

Using Participatory System Dynamics Approaches to Evaluate the Nutritional Sensitivity of a Producer-Facing Agricultural Intervention in India and Bangladesh

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Introduction

Sustainable food systems aim to achieve win-win scenarios for value chain actors and the nutritional outcomes of consumers (Kadiyala et al. 2012). However, nations such as India and Bangladesh face various barriers to this aspirational goal, with the flows of nutritious fruit and vegetables between ‘the farm and fork’ characterised by fragmented value chains, erratic environmental conditions, unsustainable wastage rates and inadequate transport infrastructure (WB 2007). In turn, consumer demand for fruits and vegetables is suppressed by the inaccessibility of rural markets, the inflation of retail prices from commission agents, and the lack of publicly accessible cold storage facilities (Minocha, Thomas, and Kurpad 2018). Attempting to overcome some of the upstream barriers is the ‘LOOP’ intervention: a horticultural aggregation system operating in Bihar state, India, and Jessore district, Bangladesh, run by the Non-Governmental Organisation (NGO) Digital Green. Under this model, fruit and vegetable supplies are aggregated from village clusters and transported to market in aggregation vehicles, with the aim being

to use collective pooling to cut transport costs, save marketing time, and increase market access and information. However, the extent to which ‘LOOP-type’ aggregation systems and their associated value chain innovations translate into nutritional benefits for nutritionally vulnerable consumers is currently under-explored.

Aims

To this end, we use system dynamics modelling approaches to (i) understand the current implications of the ‘LOOP’ aggregation scheme on the availability and affordability of fruits and vegetables (F&V) in nutritionally insecure markets in Bihar and Jessore; (ii) explore future scenarios to make the scheme more nutritionally sensitive in future; and (iii) evaluate the economic, environmental and gender-based implications along the horticultural value chain from scaling-up the scheme in future. Here we present our overarching modelling framework, an overview of the processes and features underpinning the Bihar and Jessore models, and a number of the future scenarios and their

associated implications for the availability F&V in nutritionally vulnerable markets.

Methods

Our systems modelling frameworks in Bihar and Jessore utilise various sources of quantitative and qualitative data. Following our initial value chains assessments and the quantitative analysis of the 'LOOP dashboard' dataset, we conducted a series of group model building (GMB) sessions (Lie, Rich, and Burkart 2017) with stakeholders from across the horticultural value chains in Bihar and Jessore. Here, we introduce the systems insights gained from the participatory GMB sessions, which brought together stakeholders to think about where, when, and how value chain processes take place, as well as their associated social, political and/or environmental barriers. Informed largely by the GMB sessions, the overarching structures and processes of our system dynamics models are introduced, including the key structural differences between the Bihar and Jessore models. We also briefly demonstrate the approaches used to support our models producing the 'right' behaviours for the 'right' structural reasons (Barlas and Kanar 2000), ranging from traditional pattern matching techniques to reference group meetings with local stakeholders. Lastly, we describe the main modelling scenarios alongside the techniques used to visualise the nutritional implications and trade-offs along the value chain.

Results

The GMB sessions built a consensus around the current challenges facing available fruit and vegetable supplies, whilst bridging the gap between conceptual modelling and the design of a formal simulation model. In terms of our modelling outputs, we compare the nutritional implications of the baseline 'LOOP' evolution scenario against various internal (i.e. 'LOOP') and external (i.e. across the

wider enabling environment) nutritionally sensitive scenarios. We find that scenarios such as improved cold storage utilisation and subsidy rates that vary by market destination may help to improve the availability of fruits and vegetables in small rural markets, albeit involving trade-offs with other value chain metrics, including farmer profits and retail prices. Ultimately, the systems modelling framework evaluates the spectrum of nutritionally sensitive scenarios for 'LOOP-type' aggregation systems, to pinpoint pathways and leverage points towards futures that achieve win-win value chain scenarios.

References

- Barlas, Yaman, and K Kanar. 2000. "Structure-Oriented Behaviour Tests in Model Validation." In *International System Dynamics Conference*, 19. Bergen, Norway. <https://pdfs.semanticscholar.org/f546/838e93202d0c5dd7f4534735e9c296d494ac.pdf>.
- Kadiyala, S, P.K Joshi, S.M Dev, T.M Kumar, and Vijay Vyas Vyas, Suneetha Kadiyala, P K Joshi, S Mahendra Dev, T Nanda Kumar. 2012. "A Nutrition Secure India: Role of Agriculture." *Economic & Political Weekly* 47 (8): 21–25. http://www.spandan-india.org/cms/data/Article/A201571517658_20.pdf.
- Lie, Helene, Karl M Rich, and Stefan Burkart. 2017. "Participatory System Dynamics Modelling for Dairy Value Chain Development in Nicaragua." *Development in Practice* 27 (6): 785–800. <https://doi.org/10.1080/09614524.2017.1343800>.
- Minocha, Sumedha, Tinku Thomas, and Anura V Kurpad. 2018. "Are 'fruits and Vegetables' Intake Really What They Seem in India?'" *European Journal of Clinical Nutrition* 72 (4): 603–8. <https://doi.org/10.1038/s41430-018->

0094-1.
WB. 2007. "Bihar Agriculture: Building on

Emerging Models of 'Success.'" Washington
DC, U.S.A.