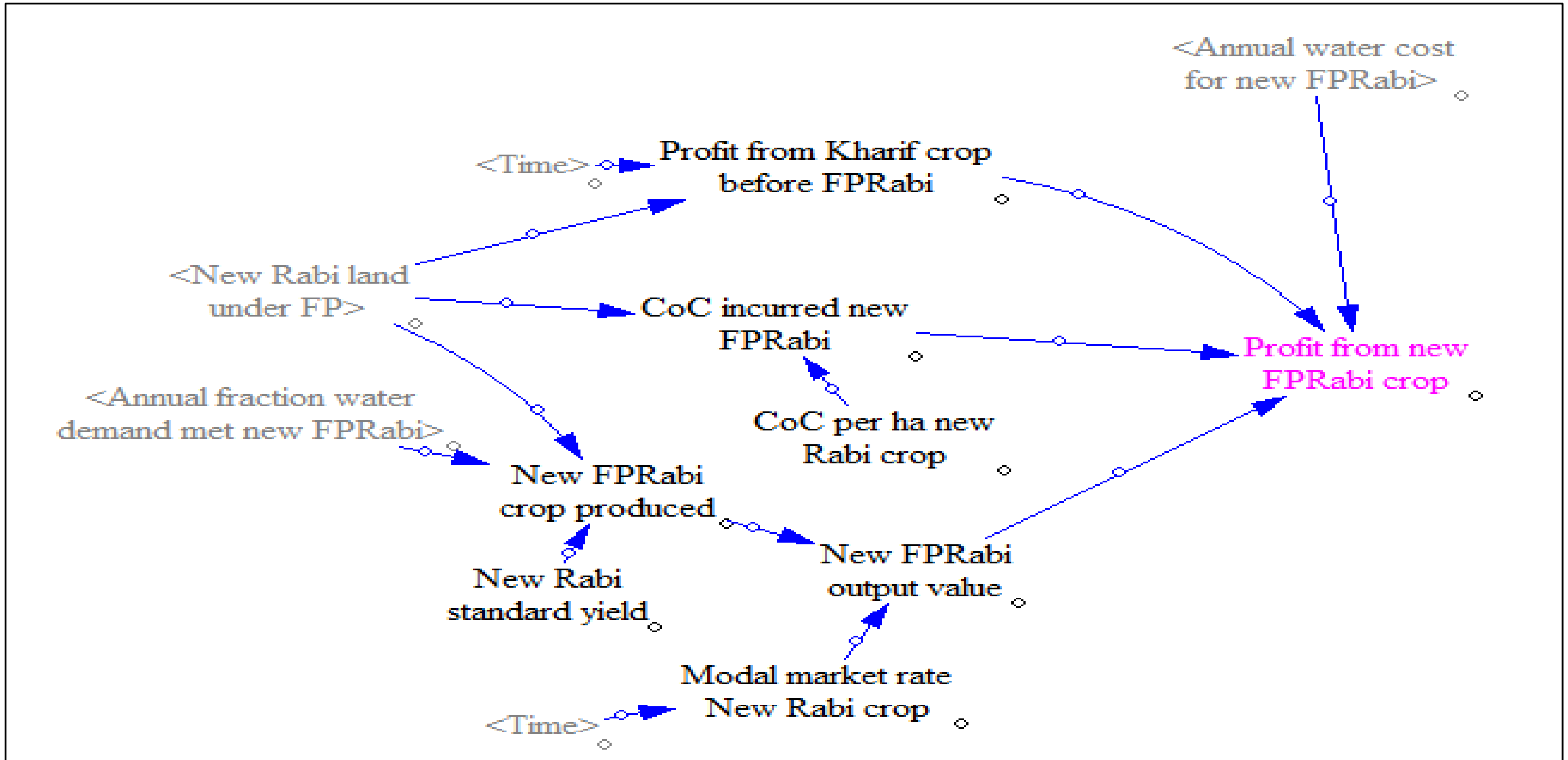
Farmpond losses and GW risk factor

- Monthly ground water demand = crop water demand + water demand to fill FP
- Ratio of GW demand to GW availability: GW risk factor
  - As risk factor rises, more farmers build farm ponds

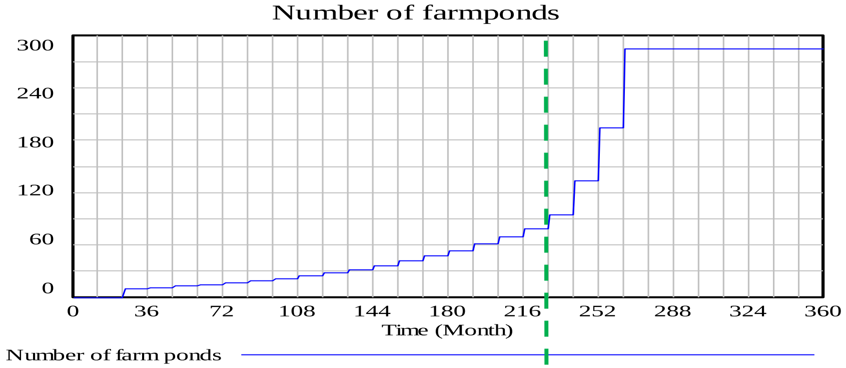


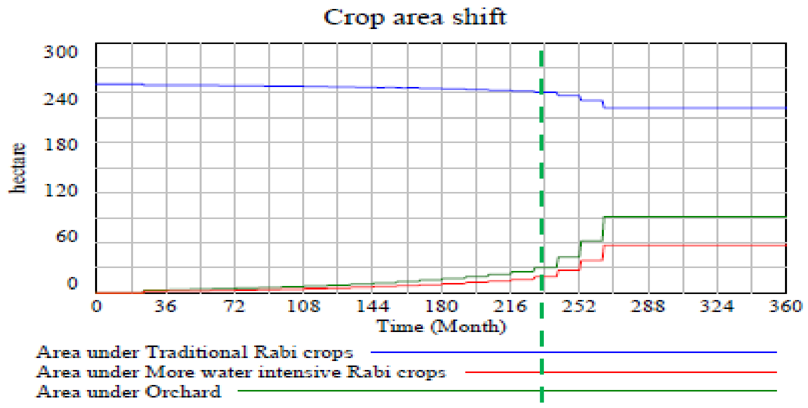
Profitability and feedback to new FP creation

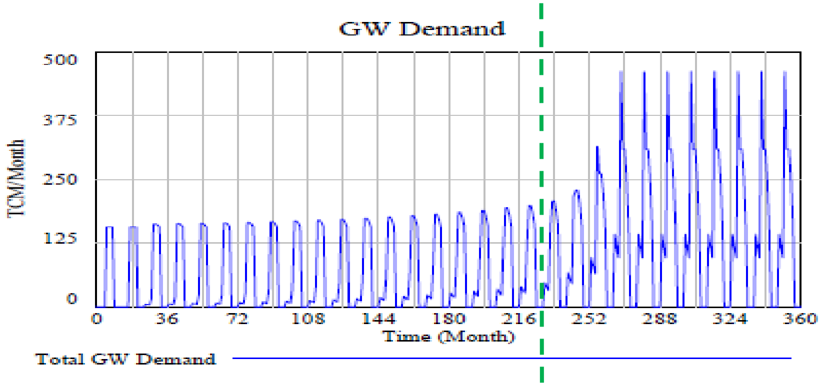
- Yield and Profitability for each type of farmer computed by allocating groundwater based on priority
- Feedback loop: Relative profitability of FP owning farmers to traditional farmers results in new farmers building FPs

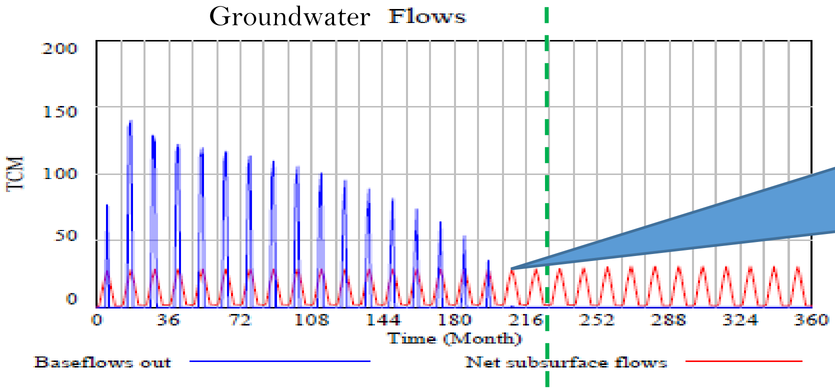


Results: Hydrological impact

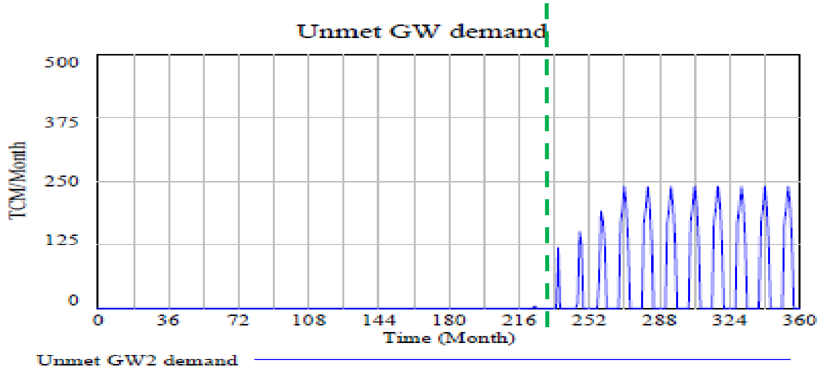


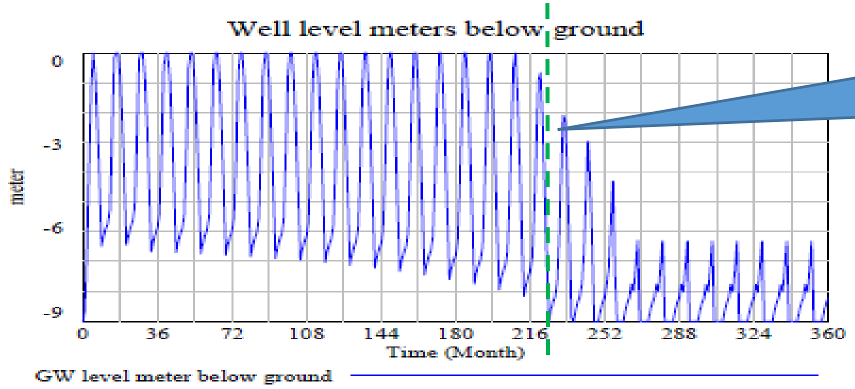






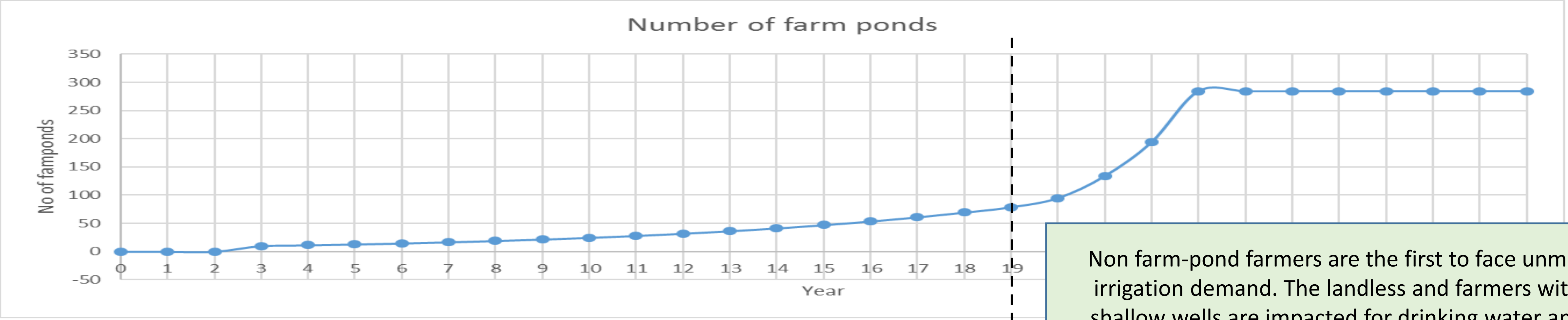
Baseflows dry up. No longer any “excess” GW in the system. Any further GW extraction severely impacts GW stock



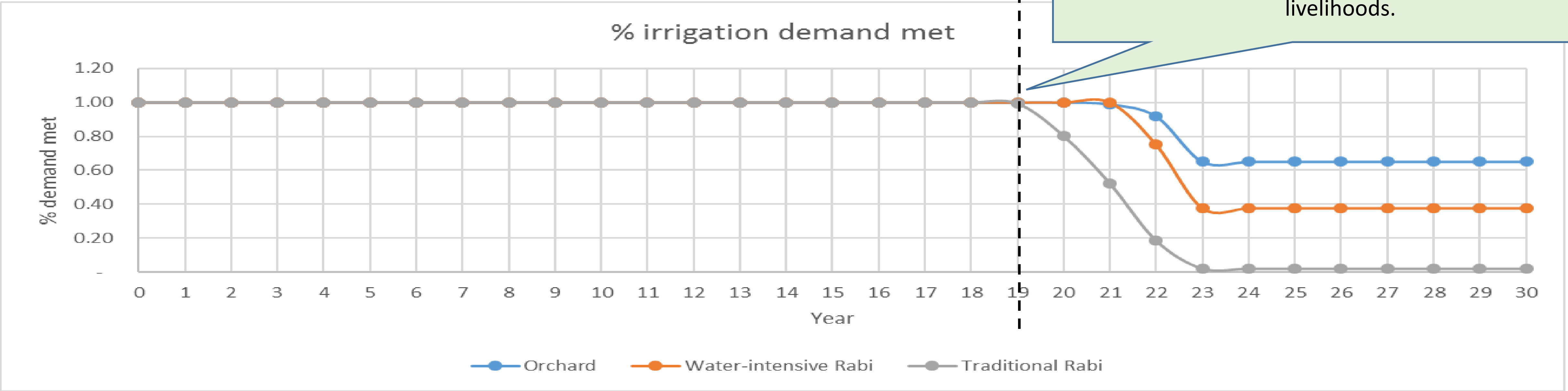


Wells no longer fill up to the brim

Results: Economic and social impact



Non farm-pond farmers are the first to face unmet irrigation demand. The landless and farmers with shallow wells are impacted for drinking water and livelihoods.



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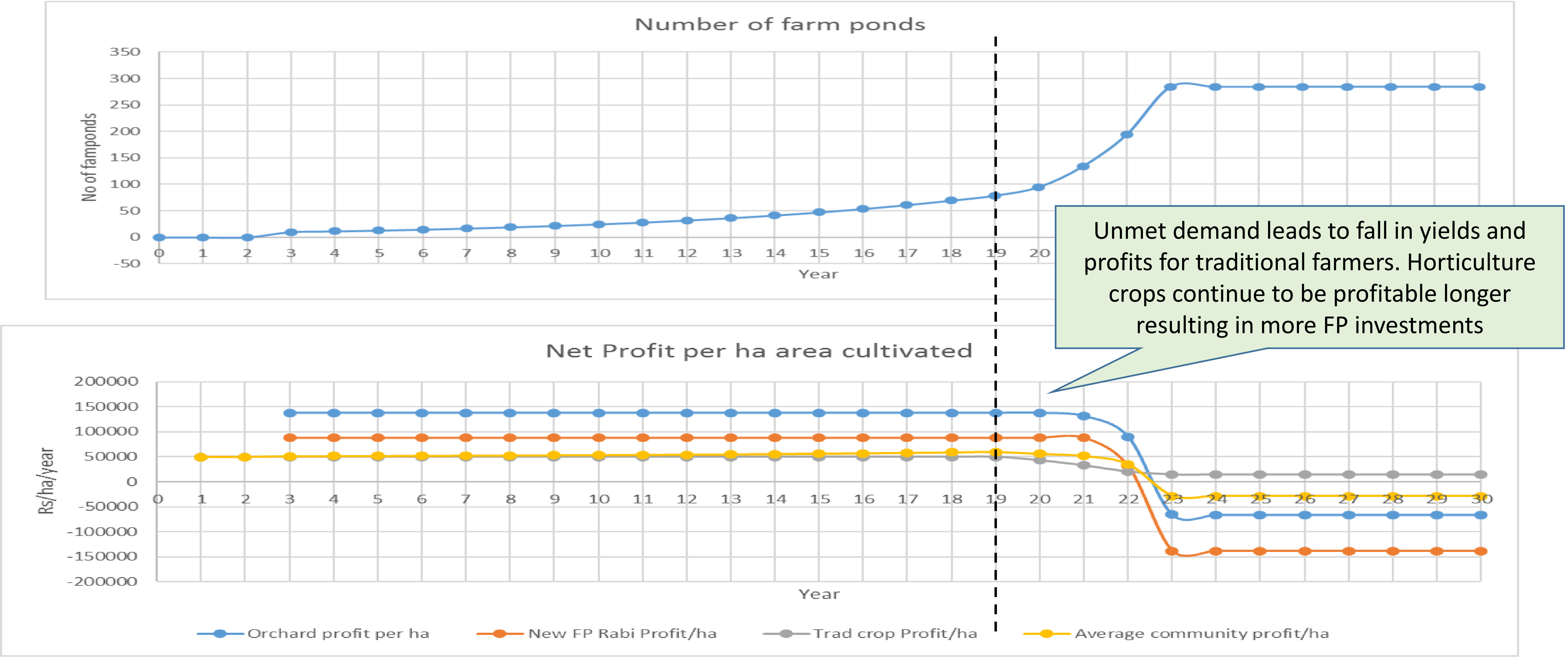

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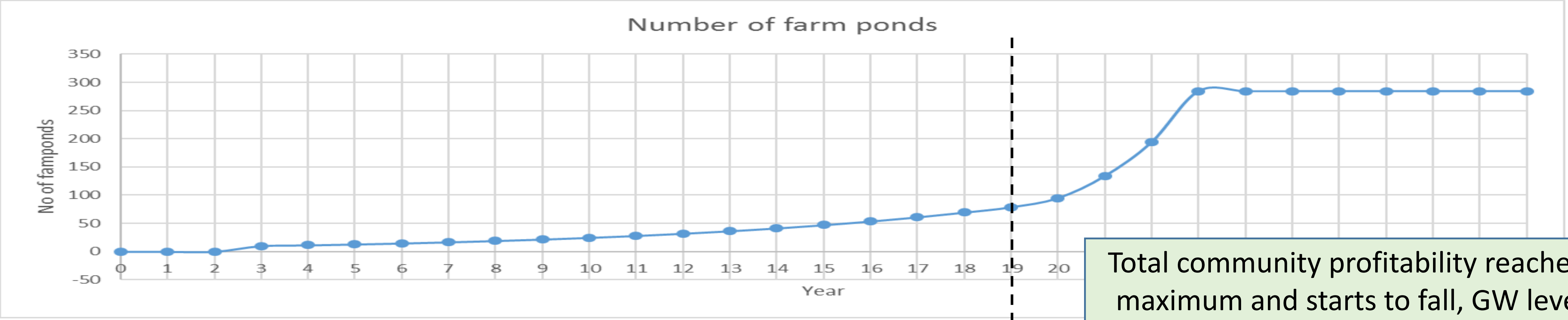
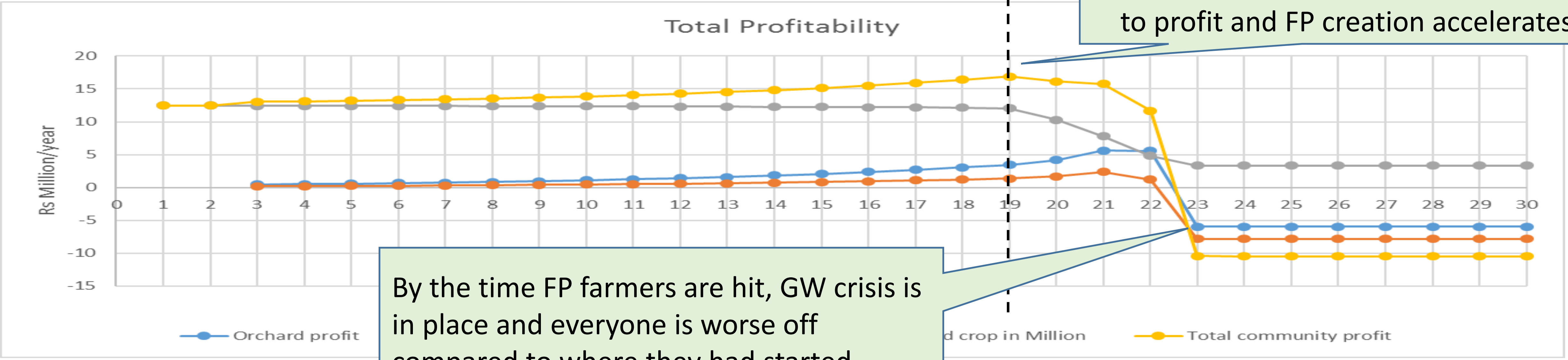


Total community profitability reaches a maximum and starts to fall, GW levels deplete yet FP owning farmers continue to profit and FP creation accelerates



By the time FP farmers are hit, GW crisis is in place and everyone is worse off compared to where they had started

Conclusion

- Farmpond: contentious topic with strongly polarized stakeholders' views
- Possible to compute a band of operation within which farm ponds can be beneficial without being unsustainable
- Necessary to regulate this limit of farm pond use. System does not self regulate. Profitable for individuals to invest in farm ponds even as community loses as a whole, ultimately leading to the tragedy of the commons
- Important implications for government programs such as the National Horticulture Mission which subsidize horticulture and creation of groundwater filled farmponds

Thank you

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