Feedback modelling of the impacts of drought on coffee production in Vietnam

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Introduction

- Vietnam is the world's second-largest coffee producer with a share of 17% of global output.
- Coffee production accounts for 10% of national agricultural export turnover and supports the livelihoods of 0.5 million smallholder farmers.
- Coffee cultivation has faced serious irrigation-related challenges, particularly during drought periods.
- Using a system dynamics approach, this study aims to examine the interrelationships and feedbacks among factors that drive drought impacts on coffee production in Vietnam.

Methods

- A series of interviews with 60 experts and farmers and literature review were employed to identify the problems related to water shortages for coffee production in Dak Lak province, a key coffee-growing region of Vietnam, accounting for over 30% of the total coffee area.

- ***A causal loop diagram (CLD)*** was used as a tool to depict the interactions between key factors and feedback mechanisms in the system.

Results

- An interruption in coffee production during drought is an outcome of complex interactions between climate system (e.g. rainfall variability) and human systems (e.g. rising water demand driven by uncontrollable coffee expansion and over-irrigation). Other influential factors include deforestation and growing water demands underpinned by population growth ***(Fig. 1)***.
- Coffee production is intensified owing to irrigation through reinforcing feedback loops but interrupted by the limits of water availability through balancing loops. The balancing phase will likely dominate in the absence of proper intervention strategies.
- Several ***systems archetypes*** are identified:
  - ***Fixes that fail:*** The side-effects of quick fixes to improve coffee production through Robusta coffee monocultures and migration policy ***(Fig. 2).***
  - ***Limits to growth:*** Coffee areas currently exceed the approved plan for sustainable coffee development. However, some factors limit this expansion, including total land area/total water supply ***(Fig. 3).***
  - ***Tragedy of the commons:*** Over-exploitation of groundwater leads to reduced irrigation supply for all farmers ***(Fig. 4).***

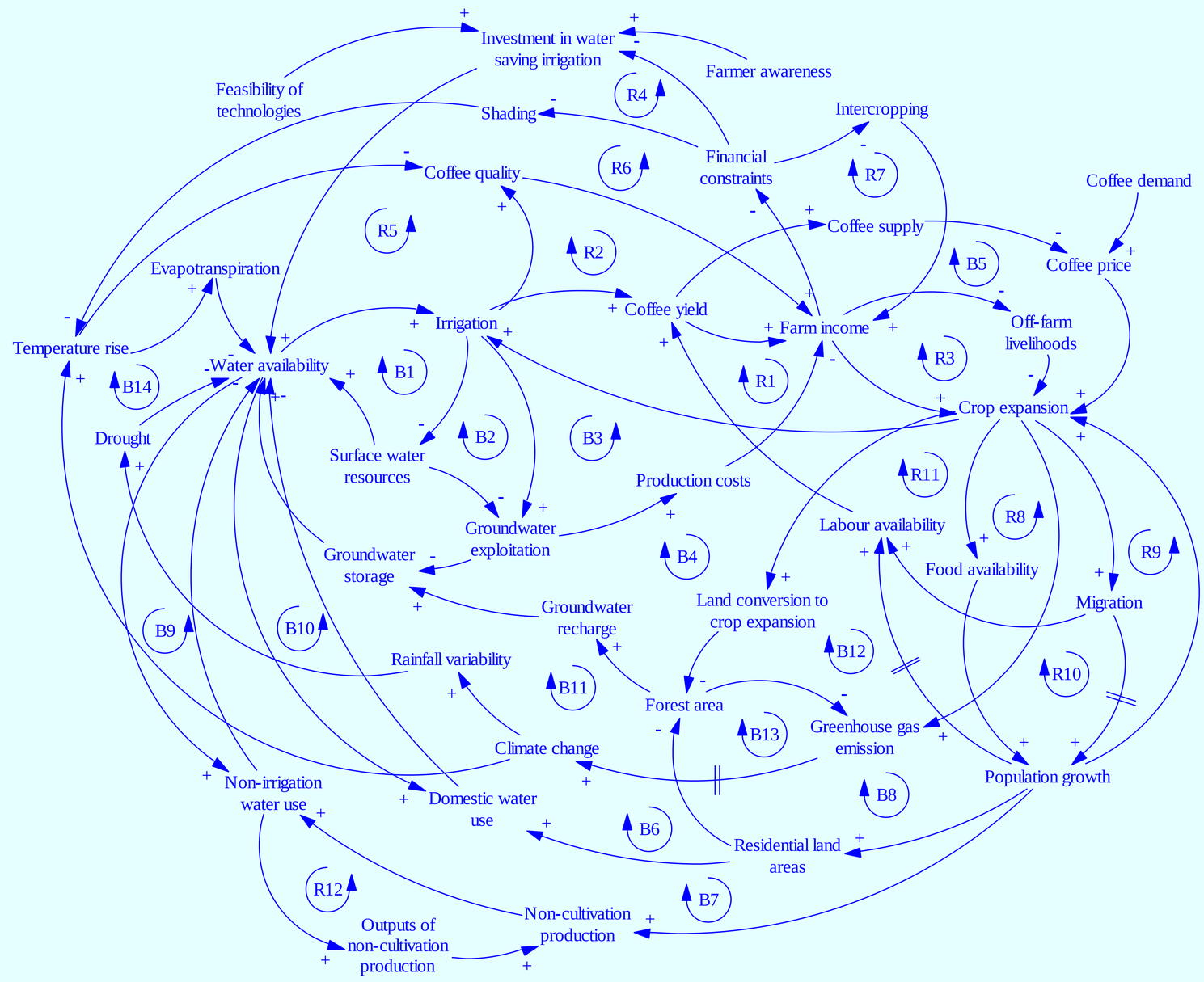

Fig.1. Causal loop diagram of the impacts of drought on coffee production in Dak Lak Province

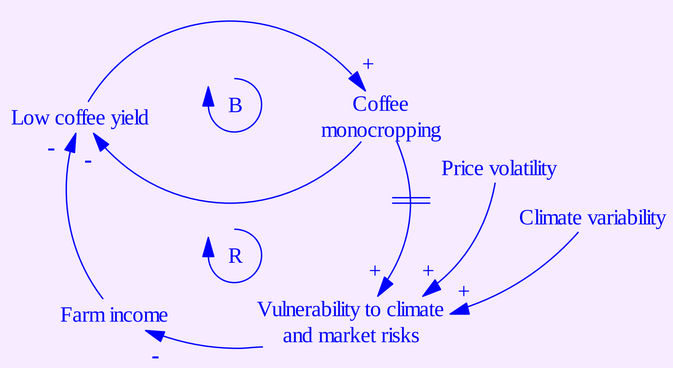

Fig.2. Fixes that fail

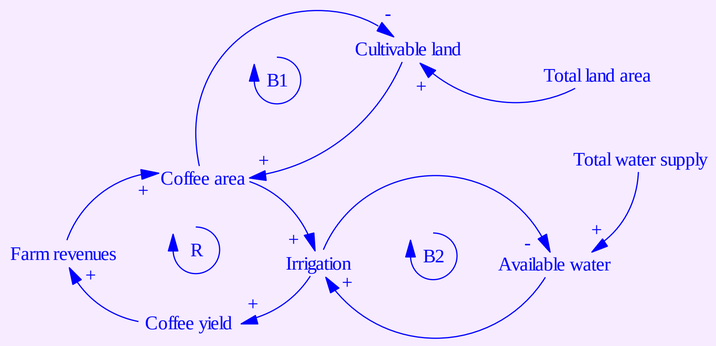

Fig.3. Limits to growth

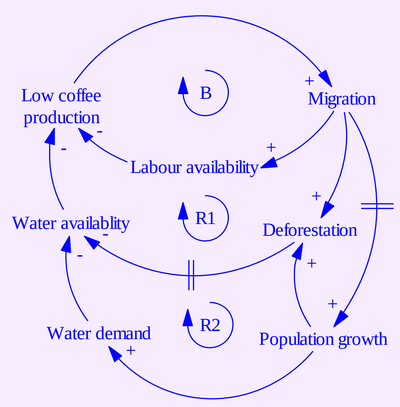

Fig.2. Fixes that fail

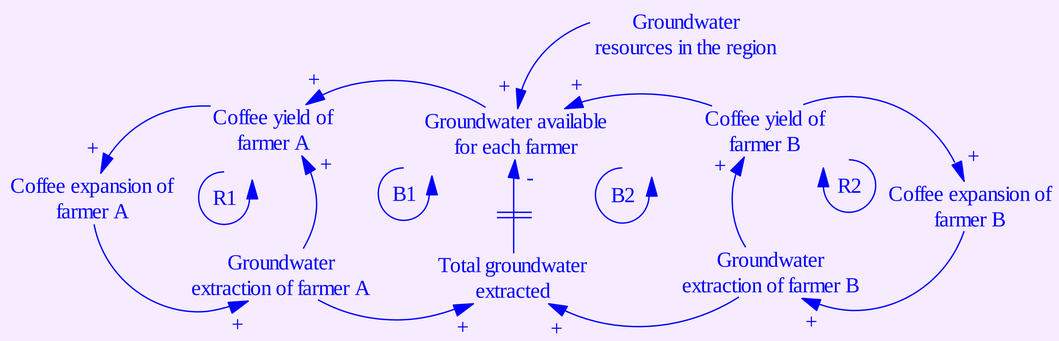

Fig.4. Tragedy of the commons

Conclusions

- Although groundwater reserves may be replenished during the rainy season, it may not be sufficient for coffee irrigation in the following dry season. Our hypothesis indicated that the unintended consequences of migration policy and inefficient agricultural practices (e.g. over-production and over-irrigation) along with changing climate conditions are most likely to disrupt coffee cultivation in Dak Lak.
- Suggested ***interventions***: Raising awareness and promoting technologies on water-saving irrigation, explicitly zoning coffee-growing areas, converting Robusta monocultures to diversified cropping systems, and controlling deforestation coupled with reforestation and afforestation.
- ***Next steps:*** A simulation model based on this CLD is in progress to quantify drought impacts and design and test potential intervention scenarios for sustainable coffee development.

Further information

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