Food Futures | Insight Article #2

What does “sustainable” food production around Bangalore entail?

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- The natural resource base of the region has been depleted by unsustainable .agricultural practices.
- The high-input, high-risk food production system traps farmers into a cycle of debt.
- “Positive deviants” show how environmental sustainability and financial viability can be balanced.
- Regenerative practices involved in organic agriculture alone do not address problems of groundwater unsustainability or farmer debt.
- Sustainable food production in the region will require groundwater management and support for climate-resilient millet cultivation and regenerative agriculture.

This article is related to the Food Futures initiative that aims to strengthen local food economies through regenerative agriculture and responsible consumption. This article explores the complexity of sustainable food production in the semi-arid region around Bangalore.

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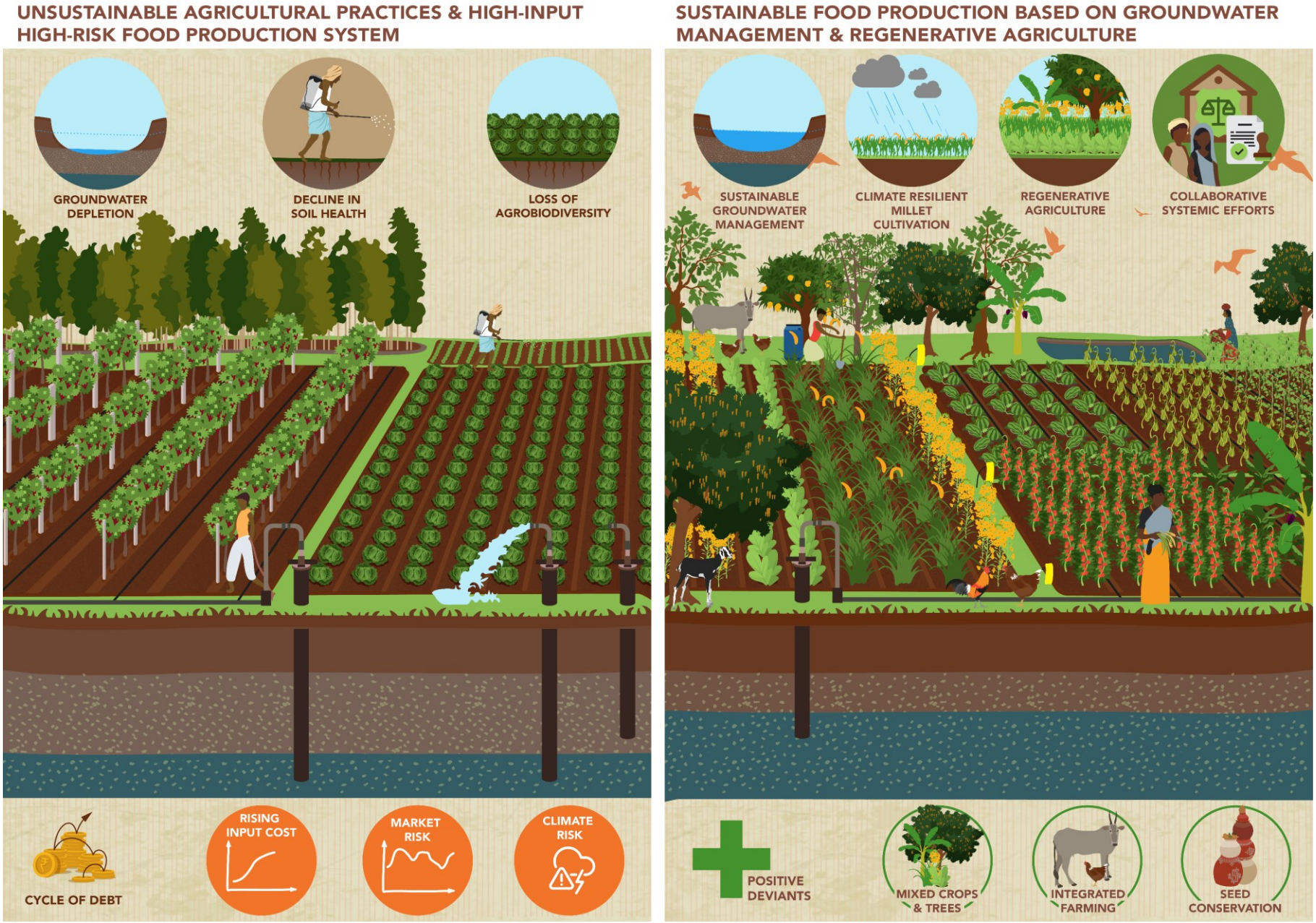

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The agricultural landscape[1] around Bangalore is experiencing environmental degradation – groundwater depletion, a decline in soil health and agrobiodiversity. Urbanisation and globalisation have changed the agricultural landscape as well as consumer preferences which in turn affect rural livelihoods and food production.

Bangalore has historically been an important trading centre in South Karnataka. The metropolitan city has witnessed rapid growth, and its present population is estimated at ~12 million citizens, which is nearly 16% of Karnataka's population. The proximity to this urban centre has made agriculture financially unviable for farming families with small landholdings, the vast majority practising rainfed agriculture. Non-farm livelihoods play an important role in augmenting the farm income of smallholder rainfed farmers. Research indicates that access to bore well irrigation and proximity to the city influence what farming families choose to cultivate [1].

Groundwater depletion and drying surface water bodies impact not only agriculture but also rural domestic water security. Soil degradation and declining agrobiodiversity add to the natural resource challenges associated with food production. With increasing food demand and agricultural intensification, environmental challenges will only deepen further in this landscape.

[1] The landscape refers to Bangalore and surrounding districts of Bangalore Rural, Tumkur, Chikkaballapura, Kolar and Ramanagara.

However, as awareness of the impacts of modern agriculture grows, there are also emerging signs of renewed interest in sustainable farming and safe food production. There are examples of farmers who have adopted practices that are sensitive to the sustenance of natural resources while also finding ways to remain financially viable. Such practices by positive deviants in the region offer hope towards more sustainable food production pathways.

We are at a juncture where there is a critical need for a shift towards a more sustainable trajectory; a new tipping point in the food production system of the landscape.

The natural resource base has been depleted by unsustainable practices.

Post-independence, the Green Revolution transformed food production in the landscape. To increase food security, the focus was on higher yields and agricultural intensification, promoted through the use of high-yielding variety (HYV) seeds, synthetic fertilisers and irrigation. Over time, there has been a partial shift from dryland crops to high-value irrigated crops; but it has been at the cost of declining soil health and neglect of dryland varieties in this landscape.

Aquifers and streams are drying.

Since the 1980s, the bore well revolution has been a tipping point in the landscape that provided access to irrigation to anyone who owned land and could afford to drill a bore well to any desired depth. With free electricity for irrigation pump

sets by the state government, the unsustainable abstraction of the common pool resource has led to groundwater depletion and the drying of streams and irrigation tanks in the region [2].

In this agro-climatically dry zone, the annual rainfall is about 830 to 1000 mm[2]. Rainfed agriculture is the predominant practice (~78% by area in 2010-11)[3]. Protective irrigation through tanks and open wells for limited cultivation of water-intensive crops in the past has given way to bore wells.

Since the early 1990s, there has been a steep increase in both the number of bore wells and the depth of bore wells drilled in the region. Today, on an average, there is one bore well for every 1.3 acres of irrigated net sown area in the region[4] and the bore depths vary between 200 ft to 1200 ft. Today, almost all irrigation in the region is completely dependent on bore wells[4] and the area wholly irrigated has increased by about 30% from 2005 to 2010[3].

As the region is underlain by hard rock aquifers with low water storativity, extensive pumping of groundwater has caused drying of aquifers [2]. This is manifested in the increasing number of bore well failures (i.e. drying) in the region.

[2] All India compiled monthly rainfall data 1901-2002 accessed from India Water Portal.
[3] Report on Census of Agricultural Holdings in Karnataka 2010-11, Part-II, Government of Karnataka, 2014.
[4] District at a Glance Reports for the landscape districts 2015-16 to 2017-18 (latest report accessible for each district).

Bore well irrigated farm in the Arkavathy watershed (2013) [*Photo Credit: ATREE*]

Since the late 1970s, eucalyptus plantations were extensively promoted in the landscape by the state government through the "social forestry" programme. This created both environmental and social impacts. Private rainfed cropped lands were converted into eucalyptus plantations to meet the needs of the industry over the fodder, fuel, small timber and fruit requirements of rural communities as purported [3]. More recently, the preference for eucalyptus plantations by large farmers are driven by labour and water scarcity [1]. Deep-rooted eucalyptus trees were observed to deplete soil moisture and reduce groundwater recharge [4]. But attempts to control eucalyptus have met with resistance. A 2017 state government order that bans fresh eucalyptus plantations has been stayed by the High Court.

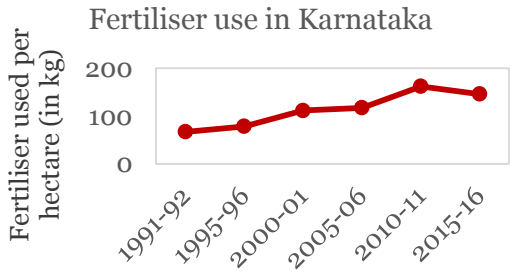
Research also indicates that groundwater irrigated agriculture is the major driver of drying surface water bodies [5]. Groundwater restoration is hydrologically possible through recharge as long as groundwater extraction is managed within sustainable limits. But this needs novel collaborative efforts at groundwater

governance that is local and contextual to this landscape.

Soil health is declining.

The Soil Organic Carbon (SOC) is low and there is soil nutrient depletion [6] due to agricultural intensification and monoculture cropping. There have been tremendous efforts to address nutrient depletion through synthetic fertiliser application, but very little effort on improving soil organic health.

The region has witnessed a steep increase in the use of synthetic fertilisers over the past 50 years, which are highly subsidised by the government (**Figure 1**). Synthetic fertiliser use, promoted since the Green Revolution to increase soil fertility for higher crop yields, has continued. However, many farmers tend to apply them in excess or disproportionately. The focus of fertilisation has primarily been on soil chemistry – through the addition of macro and micronutrients to the soil such as nitrogen (N), phosphorus (P), potassium (K), sulphur and zinc.



(Source: Agriculture Statistics Karnataka, 2015)

Figure 1: Fertiliser consumption per hectare in Karnataka (1991 - 2016)

Increased SOC is associated with improved soil fertility, erosion resistance, aeration, reduced fertiliser and irrigation use and improved drought resilience [7].

Research indicates that legume-crop based rotations can reduce the dependence on synthetic nitrogen fertilisers towards improving soil health [8].

Agrobiodiversity is being lost.

Rainfed ragi (i.e. finger millet) has traditionally been the staple cereal that is widely cultivated in the landscape. Multi-cropping of ragi with pulses such as cowpeas, hyacinth beans, pigeon peas, horse gram; oilseeds like castor and niger seeds; and millets like sorghum, little millet and pearl millet is a traditional practice in the region. This multi-cropping practice, called *akkadi salina paddati* [9] is on the decline as farmers are transitioning to mono-cropping and irrigated crops.

There has been a net reduction in area under minor millet cultivation in Karnataka. Interactions with farmers reveal that minor millets like pearl millet and foxtail millet were cultivated and consumed in this region. However, there are little public records maintained by the government on the extent and nature of minor millet cultivation. Recent efforts by the state government to promote minor millets have so far had limited impact.

Akkadi salu multi-cropping of ragi and sorghum in Sira taluk, Tumkur district (2020) [*Photo Credit: Manjunatha Amalgondi*].

Partly because of the unviability of rainfed farming, and the proximity of the urban

market, there has been an increase in borewell irrigated agriculture. Irrigated farmers closer to Bangalore cultivate vegetables and fruits for urban markets and flowers (local and exotic) for domestic and international markets throughout the year. Irrigation is also used for the cultivation of mulberry for the regional silk industry. Coconut and areca nut plantations are widespread in Tumkur and mango plantations in Kolar, Chikkaballapura and Ramanagara.

Vegetable cultivation in the region is dependent on hybrid varieties of seeds promoted and released by the state government, agriculture/ horticulture research agencies and private seed companies. Community practices of conservation and exchange of locally adapted, open-pollinated seed varieties are on the decline.

But, monocultures of this sort have an inherent tendency to be susceptible to pests. Synthetic insecticides, pesticides and fungicides are extensively used by farmers to control widespread insect and pest attacks. Increasingly, weedicides are being used for the removal of weeds, but they also affect the diversity of uncultivated, edible 'weeds' that have traditionally been a part of rural diets.

High input, high-risk food production traps farmers into a cycle of debt.

The Green Revolution that prioritised yield resulted in high-input agriculture.

High input costs of farming in the region play an important role in influencing farmers' crop choices and farming practices.

Labour costs are high in villages close to Bangalore and areas with industrial employment opportunities. Therefore, farmers prefer to choose crops and farming practices that are less labour-intensive. About 16% of agricultural land in the region is left fallow[5]. Some farmers prefer eucalyptus plantations as this does not involve any labour costs or irrigation.

With soil nutrient depletion, synthetic fertiliser application has been increasing steadily over the years. This increases inputs costs to the farmers. In the recent past, synthetic inputs are also being applied to rainfed ragi crops by some farmers, a practice that was uncommon in the region.

Annual expenditure on seeds is significant given that most farmers are completely dependent on the government and private seed companies. As hybrid HYV seeds are not designed for seed production, farmers need to purchase new seeds or saplings every sowing season.

Farmers who have invested in bore wells prefer to use groundwater to irrigate vegetables and greens as there is a large demand by the urban market. Flowers, including exotic varieties, are grown for the export market. High-value crops with all-year demand are preferred to cover the costs of bore well expenses.

Irrigated farmers are increasingly investing in poly houses for providing a controlled environment for cultivating

[5] District at a Glance Reports for the landscape districts 2015-16 to 2017-18 (latest report accessible for each district).

vegetables such as capsicum. Increasingly farmers invest in farm ponds to harvest rainwater and store pumped groundwater. To conserve water and increase irrigation efficiency, there is increased adoption of drip irrigation systems. Although there are government subsidy schemes, farmers still incur significant costs.

High input agriculture entails risks, particularly for small farmers.

Most of the agricultural land holdings in Karnataka are marginal, i.e. < 2.5 acres (~49%). The average landholding size in the landscape has decreased from 4.9 acres (1970-71) to 2.6 acres (2010-11)[6]. Small farmers face severe diseconomies of scale in making capital intensive investments.

One of the biggest expenses and risks that farmers face is drilling of bore wells. Although electricity for irrigation is free for farmers, subsidised by the government, for farmers able to and willing to invest in bore wells, there are still capital and maintenance costs of bore wells to contend with. Depending on the depth, the cost of drilling a bore well varies between Rs. 1.5 lakh to 4 lakh, including the cost of the submersible pump. And not all attempts to drill bore wells are successful. Collective groundwater abstraction exceeding recharge rate implies declining groundwater levels and drying of the shallower bore wells. Farmers resort to deepening of wells and drilling of new wells to address this, sometimes going up to 1000 -1200 ft. The costs involved are huge and this is one of the reasons why a large number of farmers in the region are perpetually in debt.

Government schemes to reduce risks do not always reach farmers.

Irrespective of the type of market, most farmers face the risk of a glut in the market, leading to falling prices, especially for perishables – vegetables, greens, fruits and flowers. It is not uncommon to see entire crops composted because of low market prices. Yet despite this risk, farmers continue to grow monoculture crops and often alternate between windfall gains and complete losses. Perishable crops are out of the ambit of the Minimum Support Price (MSP), an assured price for selected food crops offered by the government. Moreover, even for food crops such as ragi, pulses (pigeon pea and green gram) and groundnut that are cultivated in the region, the recently announced MSP does not adequately cover the cultivation cost. Therefore, the market risk to farmers is not mitigated despite government schemes.

Periods of continuous drought and unseasonal rains add to the risks faced by farmers. Crop insurance schemes that address this risk have had a limited impact [10]. Back of the envelope estimates indicate that very few farmers (~10%) have opted for crop insurance in the region[7]. Moreover, the actual insurance settlement process has been slow.

[6] Report on Census of Agricultural Holdings in Karnataka 2010-11, Part-I, Government of Karnataka, 2014.

[7] The landscape districts excluding Bangalore district. Estimated using data on main workers (cultivators) from Census 2001 and district-wise enrolment for crop insurance for kharif seasons in 2019 and 2020 (from the Samrakshane portal).

"Positive deviants" show how environmental sustainability and financial viability can be balanced.

In recent years, there is an emerging interest in low-input, regenerative agriculture. Regenerative practices such as reduction/ avoidance of synthetic fertilisers/ insecticides (as in organic agriculture), mulching, crop rotations, multi-cropping and minimal tilling indicate the potential to restore degraded soils, conserve soil moisture, improve agrobiodiversity and reduce the leaching of harmful chemicals into aquifers.

However, this is also an active area for more rigorous scientific research on what practices work under different agro-ecological conditions. While regenerative agriculture indicates obvious positive environmental outcomes, the question is can it improve farm income and reduce risks? To understand this, we visited and interacted with more than 30 farmers engaged in low-input, regenerative agriculture practices in the region.

We present experiences of three of these farming families.

The first, a farming family in Kolar, with marginal landholdings, cultivates native varieties of ragi along with minor millets, pulses, groundnuts and vegetables under rainfed agriculture. Diversity in crops is prioritised for family food security. The female head of the household is a seed-saver, who has conserved several varieties of native seeds. The family's agricultural input costs are low as they use their own conserved seeds, organic manures and pest repellents. While the farm is self-sufficient without irrigation, the family does have to supplement with non-farm income in addition to cattle rearing for dairy.

The second, a farmer in Ramanagara, has experimented with the cultivation of ragi using a method called '*guli paddati*' (on one-acre holding). This method, which relies on maintaining spacing between crops and bending of the plant stems to encourage multiple shoots, is reported to improve the crop yield [9]. While ragi and pulses are meant for family food security; for long term income, the farmer has cultivated fruit and timber trees on his 3-acre holding.

Guli ragi cultivation in Ramanagara (2019) [*Photo Credit: Manjunatha G*]

The third is a rainfed farming family in Chikkaballapura that has transitioned to organic agriculture after witnessing a gradual loss in soil health. They were guided by organic farming training workshops by NGOs. Apart from the cultivation of ragi, groundnut, pigeon pea and foxtail millet on their 1.5 acres landholding, the family earns additional income through two native cows (dairy), sale of fruits from two tamarind trees and non-farm income. A small farm pond provides supplemental irrigation. The family plans to develop an agro-forest in

the future and include a small vegetable patch for meeting home nutritional requirements.

Overall, we observe certain patterns from the "positive deviant" farming families. There is a commitment to experimentation and learning. Farmers have been inspired by different sources – farming programmes on FM radio, farming magazines and NGO organised training on organic farming. At the same time, family health and soil health concerns have led farmers to transition to chemical-free forms of farming.

Most of the 30 farmers interviewed, reported that crop yields did decline for about 3-4 years while transitioning from conventional to regenerative agriculture. The farmers, who successfully transitioned coped with the yield decline through non-farm income or transitioned only a part of their holdings to organic to meet their family food requirements. Some farming families have supplemented food crops with fruit trees for regular income and timber trees for long term income. Some entrepreneurial farmers have experimented with value-addition of ragi and coconut and established direct market linkages with urban consumers and markets.

Positive deviants indicate that widespread adoption of suitable regenerative practices in the landscape for both rainfed and irrigated agriculture offers a way forward to improve soil health and agrobiodiversity.

But, regenerative practices involved in organic agriculture alone do not address problems of groundwater unsustainability and farmer debt.

Organic agriculture is being promoted by the government and civil society organisations. Vegetables and greens are being cultivated without the use of synthetic pesticides and fertilisers by some farmers around peri-urban Bangalore. With dedicated market linkages with high-income urban consumers, organic vegetable farmers report higher and more stable income.

However, organic vegetable cultivation in the region is completely dependent on bore well irrigation in a landscape where groundwater depletion is a problem. Thus, organic farmers face similar risks as conventional farmers concerning bore well failures and have similar maintenance costs. They also have similar input costs on seeds and technology such as drip/sprinkler irrigation and poly houses. While a good number of organic farmers prepare their organic manures and insecticides, there is a growing "industrial" organic manures/ organic insecticides industry that sells ready-made manures and formulations to farmers.

While regenerative agriculture offers promising ecological practices, changing on-farm practices alone cannot solve the groundwater sustainability problem or mitigate farmer risks and improve farmer livelihoods. Sustainability in food production would require innovative approaches to managing water both

efficiently and equitably in the landscape and it would require linkages with markets so farmers can turn a profit despite diseconomies of scale and labour intensive practices involved. This is the crux of the challenge of sustainability in food production in the landscape. This needs local, creative solutions, as urbanisation continually changes the dynamics of the landscape.

What will sustainable food production look like in the region?

In a region that is changing under urbanisation, it is unlikely that the demand for irrigated vegetables, fruits and flowers will reduce. Therefore, sustainable groundwater management for irrigation is necessary and this will require collaborative efforts and innovative solutions by the government, civil society and farmers.

At the same time, increased government incentives and support for the cultivation of climate-resilient rainfed millet crops with appropriate processing infrastructure and market linkages have the potential for improving farm livelihoods and reduce the tendency to shift to high input, high risk irrigated crops for improving farm income.

Across the landscape, there is a need for a long-term, well-planned programme that supports regenerative agriculture practices for both rainfed and irrigated crops for restoring soil health and sustainability.

Sustainable food production in the region is a complex, multi-dimensional challenge that requires systems approaches and collaborative efforts. This requires planning beyond food security towards both the environment and farmer well-being.

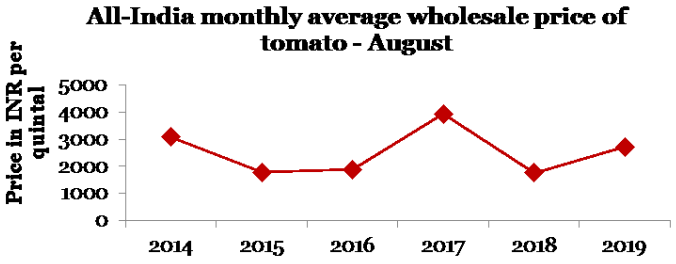
BOX 1: ESTIMATED COSTS AND RETURNS FROM VEGETABLE CULTIVATION IN THE REGION

Tomato crop – conventionally grown (1 acre)

Input cost: ~INR 1.2 to 1.5 lakh (per season)
Cultivation mode: Monoculture cropping

Farmer income: Highly variable, subject to market price and weather risks.

Can fluctuate between complete loss to profits ranging from INR 1.5 to > 5 lakh. On an average, one in 3-4 crops yields large returns.



Data Source: Monthly report tomato (April 2018, June 2020), Ministry of Agriculture and Farmers Welfare, GoI.

Vegetable crop – organically grown (1 acre)

Input cost: ~INR 40,000 – 50,000* (per season)
Cultivation mode: Multi-vegetable cropping

Farmer income: Less variable, distributed and regular. Risks mitigated through vegetable patches in different batches at different stages of growth.

Income depends on type of market linkage for organic produce. With dedicated markets, can possibly earn profits ranging from INR 1 to > 2.5 lakh.

(* Assuming owning sufficient livestock for organic manure)

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Suggested Readings

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