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India - State of Bihar, Factor : Climate Volatility

### **Strengthening Agriculture in Indian State of Bihar to Increase Resilience to Climate Volatility**

The frequency of extreme climate-related disasters, including floods, droughts, storms and extreme heat, has doubled around the world since the early 1990s (FAO). These disasters affect agricultural productivity, resulting in loss of income and increased volatility in food prices. The impact is a global increase in poverty and food insecurity. In developing countries like India, where there is a large population already struggling with food insecurity, the impact of climate volatility is magnified.

India is one of the fastest growing economies in the world (Economic Times). However, despite undergoing two decades of considerable economic growth and accelerating urbanization, the country still houses a staggering population of food insecure. Although India has a lower Global Hunger Index compared to nations like Chad, Yemen or the Central African Republic, India's massive population makes it home to the largest number of food insecure people in the world, an estimated 255 million (USDA). Furthermore, India has the highest number of children with chronic wasting (25.5 million) and stunting (46.6 million) in the world (2019 GHI report), and 51.4% of women in reproductive ages between 15 to 49 years suffer from anaemia, making food insecurity a critical public health emergency. India is expected to add nearly 273 million to its population of 1.37 billion in the coming years, making it the most populous country in the world by 2027 (UN World Population Prospects). The rising population only further exacerbates the lack of access to nutritious food in India, and increases the urgency of finding solutions to the food insecurity crisis.

In 1947, India gained its independence from Britain, and subsequently became the largest democracy in the world. Its government system is a parliamentary model much like the United Kingdom. Although trends have shown a steady increase in urban population, the country still has a significant (67%) rural population. India has one of the greatest supplies of arable land globally, second only to the United States, which is why the agricultural sector is the largest industry in India. Over 65%-70% of the population is employed in the agricultural sector. India is also the world's largest producer of milk, legumes and jute (a fibre used to make burlap), and ranks second in the production of rice, wheat, sugarcane, groundnuts, vegetables, fruit and cotton. It is also a major producer of spices, fish, poultry, livestock and plantation crops (FAO).

In my research, I found that farmers in the state of Bihar (Figure I below) are struggling to a greater extent than other provinces in India, largely because the state is one of the poorest in the country, with a poverty incidence between 46-70% and high illiteracy rates (particularly among women, who have low social status). Many areas in the state are notorious for considerable prevalence of gang violence and a lack of police control.



Figure 1: Indian State of Bihar

Bihar, a landlocked state located in the Eastern region of India, is also one of the most populous areas of India, with a population of 128 million. The average earnings of farmers are the lowest compared to all other Indian states, at Rs. 1,652 (\$22) per month compared to Rs. 12,841 (\$179) in the state of Punjab (Financial Express). 77% of the population is employed in agriculture, making it the primary determining factor of food security in the state. 91% of the farmers in Bihar are marginal farmers with less than 2 acres of land (BPSP Notes). The average farm size in Bihar is 0.48 acres compared to the national average of 2.6 acres (Stirring Pyramid). To put this into context, the average farm size in the United States is 444 acres.

The primary barrier faced by farmers in India today is the increasingly unpredictable climate conditions, leading to unseasonal rains and greater frequencies of extreme weather events like floods and droughts. Although this is a problem across India, the situation is far more dire for the state of Bihar. A study of climate vulnerability conducted by Indian Council of Agriculture (ICAR) identified Bihar as the most vulnerable state to climate change impacts in India (The Wire). The paradox of floods and droughts occur simultaneously almost every year in Bihar, leaving the agricultural industry in a highly precarious position. Changes in seasonal patterns have reduced the previously consistent days of rainfall during the monsoon and resulted in shorter winters, contributing to changes in cropping. Climate volatility exacerbates many existing problems (including water scarcity, government corruption and high illiteracy rates) through greater frequency of droughts, unseasonal rains, and floods. High population density, unplanned urbanization, rapid deforestation, and socioeconomic conditions are compounding the state's vulnerability to climate change. Over two-thirds of agriculture in Bihar is dependent on the monsoon (seasonal rainfall). Nearly 60% of farms lack irrigation facilities, leaving millions of farmers reliant on the rains. Increased natural disasters have exacerbated crop losses, volatility in food prices, and has also led to a greater number of farmer suicides. The profession of farming in Bihar is now facing growing insecurity as many young men migrate to urban areas in search of non-agricultural employment. The rural to urban migration rates in Bihar are the highest in India, as more farmers flee the unstable conditions of rural farms. A 2018 survey of 5,000 farmers across 18 states in India found that 76% of farmers would prefer to quit farming (NSSO), and a majority of the respondents stated their crops were destroyed due to unseasonal rains, drought, floods and pests (Down to Earth).

### Typical Family:

I was able to get in contact with a young man in the state of Bihar named Mr. Arvind Kumar, who hails from a small rural town in the East Champaran district of Bihar. Mr. Kumar owns a farm of around 3 acres, and lives in a 2-room home with his wife, 2 children and parents. When asked if his land was a similar size to others in his region, he stated that he would consider himself a moderate-sized farmer. The average family size in Bihar is 5.5 (with 1.8 average children), and a large percentage of families live in 1 to 2 room houses made of mud bricks and mud flooring. Mr. Kumar said that his typical diet consists of

roti (wheat), lentils (legumes) and occasionally some vegetables. Like many farmers in India, he is a vegetarian so he does not consume meat or eggs. Mr. Kumar also explained that many rural farmers maintain livestock as an additional source of income, adding that his own family keeps goats, which allows them access to dairy products.

The average consumption of meat per person is about 8.8 pounds per year in India, compared to 222 pounds per year in the US (Quartz India). However, eggs, dairy and meat consumption in Bihar is much lower than the average consumption across India, which is a significant contributing factor to the large malnourished population in the state (Telegraph India). Most of the small farmers rely on subsistence agriculture, and cannot afford to eat foods with a high nutritional content (such as vegetables, meat, dairy and eggs). A majority of the rural population is self employed, individual farmers who also work as laborers on larger farms for additional income. Mr. Kumar explained that rural populations in Bihar have limited access to qualified doctors, which is reflected in the disparity between the life expectancies of rural populations (69 years for women, 66.4 years for men) and urban populations (73.7 years for women, 71.2 years for men). The literacy rate in Bihar is the lowest of all other states in India at 61.8% (compared to 94% in the state of Kerala). Mr. Kumar said that his town does have a public school, but it doesn't have qualified teachers and many children have transportation difficulties in getting to school even if they were to attend.

### **Major Barriers for a Typical Farmer:**

The majority (over 91%) of farmers in Bihar own very small farms, and as a result they are unable to negotiate profitable prices for produce. The lack of income means that they cannot invest in modern farm equipment, and continue to rely on cattle and ploughs in order to cultivate their fields. About two-thirds of farms in Bihar are dependent on rain water from the monsoons (seasonal rainfall), which is why a change in rain pattern drastically alters the overall annual income for a farmer. They depend upon timely and predictable rainfall, and a proper temperature for preparing seedlings, along with the transplantation, development and growth of crops. In recent years, farmers have suffered income losses stemming from the unexpected heat waves or sudden temperature drops, resulting in low yields. In some cases, farmers must plant several batches of seeds to try and mitigate potential losses, as the seeds may go to waste because of late or excess rains (The Nation).

In 2019, vegetable produce contributed to 81% of the agricultural income in Bihar. However, only 26 percent of farmers cultivate vegetables. Mr. Kumar, like most farmers in Bihar, cultivates wheat and lentils on his land. When asked why he would not try harvesting vegetables in order to earn a higher income, he replied that most people do not have access to cold storage facilities, which vegetables (unlike grains and lentils) require. Mr. Kumar further explained that vegetables perish easily, which means that he runs the risk of losing his produce before he can find a buyer. Another issue he mentioned was the flooding in Bihar which results from flat land that concentrates any heavy rains that fall in the northern mountains of Nepal. Mr. Kumar lives in close proximity to the Gandak river, and in recent years heavy rains have caused severe flooding on his farm, resulting in crop losses. He also stated that in other regions of Bihar, farmers faced alternating droughts and floods depending on the rapidly shifting monsoon rains.

Despite government efforts to create programs that help farmer vulnerability, many farmers are unable to access these benefits. Tenant farmers often have low education levels, and subsequently are unaware of government programs. Any allowances from such programs are usually claimed by land owners, while the tenants who actually farm the land receive no government assistance. The lack of education also culminates in a shortage of credit access, as a majority of small farmers cannot access institutional credit without proper land documentation. These workers primarily depend on village traders, who give them pre-harvest loans. Mr. Kumar explained that farmers do not typically approach government banks for loans, due to the widespread corruption of many banking officials. For example,

Mr. Kumar disclosed that public servants at banks often charge a 30% commission for filing the appropriate paperwork, which makes it difficult for small farmers to repay their loans. Farmers typically take pre-harvest loans to buy seeds, fertilizer and pesticides. Low yields, unseasonal rains, and natural disasters are all major causes of food price fluctuations. If the profits from the yield are not enough to cover loans, then farmers are forced to accumulate debt for years on end. The cycle continues as traders continue making profits on the produce, while farmers are left in poverty. A survey commissioned by the National Bank for Agriculture and Rural Development and undertaken by Punjab Agriculture University found that marginalized farmers with smaller farms have six times more debt than industrialized large farm owners in the state of Punjab (The Diplomat).

In India, an estimated \$7 billion dollars worth of crops are lost every year to pests (Economic Times). This problem is only going to worsen in the future, as scientists predict that rising temperatures due to climate change not only increase the pest population, but also their metabolism. Insects burn calories at a faster rate when their surroundings heat up, forcing them to eat more. Elevated carbon dioxide levels can increase the levels of simple sugars in leaves and lower their nitrogen content. This means insects will consume more food in order to meet their metabolic requirements of nitrogen (India Climate Dialogue). The low purchasing power of small farmers in Bihar also means that they are often unable to afford pesticides. Although the government has programs to provide subsidized seeds and pesticides to farmers, a lack of awareness, along with corruption and inefficiency in the delivery system culminates in little to no benefits for farmers. Mr. Kumar confirmed that he is unable to rely on government supplied provisions because government programs are inefficient at providing seeds or pesticides in time for the crop.

The Indian government spends around 26 billion dollars on incentivizing farmers through fair value and the distribution of food grains to families below the poverty line. Farmers receive a basic support price for their produce, and families considered below the poverty line are provided rice, oil and lentils (in some states) at a subsidised rate from federal food shops across the country. However, the effects of these implements do not have widespread benefits as many impoverished individuals fall through the cracks of the system.

### **Solutions:**

**Promote Cooperative Farming Practices:** While there is an abundance of arable land in India, the properties are divided into small and scattered holdings by individual farmers, which decreases the farmers' negotiating power. Negotiating power is crucial as it enables farmers to obtain concessions from larger agencies, which promotes their economic independence and stability. The main reason why lands are fragmented into micro-farms is India's inheritance laws, which state that a father's land must be equally distributed amongst his sons. As a result, farm sizes have diminished with each passing generation. Along with the decreased negotiating power, there are a number of other disadvantages to small-scale farms. For example, irrigation is harder on fragmented fields, which means that a disproportionate amount of labor and time is expended manually watering compared to the yields produced. The government of India has attempted to enact legislation to consolidate individual farms; however, it has only been implemented in Punjab, Haryana, and some parts of Uttar Pradesh. Furthermore, this legislation has been largely unsuccessful at providing tangible benefits to farmers.

Alternatively, farmers should turn to cooperative farming, which allows farmers to share farming equipment and financial resources, giving them the ability to purchase higher quality seeds and fertilizer. Farmers can also construct cold storage facilities collectively in order to store their produce until they can find a competitive buyer. Cooperative farming also allows for support groups, in the case of an environmental catastrophe, and makes modern practices (like fertigation or drip irrigation) more affordable.

The national Co-operative Development Corporation was established in 1963 in India with the aim of promoting and financing rural cooperatives. Currently co-operative farming is very successful in dairy and sugar industries in India but they are not as popular in agriculture. Some states like Maharashtra and Gujarat have a number of successful farmer cooperatives but in Bihar there are not many successful farmer cooperatives. Most of the existing cooperatives in the state are promoted by the government, which leaves the decision making mostly in the hands of a select few with influence. Small farmers have very little say in these decisions, leading to very little benefit (Tata Cornell Institute). The existing cooperatives in Bihar have multiple issues, such as no accountability, a surplus of members, membership restrictions based on caste and control by non-farmers etc.,

The government, rather than trying to create and run the cooperatives, should provide education, guidelines and incentives to farmers to create and run the cooperatives on their own. The cooperatives should ideally not have more than 500 members so that the concerns of individual farmers are not lost. They must have a member elected body to create guidelines for incentives and penalties for farmers to ensure accountability in the quality of produce. Having produce differentiation and labeling (based on quality) has shown to help farmers gain a better income for high quality produce.

An example of one such successful co-operative group is MAHA Farmers Producer Co., Ltd (MAHAFPC). There are over 200 Farmer Producer Companies (FPCs) under MAHA in the state of Maharashtra, and each individual FPC caters to an average of 300 to 500 farmers in their area. These farmers are able to participate in government aid programs and receive fair prices for their produce because they are represented by FPCs in the market. FPCs also help mitigate the corrupt practices of “middlemen” by allowing farmers to receive benefits directly from the government.

**Raise Farmers’ Awareness of Modern Climate Smart Agricultural Practices:** Farmers must be provided greater educational opportunities to learn about modern agricultural practices, including crop diversification, use of drought and flood resistant seed varieties and water management techniques.

- ***Crop Diversification:*** The diversification of crops improves their resilience to climate volatility and promotes the ability to suppress pest outbreaks (BioScience). Farmers can assist in creating biotic barriers against new pests by increasing the plant diversity of their farms in ways that promote the proliferation of natural pest predators. Spatial and temporal distributions of plant species that mimic natural systems will be able to maintain greater diversity of species and therefore lead to greater natural enemies of crop pests. Programs to educate farmers and provide assistance in picking the right combination and schedule of crops can increase crop yields and mitigate the impact of climate volatility.
- ***Use of Climate Resistant Variety:*** Farmers must be provided subsidized seeds or educated about the adoption of climate resistant seed varieties. For example, certain varieties of rice (Ex. Scuba rice) can withstand up to 17 days of complete water submersion, while Sahbhagi Dhan or Sushk Samrat rice varieties are drought resistant. Depending on the regional susceptibility to climate events, an education in the essential information about seed varieties could assist farmers in lessening damages stemming from natural calamities. Furthermore, rice and wheat are both highly sensitive to temperature fluctuations, making them more susceptible to climate volatility. Rice in particular is arduous to farm, because it is exceedingly water-intensive and requires a very particular temperature. Currently, the government provides a guaranteed minimum price support for rice and wheat crops. Unfortunately, this discourages farmers from attempting to plant other crops which might actually have a greater return on their investment. The government could also incentivize greater cultivation of climate resistant crops (Ex. millets) that are also more nutritionally balanced, rather than relying solely on wheat and rice.

- ***Sustainable Agriculture Practices:*** Smart management of fertilizers is crucial for decreasing greenhouse gas emissions, while also increasing crop yields. Using higher amounts of organic carbon in fertilizer is beneficial in reducing N<sub>2</sub>O emissions for farms where the water index is low due to rapid percolation of water (EDF Report). Increasing soil organic carbon stocks on a large scale is crucial for climate change mitigation, as carbon in soils can be stored for long periods, and is therefore secured in biomass and prevented from entering the atmosphere (UC Davis). This process, called carbon sequestration, also benefits farmers by increasing crop yields through greater overall soil quality. In the United States, croplands and forests currently sequester around 12% of all carbon emissions (ATTRA Sustainable Agriculture Program). Changes in soil management techniques could potentially return more than two thirds of carbon lost from soils back underground (Ohio State University).
- ***Water management techniques:*** Greater education in drip or micro-irrigation techniques would be beneficial in furthering water conservation efforts, as well as increase crop yields. Keeping the water index for rice farming near 250 cm of water facilitates shallow flooding and prevents extensive loss of crops, and implementing watersheds is highly effective at mitigating flooding by reducing surface runoff, increasing groundwater infiltration, and decreasing surface travel time (American Water Resources Association).
- ***Restoration of Degraded Land***  
About 33% of viable land in Bihar has been degraded due to faulty agricultural practices, soil erosion from water and wind, as well as deforestation (Agriculture Research). This is problematic, because degraded farmland causes low agricultural yield. Studies show that stopping ploughing and planting cover crops directly after harvesting will preserve moisture and replenish soil nutrients. During floods, using mineral fertilizers can result in runoffs that are harmful to the surrounding environment. Using organic manure and compost helps reduce runoff and bio-waste, while also allowing waste to be reused in farms, increasing soil nutrients and decreasing the use of mineral fertilizers. The government could also implement incentives to rotate fields in order to allow restoration of soil nutrients and prevent over-farming of land.

**Flood Preparation :** A well maintained drainage system is critical for protecting farmland in the case of floods. Channels and culverts must be continuously maintained in order to ensure proper drainage. Creating run-off ponds and sediment traps on farms would help mitigate the damages of floods. Furthermore, discharging roof water into swales and/or soakaways around the farm to slow water down would help recharge groundwater, improving surrounding water saturation and availability. Improving the rate at which water gets through the surface and into the soil (water infiltration) can help prevent flooding and replenish groundwater, while also increasing the water concentration held in the soil. Another way to recharge groundwater is to loosen the soil to leave a rough surface after harvesting, which allows more water to soak in, preventing run-off which depletes soil nutrients and causes soil erosion (Farmers Weekly).

**Tank Irrigation :** Tank irrigation is a possible solution which could mitigate the effects of the water scarcity crisis. Utilizing an ancient method of building artificial reservoirs (mostly dug outs or enclosed bunds), tank irrigation allows farmers to harvest and store monsoonal rainwater, which can be used for irrigation and drinking water during dry spells. Locally elected governing bodies in villages, called panchayats, should be supplied government funding in order to build and maintain tanks and aid water management during dry seasons. These tanks are known to help increase ground water levels and also reduce water runoffs into rivers during heavy rains.

Tank irrigation has already been established in the state of Telangana, which implemented the Mission Kakatiya project in 2015. The project, which aimed to restore silt-filled tanks and ponds in villages across the state, successfully restored 46,531 ancient minor irrigation tanks. Each tank aimed to irrigate 2 million acres of farmland, and the silt (rich in soil nutrients) removed from the dilapidated tanks was reused as fertilizer on farmers' fields (Government of Telangana: Mission Kakatiya). Farmers in Telangana have suffered for decades due to the persistent lack of water. The Kakatiya project successfully improved crop quality and productivity, raised the groundwater table from 6% to 9%, and restored the livelihoods of the fishing community.

**Subsidize Diverse Food Groups :** Currently, the Indian government provides grains at subsidized prices for low-income families. While this is a step in the right direction, individuals require more than carbohydrates alone in order to meet the necessary nutritional requirements for a healthy diet. A majority of small farmers in Bihar do not make enough income to afford fruits or vegetables. Furthermore, any livestock they maintain is to compensate for income and not for consumption, which means that sources of protein are scarce. In order to decrease the high malnutrition levels in the farmer population, the government must help subsidize other necessary food groups (such as proteins and vegetables).

### **Conclusion:**

In conclusion, the system of distribution in India for agricultural aid has been ineffective in solving for poverty and hunger. India's growing population has led to a greater demand for food and resources, while extreme weather events and rising temperatures have led to decreased crop yields. In the last five years, the number of food insecure people in India increased by 62 million people, and child wasting and stunting rates have worsened (NFHS). Furthermore, the rising prevalence of droughts, floods, and tropical storms puts property, livelihoods, and lives at risk. Over 2,400 Indians were killed in extreme weather events in 2019 (The Hindu), and millions were displaced by cyclones and floods. Agricultural production has also reduced, as crops are highly sensitive to changes in temperature and precipitation and thus are drastically affected by climate anomalies. Bihar's low agricultural productivity can largely be attributed to volatile and unpredictable weather conditions (Indian Council for Research on International Economic Relations). Without extensive efforts on local, state and national levels to reduce greenhouse gas emissions and mitigate climate change impacts, instability in the agricultural sector will worsen. Proactive measures on part of the government of India and non-profit organizations are necessary to prevent greater malnutrition, poverty, and exploitation of India's vulnerable population.

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