Food Futures | Insight Article #1

Using systems thinking to create a sustainable food system

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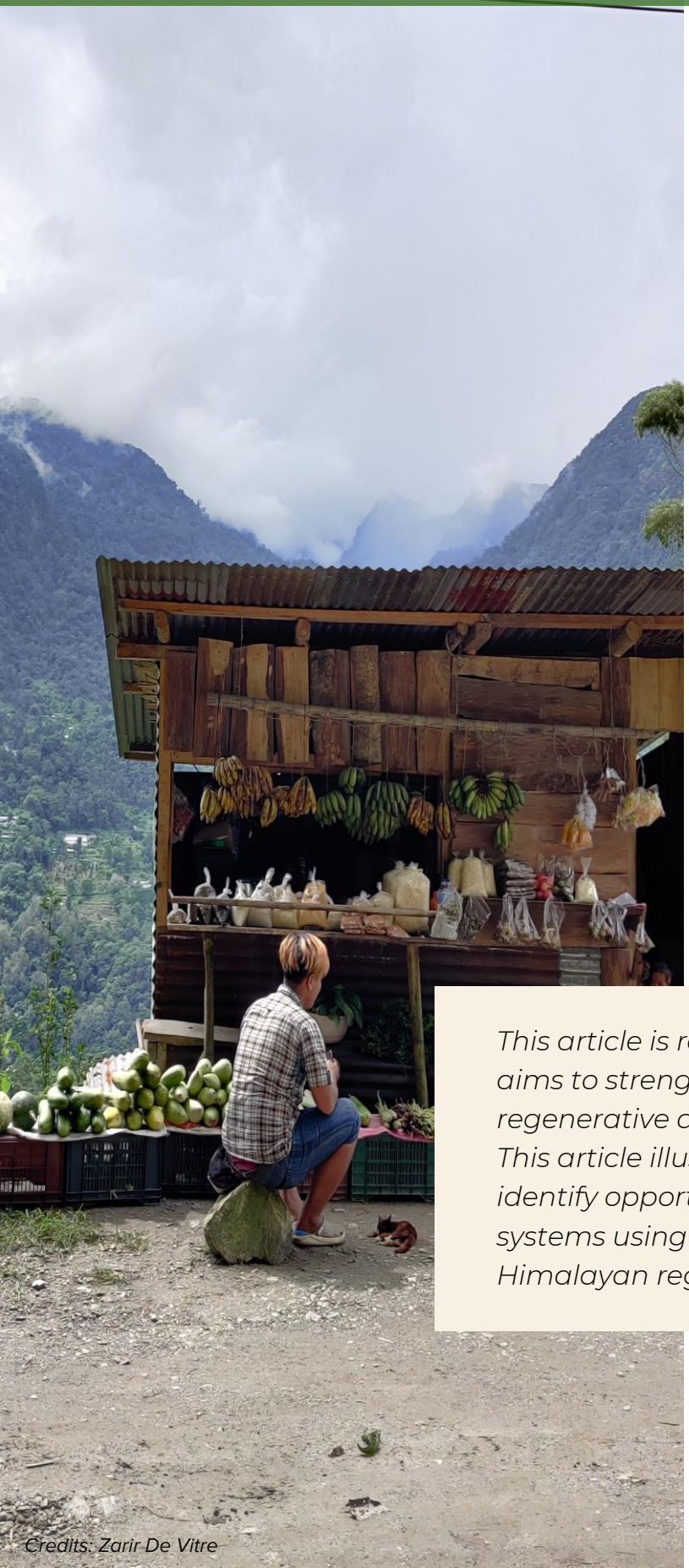
June 2020



Credits: Zarir De Vitre

- Food systems are complex and face multiple challenges.
- Systems thinking offers a way to understand such complex systems and their interactions.
- Systems thinking can reduce the risk of unintended consequences and aid in creating solutions.
- To develop a systems map of the Sikkim Darjeeling Himalayas, we examine historical trends and change-making signals in the food system.
- The systems map helps identify leverage points and intervention opportunities towards creating a sustainable food system.

This article is related to the Food Futures initiative that aims to strengthen local food economies through regenerative agriculture and responsible consumption. This article illustrates how systems thinking can help identify opportunities for creating sustainable food systems using the example of the Sikkim Darjeeling Himalayan region.

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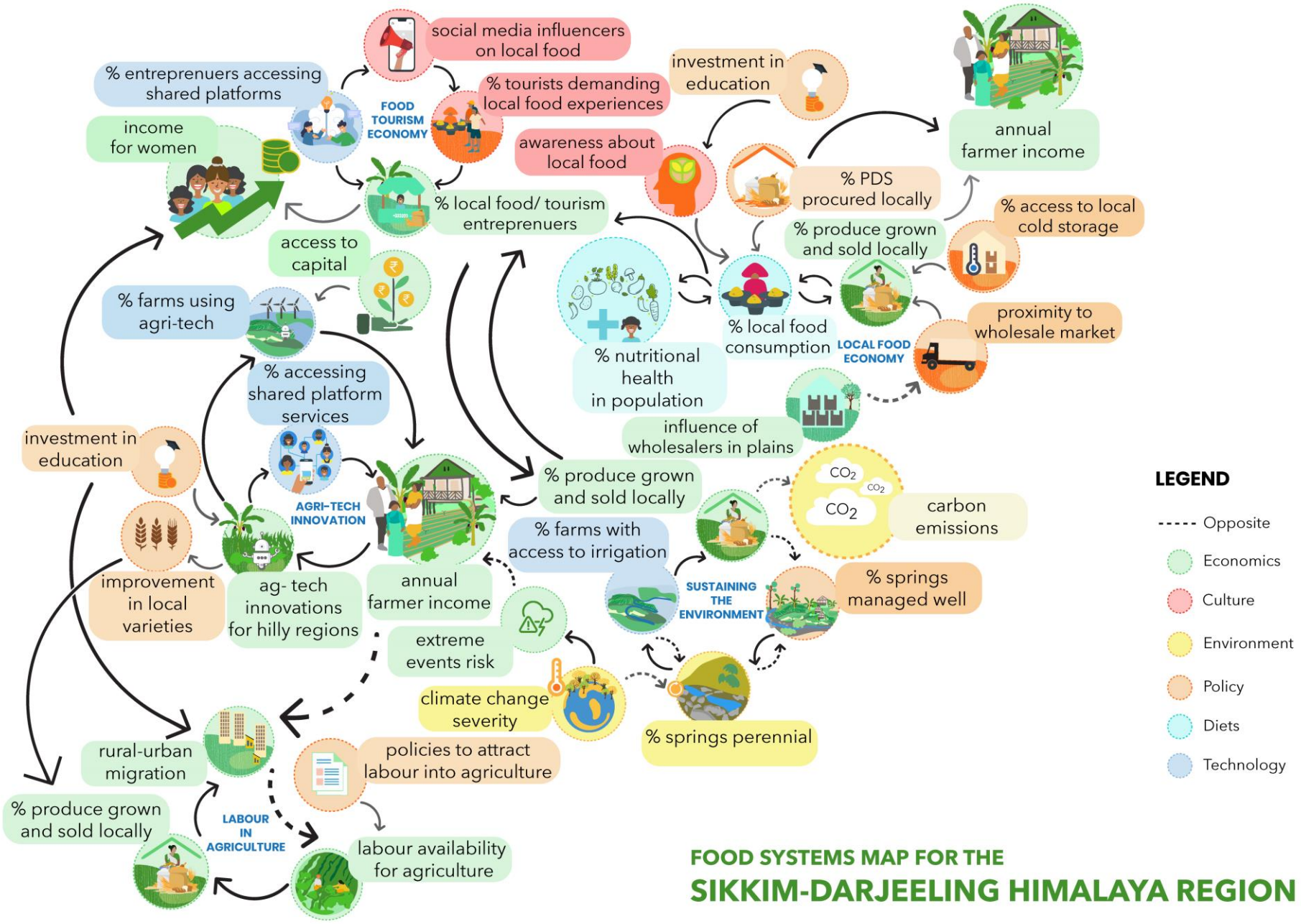


FOOD SYSTEMS MAP FOR THE
SIKKIM-DARJEELING HIMALAYA REGION

Credits: Sarayu Neelakantan

Food systems are complex and interconnected, yet most efforts to improve them tend to look at them in parts. This has often resulted in unsustainable food systems with adverse environmental and social impacts. We show how a systems approach can help better understand our food systems and identify opportunities to address multiple challenges simultaneously. We illustrate this with the example of Sikkim-Darjeeling Himalayan food system.

Our current food system is broken...

The current global food system lies at the heart of some of the largest and most complex problems we face today, including hunger, poverty, water insecurity, ecosystems collapse, and even climate change.

How we grow our food, how it is transported and distributed, how much is consumed and wasted, all have environmental and social impacts. On one hand, food production through agriculture and allied activities generates livelihoods for millions in the developing world. One the other hand, it generates multiple environmental challenges. Increased synthetic fertiliser application has led to soil degradation, monoculture cropping and hybrid seeds have reduced crop diversity and pest resistance, excessive irrigation has led to waterlogging, soil salinity and groundwater depletion.

At the same time, complex logistics in food transportation associated with globalisation has increased food miles and associated carbon emissions. Huge inequities exist in the distribution of food contributing to twin problems of hunger and malnutrition on one hand and obesity and lifestyle diseases on the other.

There is a need to transition to a more sustainable and resilient food system. Recognising this, over the past decades, efforts to address food system challenges have largely focused on specific aspects of the system. What has been missing is the understanding and addressing the linkages between various aspects that constitute this complex system.

Why systems thinking can help better understand food systems.

Systems thinking offers a way to understand complex systems; their components, as well as how they interact with each other [1]. Food systems involve processes and infrastructure for cultivation, storage, processing, exchange, distribution and consumption. Many factors influence food systems, including finance, policy, health, and culture.

Although we live in a world of interdependent systems, our traditional ways of "knowing" the world are "reductionist"; setting up hypotheses to look at a few components at a time. But reductionist thinking often increases the risk of suboptimal solutions or unintended consequences.

For example - Jevons paradox occurs when technological progress increases the efficiency with which a natural resource is used, but increasing efficiency means it is cheaper to use. As a result, demand for the resource rises, further increasing consumption. The paradox is that efforts

to conserve the resource by improving efficiency may increase resource use.

Given the interconnected nature of food systems, we need a more holistic understanding of the problem and solutions that are more robust.

Systems thinking can reduce the risk of unintended consequences and aid in creating solutions.

Systems thinking involves a fundamental shift in beliefs and assumptions that often dominate our worldviews. Instead of simple linear cause-effect relationships common to reductionist approaches, systems thinking helps visualise interconnections between different parts of complex systems more clearly, providing a 'birds-eye' view.

Systems maps are tools that help visually represent systems - illustrating their elements and interconnections. The maps are represented as "interconnected arrays of relationships and feedback loops." The maps highlight patterns and help discover relationships that are often not predictable by conventional approaches.

One example of a "pattern" is a feedback loop, which demonstrates how some interconnections get amplified while others get diminished. In a **reinforcing feedback loop**, the abundance of one element leads to the growth of that one element, which can result in it dominating the system. The exponential growth of bacterial population illustrates a reinforcing loop. This kind of feedback loop can result in a positive transformative change or can create an undesirable situation. In contrast, in a **balancing feedback loop**, the elements of the system work to balance each other out, seeking equilibrium. For example, in nature, the existence of an ideal combination of predators and prey allows an ecosystem to remain in balance and thrive. Changes such as the introduction of additional predators throw the system out of balance as available prey population reduces.

Systems thinking helps recognise which relationships and connections drive the dynamics of the system on the whole. This helps identify key leverage points that can help shift the system to new states. This is what helps identify opportunities to transition to more sustainable food systems.

Developing a systems map involves investigating historical trends and characterising the present state of the system. But studying past trends is not sufficient for "future-casting" (being able to predict possible future trajectories), much less understand what actions would lead to a more desirable trajectory. This is because technology, policies and politics, and people's aspirations are constantly evolving in unpredictable ways.

While we cannot accurately predict future trajectories of the system, at best we can closely read today's "signals" - emerging ideas, technologies and people's aspirations, and overlay them on what we do understand of the system. What this

helps us do, is assemble the pieces we do understand about the system, to help us place new developments in context.

Historical trends and change-making signals in the Sikkim-Darjeeling Himalayas

The food systems map of the Sikkim-Darjeeling Himalayas is developed based on a review of the literature to identify historical trends and dependencies. This is complemented with interviews to understand people's aspirations and capabilities, and analyses of technology, policy and culture signals.

The Sikkim-Darjeeling Himalayas rise from the flood plains of North Bengal. The topography rises from the foothills at 100m to the highest point-Mount Khangchendzonga at 8,586m. Within just 220 km, the climate ranges from subtropical in the south to tundra in the north. This region is one of the highest rainfall regions in the country with annual averages of 2100 - 2300 mm[1].

Tourism is an important part of the economy: the confluence of the Teesta and Rangeet rivers (2020) [*Photo Credit: Zarir De Vitre*]

The agriculture practised is still traditional while there is a trend towards cash crops like cardamom, ginger and exotic fruits like kiwi and ground apple. Although agriculture (much of it organic) is a primary economic activity, it is increasingly eclipsed by tourism and tea plantations.

The food and the culture of the region are intimately linked and reflected in the rich ethnic diversity made up of groups of Nepali, Lepcha, and Bhutia origin, as well as settlers from the plains. Staple foods mainly consist of rice, wheat, potatoes, millets, buckwheat, naked barley and maize. Seasonal vegetables, foraged wild edibles, meat, dairy as well as insect protein are important parts of the diet.

This food system has unique characteristics that shape both production and consumption, and their interdependencies. Historical trends and emerging signals inform our understanding of the food system.

Traditional Nepali thali meal at Rampuria village with millet, corn, rice, bamboo, stinging nettle, squash, pumpkin and fern (2020) [*Photo Credit: Zarir De Vitre*]

[1] All India compiled monthly rainfall data 1901-2002 accessed from India Water Portal.

Historical trends in the food system

Trend #1: Hilly terrain results in fragmented supply chains.

Food transportation to and from the region is difficult because of the terrain. This results in supply chain monopolies with middlemen capturing much of the profit [2]. It makes achieving economies of scale difficult and makes smallholder farming unviable.

Trend #2: The region is vulnerable to climate change and declining water availability.

The mountain region has warmed faster than the global average during the last century, affecting vegetation structure, spring water discharge, community composition and ecosystem dynamics. Being a primarily rainfed region, farmers are especially vulnerable to climate variability [3].

Trend #3: Government programmes increase dependence and reduce agrobiodiversity.

Policy plays a major role in shaping agriculture and affecting public health, nutrition and agrobiodiversity in the region. The government food security programme (targeted public distribution system) prioritises distribution of food grains (rice and wheat) and sugar to eligible households (as of 2012, 75% of rural households and 40% of urban households in Sikkim). But the programme fails to include locally grown and native foods, ignoring nutritional and environmental benefits and local food culture. Food grains are distributed from a larger pool, mostly grown in other parts of the country [2].

Seeds supplied by governments prioritize yield over variety and cash crops over food crops, and thereby disincentivises conservation of local varieties. As they are high yielding hybrid varieties, they produce no seeds for the next season, thereby increasing dependence on government/ private seed companies.

Trend #4: Tourism and local aspirations are altering the food culture.

In the picturesque region, tourism has become an increasingly important source of revenue, sometimes at the expense of agriculture. There has been an incredible growth of homestays in the region, and many small farmers have given up farming to cater exclusively to tourists. But mass tourism is quickly changing diets and food culture, with most tourists demanding food that is not native to the region. Increasing tourism has been driving agriculture to meet the food preferences of tourists, with the adverse effect of diminishing local agrobiodiversity and local food culture.

Trend #5: Local aspirations are driving rural-urban migration.

Despite good primary school enrolment, declining quality of education has resulted in parents preferring to send their children to study and work in urban areas or

outside the region. This has reduced farm labour availability in the region and made agriculture economically unviable. Due to the hilly terrain and heterogeneity, mechanisation of agriculture has not emerged in response to the labour problem.

Change-making signals in the food system

Signal #1: Entrepreneurial interests.

In terms of aspirations, from interviews, it is clear that many inhabitants would prefer to stay close to their families and preserve their culture. Traditional food is still cultivated and sold in markets outside the big tourist towns. Many from the younger generation prefer not to migrate, but pursue entrepreneurial activities such as adventure sports and nature guides.

Signal #2: Agri-tech innovation.

There are also external signals of how the region could evolve, based on technological advances that are transforming everything else. Innovations in the areas of mechanisation, storage, information and communication technologies, and precision farming specially catered to the hilly terrain can improve farmer livelihoods without resorting to mono-cropping and other practices detrimental to the environment.

Signal #3: Shared services platforms.

Technology is already transforming food supply chains and markets. One of the biggest impacts of shared services platforms like Airbnb, Uber, Etsy and Swiggy in recent years is that it has allowed small home-based entrepreneurs to access customers in a historically unprecedented way. This makes it possible to connect individual buyers and sellers. For the first time, it is possible to scale "heterogeneous" product offerings, instead of a few large companies selling a limited number of branded products to everyone. There are local aggregators who use digital platforms for their enterprises.

Signal #4: Spring rejuvenation programmes.

Better management of spring systems, both in enhancing recharge as well as instituting mechanisms to allocate and distribute water resources equitably is being undertaken by non-governmental organisations and the government to ensure that crops can weather the prolonged dry spells [4].

Mountain spring in Darjeeling town (2018) [*Photo Credit: Rinan Shah*]

Applying systems thinking to characterise the Sikkim-Darjeeling Himalayan food system

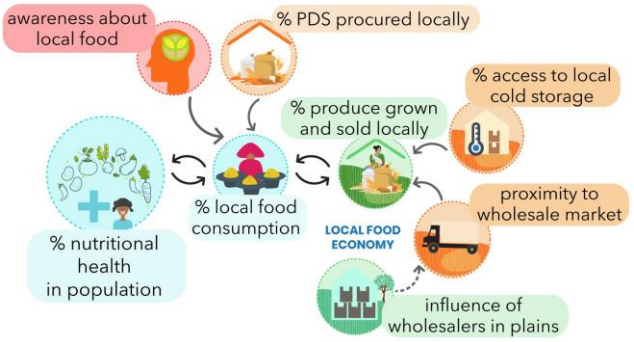
The systems map of the Sikkim-Darjeeling Himalayan food system consists of five interlinked loops. The initial three loops are reinforcing while the last two are balancing loops.

Feedback loop #1: Food tourism

Tourism can be an important driver of demand for local foods. Tourist demand is driven by consumer awareness, as well as the capacity of local entrepreneurs to reach potential customers and provide consistent enjoyable local food experiences. Once tourists associate the region with high-quality local food experiences, it will spur more entrepreneurship. Entrepreneurs will compete to reach customers, further expanding consumer awareness. Tourists returning home with positive experiences will further increase demand. This is thus a positive reinforcing loop, provided the environment does not become degraded by mass tourism.

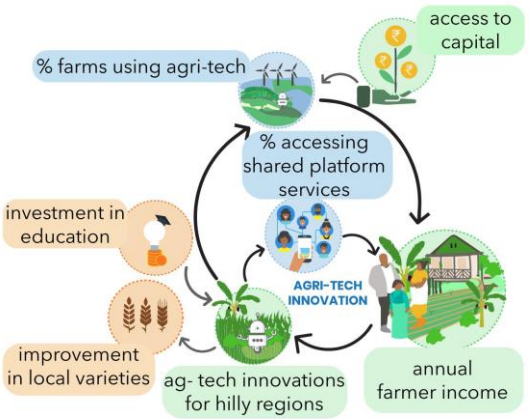
Feedback loop #2: Local food economy

The local food economy depends on local demand as well as tourism.



Local demand for local food depends on awareness and preservation of local food culture. It is also influenced by the government Public Distribution System (PDS) policy. Diversification of food supplied through the PDS to include local, native foods will benefit local farmers and result in better nutritional outcomes. This not only requires a policy change also but will also require investments in establishing local wholesale markets and food storage infrastructure, thereby creating a positive reinforcing loop.

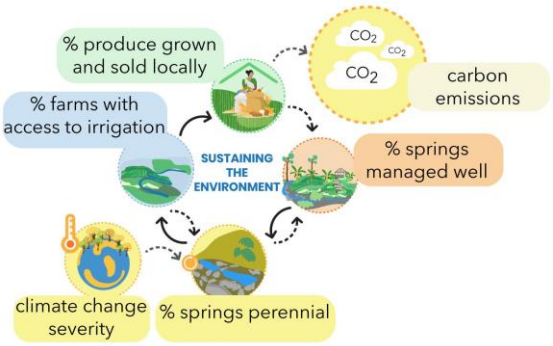
Feedback loop #3: Agri-tech innovation



Agriculture technological innovations for mountainous regions have generally lagged because of low economies of scale. Policies, both in creating tech-funds, specifically for hilly regions, as well as investments in higher education in the region, are likely to be critical for

increasing innovation and in turn farm incomes. Agri-tech innovations can include innovations at the farm-level, in transportation and distribution, climate change adaptation and mitigation, and addressing human-animal conflict. This is also thus a positive reinforcing loop.

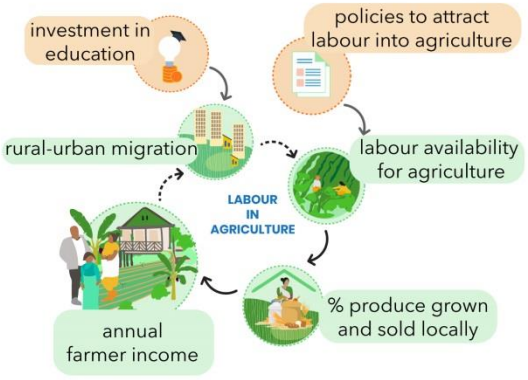
Feedback loop #4: Sustaining the environment.



Interventions to increase yields and farmer incomes are likely to require irrigation. This will need investments in small-scale irrigation systems to allow farmers to access and use local springs efficiently. While rainfall is abundant, storage for the dry season poses a challenge. Groundwater recharge programmes can address this to ensure discharge from springs through the year.

However, the water available in the region is finite. If the region shifts to water-intensive crops, over-abstraction will cause springs to dry up. Even if we invest in recharge programmes, they must be accompanied by springshed management to ensure wise and equitable water use. Ultimately, the environment has a limited carrying capacity, which acts as a check on unlimited growth. Therefore, this is a balancing loop.

Feedback loop #5: Agricultural labour



The region has experienced a decline in agricultural labour availability. This has increased wages, making agriculture unviable. If the goal is to revive the local food economy, a balance between farmer profitability and wages needs to be maintained. However, the balance is mediated by technology. If agriculture is to remain viable and yet pay decent wages to farmworkers, labour productivity of agriculture must improve through technology [2]. Voluntourism and farm stay experiences (external labour inputs that do not cost the farmer anything) may also be a creative way forward.

Identifying opportunities for creating a sustainable food system

Traditionally, systems thinking has been used as an analytical tool. In recent years, it has begun to be seen as a tool to develop interventions. Though powerful on its own, the 'bird's-eye' view of systems thinking can be further strengthened by integrating it with design thinking principles.

In the recent past, design thinking has been increasingly applied to solving social problems across different parts of the world. Simply put, it is a creative, iterative approach to problem-solving that is centred around the stakeholder whose needs are being designed for. One of its key strengths is that it is decidedly 'actor-focussed'. However, this narrower focus can be problematic when attempting to tackle structural and systemic issues within a larger, dynamic system. An integrated approach where systems thinking is complemented by design thinking to develop intervention opportunities presents an exciting prospect for problem solvers.

The different feedback loops in the Sikkim-Darjeeling Himalayan food system, when linked together suggest pathways for interventions.

There are no perfect solutions, but knowledge of trade-offs and their impacts minimises risks and improves decision making.

To envision a sustainable food system which provides sustainable livelihood opportunities and achieves food and nutritional sovereignty for all while preserving the environment, we employed systems thinking and created a food systems map for the Sikkim Darjeeling Himalayan Region. This helped us to identify not only the interlinked loops but also the levers which we can use to make the changes we wish to see. Through this exercise, we drastically reduce the risk of strengthening any loop without the requisite environmental checks and balances in place.

The beauty of this approach is that we enter with the awareness that there are no perfect solutions and each choice that we make has an impact on other elements of the system. However, knowledge of the trade-offs allows us to reduce their severity and improve our collective decision-making. This is the essence of designing interventions from a systems perspective.

Acknowledgements

This article is based on research supported by the Rohini Nilekani Philanthropies and the Sustainable and Healthy Food Systems (SHEFS) programme supported by the Wellcome Trust's Our Planet, Our Health Programme [Grant number: 205200/Z/16/Z] through the London School of Hygiene & Tropical Medicine [Grant number: EPPHZK99].

Suggested Readings

[1] D. H. Meadows, *Thinking in Systems: A Primer*. UK: Earthscan, 2009.

[2] M. P. Lama, 'Sikkim Human Development Report 2001', Government of Sikkim, New Delhi, 2001.

[3] M. L. Arrawatia and S. Tambe, Eds., *Climate Change in Sikkim - Patterns, Impacts and Initiatives*. Information and Public Relations Department, Government of Sikkim, 2012.

[4] S. Tambe, G. Kharel, M. L. Arrawatia, and H. Kulkarni, 'Reviving Dying Springs: Climate Change Adaptation Experiments from the Sikkim Himalaya', *Mountain Research and Development*, vol. 32, no. 1, pp. 62–72, Feb. 2012.