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# Into the New Age of Sustainable Agriculture and Policy Planning Process in Punjab Post Green Revolution

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***Abstract*—** *This literature review and analysis aims to examine the shortcomings of current agricultural initiatives in India, focusing on the region of Punjab. Successful, sustainable policies must consider the behaviours and motivations of the audience in order to desire a change. A systematic approach, coupled with behaviour analysis, is explored in this paper to help inform policymakers during the planning process to minimize potential limitations towards food security and sustainable agriculture.*

***Keywords*—** *Sustainable agriculture, policy, Punjab, behaviour change, Green Revolution.*

## I. INTRODUCTION

Current global agricultural practices are unsustainable for long-term land use. Unsustainable practices in agriculture in particular fail to consider the capacities of landscapes, assume infinite access to natural resources, and push the biosphere beyond its limits. In order to meet food security demands, land use systems have intensified, placing greater pressure on the environment (Anja et al., 2012). This dilemma has stimulated conversations around ways the world can better equip itself to be food secure. Climate change has further exacerbated the situation for farmers as increasingly variable climate and weather patterns (Priyadarshini et al., 2020) affect planning, planting, and harvesting, which requires intense adaptation practices that can be economically draining (Datta et al., 2022). The problem with inconsistent weather becomes more challenging when the consumer demand for produce is higher than the quality and quantity of crop available for consumption. The international food trade prices became challenging with increased transportation and energy costs, and the COVID-19 pandemic restrictions, leading to a record high of 48% of countries experienced high food prices in 2020 (United Nations, 2023). High food prices often requires government intervention, which may include subsidization, policies, regulations, and innovation. One of many examples is from the Philippines in the 1970s, where the country began to strive for food self-sufficiency, especially for rice, sugar, coconuts, and other high value crops. As the government decided to implement a subsidised credit-fertilizer extension program, the initial phase resulted in 40% of rice fields covered in subsidised fertilizer, relieving financial burdens during a competitive global market price for rice. Through the 1970s and 1980s, the Philippines was able to reach self-sufficiency. However, the success was short-lived as rice scarcity rose in the 1990s, (Djurfeldt et al., 2005) partially because policymakers only used one method of subsidization rather than a variety of options. Utilizing one method of assistance such as subsidization does not consider the variety of options that will deter from a single point of failure. Although subsidization aids farmers, it is not a long-term solution in terms of self-sufficiency in agriculture.

## II. INDIA AND THE GREEN REVOLUTION

Long-term success depends on consistent human decisions that work towards a similar goal. Agriculture and land use policies that aim to ignite behaviour change in farming practices should prioritize the target audience and decision-makers: small farmers. Farmers are at the "front lines" [Datta et al., 2022, p. 100543] of battling climate change, as they feel the first effects of shifting weather and depleting natural resources (Datta et al., 2022); therefore, this group is the focal audience for agricultural policies in India. If governance merely focuses on economic stimulation or consumer choice demand, then the internal motivation for the audience to effectively change behaviour and action will result in stagnant policies. An example of this includes the Green Revolution from 1970s through 1980s, particularly in India, where advanced technologies permeated to reduce imports of staple crops such as maize, wheat, sugarcane, and rice, and drive the country into self-sufficiency. Technologies included improved seed varieties, fertilizers, farm chemicals, and mechanized farming (Larson et al., 2004). The goal of this strategic change was to combat the challenges of price increases in imported foreign exchange requirements by becoming internally food secure; a similar thought process to the earlier example of the Philippines. Post-Green Revolution India did indeed transform the country into a food secure nation, with an increase of wheat by 366%, sugarcane by 152%, maize by 136%, and total food grains by 133% (Larson et al., 2004).

The largest contributors to this change were large scale farmers, particularly in Punjab and Haryana; small farmers opposed expensive investments of change such as deep wells to extract enough water to fill rice patties (Djurfeldt et al., 2005). Eighty-five percent of small farmers have low financial resiliency and cannot participate in risky investments (Datta et al., 2022). As the production of food was increasing, the



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population continued to grow exponentially, social systems failed to improve correspondingly, and this resulted in unequal food distribution. Wealthier states such as Bihar, Orissa, Madhya Pradesh and Rajasthan were prioritized for grain, while lower castes still suffered from unstable distributions (Djurfeldt et al., 2005). Subsidization is a flawed and inequitable scheme post-Green Revolution since farms with smaller percent areas receive less subsidies, and large farmers benefit more from subsidization programs, also seen in Table 1. The correlation between land area and financial assistance places smaller farms at a disadvantage, as small farmers individually only contribute an insignificant amount to the total production of grain (Ahluwalia et al., 2003).

TABLE 1: Percentage Distribution of Benefits of Input Subsidies across Farm-sizes Punjab (1995/96)

| | Marginal (<1ha) | Small (1-2ha) | Medium (2-6ha) | Large (>6ha) |
|---|---|---|---|---|
| Percent Area Cultivated | 3.0 | 5.8 | 41.1 | 50.2 |
| Percent Farms | 18.7 | 16.8 | 46.2 | 18.4 |
| Percentage Distribution of: Fertilizer Subsidy | 2.5 | 4.8 | 40.5 | 52.2 |
| Power Subsidy | 1.8 | 4.1 | 46.0 | 48.1 |
| Canal Water Subsidy | 1.4 | 3.6 | 39.9 | 55.1 |

Source: Ahluwalia, D. et al, 2003

This type of support has also deflated in funding since the price of agricultural subsidies has increased, but the national government continues support at the minimum support price (Singh, 2012). Although Punjab is one of the larger sectors of production, public expenditures are miniscule compared to other states, resulting in institutional limitations of improvement beyond the Green Revolution.

Even though the purpose of shifting to intense grain production was to help India reduce importation of rice, the inconsideration of farmers as the target audience of interest led to an overall decline in production over time. While rice production skyrocketed in Punjab during the Green Revolution, the fall of this momentum in public support contributed to the status of 40% farming employment, the lowest in India (Singh, 2012). Another example of inequality includes degradation of soil quality from intense influx of fertilizers and monocropping for decades coupled with financial inability to build efficient structures, such as vast water irrigation systems (Joshi et al., 1991). The success of policy is determined by crop yield and surplus, however, these indicators ignore the underlying social and economic issues that remain. Since the Green Revolution and its declination, India has now shifted goals towards sustainable agriculture and conservation. In the National Convention on Biological Diversity's fifth convention, India made promises on 11 biodiversity targets aiming for sustainable agriculture management, biodiversity education, diverse livestock production, and proliferation of resources to attain these goals (Ministry of Environment, Forest & Climate Change, 2014). Reimagining the role of agricultural policy as one that strives for these targets requires creative intervention strategies. Current literature that analyses potential impacts of agricultural policies in Punjab lacks focus on small farmers as the target audience and the behavior change necessary to mitigate policy resistance. Small farmers need to be the focal audience of the agricultural policy planning process, especially for equitable policies attempting to enforce more sustainable techniques. Therefore, this paper uses systems thinking as an effective diagramming technique to better visualize various stakeholders and components of implementing agricultural policies. In addition, we explore policy interventions that include thought processes such as backwards thinking and behavior analysis, which enhance success in helping the target audience of small farmers in Punjab. Ultimately, the goal is to paint a more comprehensive picture for guidance during the policy planning process.

Specifically, this study utilizes a three-part examination to visualize the current agricultural system in Punjab and strategize ways to overcome limitations on farmer behavior change. The integrated approach to this type of analysis keeps small farmers as the focal point of the policy implementation. This methodology will follow the Moser and Ekstrom (2010) policy analysis, which investigates challenges during the pre-planning process of policy-writing. In efforts to ensure policy implementation is sustainable for long-term success and mitigate policy resistance, a 1) systems thinking diagram is created as an example where moments of intervention points can occur in the farming structure in Punjab. To further understand the incentives and motivations of small farmers, this paper introduces 2) backwards thinking and behavior analysis as another imperative consideration to be a part of India's policy planning process. In addition to using this model, 3) an example of potential limits and barriers in agriculture policies is presented, attempting to influence better farming practices. This type of brainstorming portrays areas policy can overcome and events that will continue to hinder success in better agricultural practices for Punjab's environment and small farmers. The goal of the detailed and multi-dimensional analysis is to exemplify incorporation of these models as part of the pre-implementation or planning process of policy enactments in Punjab.

## III. Part 1, Systems Diagram, System of Concern: Agriculture in Punjab

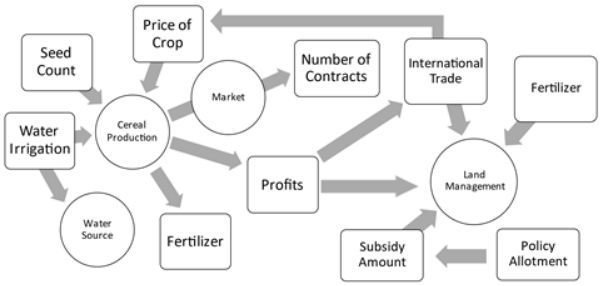


Figure 1. Inflows, outflows, and stocks in the agricultural system of Punjab, India

Systems comprise of interconnected elements that function for a purpose, which determines its behavior. Drastic or slight changes to a system can slowly change the behavior over time. A successful system aims for harmony in its cycles, function, and overall purpose (Meadows, pp. 16, 2008). Visualizing a

systems diagram is an efficient way to begin any planning process, although the focus of this analysis will be to visualize the overhead state of agriculture post-Green Revolution in Punjab.

Fig. 1 shows the interconnections between a range of factors in the agricultural system including cereal production, profits, land management, international trade, water source, market, and policy funding. Inflows and outflows are considered factors that affect the main foundations of a system, which includes all other elements impacting the state of the system. An increase or decrease of these flows affects the foundations, also called stocks, which change the behavior of a system (Meadows, pp. 17, 2008). During the Green Revolution, fast growing cereal seed varieties increased, fertilizer use increased to meet India's new goal of food security, tube wells and water irrigation increased (Joshi et al., 1991), profits increased, international trade increased, policy allotments supporting Green Revolution initiatives increased, and market availability (government fair price shops) increased (Witsoe, 2006). By increasing every inflow of a system, the outflow was greater profitability and food security by the 1990's (Larson et al., 2004), which changed the behavior of the agricultural system to produce abundant cereals.

The major intervention to change the function of the system during this time was subsidies. India provided subsidies for chemicals, particularly nitrogenous fertilizers, to meet minimum support prices from India's government (Witsoe, 2006), high-yielding variety seeds (Arora, 2013), and water irrigation structures (Gulati et al., 2017). Subsidies have been directed in different areas to improve production, but providing all the means to grow food does not inspire accountability for improper land management practices. For example, Punjab's tube well irrigation systems grew as the government provided more wells, shifting away from canals as the need for water was high. Punjab's water use continues to rise, decreasing the water table by 70 centimeters per year from 2008-2012 (Gulati et al., 2017). To meet food demands, water use only increases, and now the government has implemented another subsidy through the agricultural sustainable program, providing 80% subsidy for drip and sprinkler irrigation use instead of wells (Gulati et al., 2017). Additionally, power and energy for water pumps was free, promoting inefficient use of electricity and water. The availability of subsidies has also created a burden on state funding (Gulati et al., 2017). As chemical fertilizer subsidies became widely accessible and encouraged for production, soil testing was not required (Witsoe, 2006), which resulted Nitrogen, Phosphorus, Potassium ratio of 36:8.74:1, indicating high use of fertilizer urea (Gulati et al., 2017). This imbalance led to degradation of land fertility (Gulati et al., 2017) and soil health. The prevalence of these subsidies was a part of a greater government institutional change with the creation of Agricultural Prices Commission (now Commission for Agricultural Costs and Prices), the Food Corporation of India, the Central Warehousing Corporation, and State Agricultural Universities (Arora, 2013). The issue with this type of mass spending is there will be a cap as money is a limited resource. Since 1999, agricultural growth has only declined due to public extension programs or subsidies collapsing (Witsoe, 2006). The downfall of institutionalized assistance is the decision remains at the level of the decision makers in federal entities that plan, write, and execute policies, lacking realistic capacity building. A study interviewing citizens of Fiji inquired about their opinions of climate change agendas and policy implementations, which revealed people generally thought government officials had misconceptions about the capacity without proper understanding (Wong et al., 2013). In India, farmers had subtle reliance on extension services since they hardly had interactions with agents and did not receive proper knowledge of resources (Datta et al., 2022). These opinions can be addressed in the policy planning process by policymakers understanding the agricultural system and farmers as the consistent stakeholder within the system. In the case of Punjab, the national government decided to intervene in the system by spending funds on developing infrastructure for water or provide money for fertilizers, without realizing the non-renewability of resource depletion, which would eventually drop the success rate for a short-sighted plan. Since funds are a limited resource, using this strategy to increase inflows for production and profits eventually diminishes. The capacity of the environment and farmers to coordinate crop production at a profitable rate can be maintained by reimagining interventions in functional systems. The type of intervention, with a goal to fix the entire structure and intercede at one point in the system (single point of failure), becomes problematic over time, and is considered a trap (Meadows, pp.114, 2008). The trap in this case would be policy resistance, which arises when sub-systems have separate goals from the main system. The sub-system in this case would be a variety of subsidies and institutions set up that each have different directions and intensification of one sector reduces intensification of another. For example, the intense use of water, allowed and encouraged by policies during the Green Revolution, led to current depleting resources and increased extraction costs, becoming more of a financial burden instead of proper government assistance (Joshi et al., 1991). Ineffective, short-term solutions do not consider farmers as the center of the system because they only provide temporary relief within the government's capacity. The goal of irrigation subsidies and infrastructure was to provide funds so that India could be more self-sufficient, however, as water use intensified, the financial assistance and profits over time decreased, leading to long-term damages.

## IV. Analysis and Recommendations of Sustainable Agriculture as an Intervention Strategy

A current intervention strategy to address the negative effects of the Green Revolution is sustainable agriculture. The National Institution for Transforming India aims to monitor and create ministerial collaborations that meet Sustainable Development Goals (Priyadarshini et al., 2020). Since the initiation of Sustainable Development Goals, agriculture interventions have access to global initiative strategies, worldly visions, and data to create strategies that can assist in more sustainable practices. Ecosystem services are usually



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financially compensated by the state or national government, but this type of financial return are not long-term incentives for farmers to consider the impacts of environmentally damaging practices. Additionally, current approaches to educating and initiating sustainable practices are usually seen as inaccessible incentive for small farmers, discouraging organic methods (Priyadarshini et al., 2020). The Green Revolution fertilizer influx encouraged farmers to intensify chemicals for pest management and quality yield. After decades of believing and practicing these methods, which indeed was successful short-term, expectations to shift thinking towards new processes is unrealistic and produces limits for re-educating organic or sustainable farming methods. In order for policymakers to create better working regulations, knowing the current state of agricultural structure and the behaviors of stakeholders making decisions becomes a backbone for comprehensive understanding. In this paper, small farmers are the main stakeholders in the outlined system; however, this lens can be altered when viewing the agricultural system, depending on the goals and parties involved in the policymaking process; therefore, expansive research on policy adaptations through systematic thinking for sustainable agriculture is necessary.

At times, sustainable agriculture seems to heighten risk, as environmental regulations work to ensure public health, while farmers need results that meet consumer demand. Policies should strive to become a harmonizing middle ground, propelling activities while providing creative support. Sharing common goals and commitments, especially related to climate change, maintains cooperation between different sectors leading to productive actions. For example, the positive relationship between the German government and European Union (EU) along with a strong German ambition and like-minded states, led to achievements in renewable energy sources with 4.2% primary energy coming from renewable sources by 2006. German states supporting the national standard also contributed to administrative success (Weider et al., 2008). Although success is measured by direct, quantitative results, the impacts of a policy must have enhanced goals, where the policy can equip those closest to the problems, provide tangible incentives, and offer innovative resources, also knowns as backwards thinking.

## V. Introduction to Backwards Thinking

Backwards thinking encourages working from a particular behavior, thinking about the organization of stakeholders involved, operational workings, and for each level of implementation process, identify the target behaviors needed. This type of strategized perspective determines the root of a goal. On the other hand, policymakers tend to use forward mapping where a mission is defined, plans are outcome focused on a target population, and ideas are consistent with the end goal in mind. The fallback of this strategy is the assumption that policymakers control the governance of organizations or institutions (government entities, departments, and private parties), and processes that is a main contributor to successful implementation.

Backwards thinking questions if outcomes will increase likelihood of successful implementation by starting at the last stage or component of a problem instead of the first (Elmore, 1979). For example, the last stage of sustainable agriculture includes the small farmer practices and everyday duties as a part of their growing process. Focusing on the behavior of farmers allows better understanding of how the structure of the system, in this case sustainable agriculture, works from the lowest level. Backwards thinking targets the behavior of the system to create policy, instead of assuming the system already has resources in all units of organization (Elmore, 1979). This process in policymaking considers complex human behavior patterns. Analyses of farmer behaviors show age, gender, experience level, attitudes, and beliefs are all contributing characteristics of decision-making. Feelings of control in decision-making and self-efficacy (considering the Theory of Planned Behavior) are important for building farmers' confidence and belief in own autonomy. Policies that are not targeted to consider the behaviors will not be effective tools as they follow a one-size-fits-all method. Approaching people with ideas that are not easy to adopt or lack incentive will fail and are impractical for changing behavior (Rose et al., 2018b). Behavior change is not a limitation on climate change policy, rather a barrier that can be addressed under policy strategically utilized.

## VI. Part 2, Backwards Thinking Strategised for Farmers and Recommendations for Policy Planning

To utilize backwards thinking as a tool in understanding farmer priorities and patterns of behavior, we consider the factors outlined in Rose et al., 2018b. This publication exemplifies a comprehensive social science literature review and is used in conjunction with the analysis of backwards thinking, another strategy to understand farmers. This paper combines the two ideologies (systems thinking and backwards thinking) into one method that can be adopted in the policy planning process. The first consideration in backwards thinking is *personal*, which encompasses age, experience, and attitude. A study found a negative correlation between increasing farmer age and adoption of risk management practices in Ethiopia (CITATION). As farmers increase in age, there may be a tendency to be less reactive towards changing practices or new forms of agriculture. Another example includes personal beliefs, where farmers in the UK with strong values followed through in revising environmental management. According to Rose (2018b), farmer decision making is impacted by *family, friends, and peers*. If these parties are influential to farmers, it is also important to include these groups in education or outreach efforts pertaining to encouraging a change in management practices to align with sustainable agriculture goals. Additionally, *trusted* advisors have an influence on farmers' decisions. In the Netherlands, ranchers changed their animal husbandry habits and techniques because health and feed advisors suggested certain changes. In India, a study by Platt et al. (2021) states that there is a collective belief that embodies the community's opinions, attitudes, and adaptation likeliness (Datta et al., 2022). A collective belief such as adopting sustainable agricultural

practices can influence farmers to either continue traditional methods or change. A more social concept is *societal pressure*, which has shown to affect farmer decisions in Cambodia and Mexico, as this type of pressure changed their approach to animal welfare. As more farmers take advantage of new initiatives and support from the federal government in adopting sustainable techniques that also meet national goals, the domino affect can create this social pressure for laggards or farmers unwilling to change. Another factor is ensuring a *sense of control in decision-making*, which can be difficult to navigate if the goal is to entrust farmers to choose sustainable agriculture.

Since agricultural policies guide the behavior and decisions of farmers, its useful to explore the types of policy instruments that encourage or influence certain decisions. Understanding ways policies can insist decision-makers can be powerful. Opt-out policies are a type of policy defined as those that allow people to make decisions based on their own knowledge and willingness to learn, enveloping a sense of control (Keller et al., 2011). An example of opt-out policy are subsidizations for fertilizers during the Green Revolution, which were widely available, though not required. Farmers could either use or not use fertilizers, and the policy displayed active choice for farmers to opt-in or opt-out of policy guideline use to receive financial assistance. Another example of active choice is farmers taking advantage of open policies and unregulated water use, leading to excessive water consumption for grain production. Eventually, the availability of water plateaued and declined, negatively impacting long-term cereal sufficiency, a result that counterintuitively deters away from the initial aim of the Green Revolution. Resource depletion, an outcome of a policy meant to help India reach self-sufficiency, displays the ineffectiveness of opt-out policies. India's national target five of the Convention on Biological Diversity, aims to ensure sustainable management is adopted in agriculture, forestry, and fisheries by 2020 (Ministry of Environment, Forest & Climate Change, 2014). In order to meet this commitment, opt-out policies must hold accountability over short-sighted decisions from farmers. A way to combat this behavior is inviting forced decision-making or enhanced active choice (Keller et al., 2011), a proposed decision-making theory that allows for this sense of control, while encouraging a direction with more power and overcoming resistance to utilize sustainable techniques. Instead of waiting on respondents to opt-in to the best decision, people are required to decide either one or the other; in this example, a possible active decision-making policy would either influence farmers to use drip irrigation systems by providing infrastructure resources or farmers can continue to use tube wells and pay fees for excess water use. If federal support is providing resource and infrastructure assistance, then it will serve as an attractive option to push for more sustainable choices. It's also beneficial to remind people of all they lose if they opt out of the un-preferred alternative. Decision-makers are unlikely to seek thorough information about costs, risks, and benefits (Keller et al., 2011). Therefore, proper advocacy through outreach of preferred alternatives is a powerful tool to ensure education. Indian farmers lack trust in the government because they are unaware of resources or information on better farming strategies and technologies (Datta et al., 2022). Expansive outreach of federal and local programs can bridge this mistrust and encourage policy adaptation in their practices. This can be coupled with enhanced active choice, which allows for self-efficacy, as decision-makers are not forced to make a certain decision, but instead are aware of resources, financial assistance, technical assistance, educational opportunities, networking events, marketing strategies, and other training methods. Compliance based rewards are also tools that can encourage consistent compatibility between farm management strategies and policies.

Sustainability requires longevity in motivation, thus various forms of incentivization are imperative for farmer success. Innovation involves more than technological advancements or opportunities; it requires creative thinking. In Indonesia, one of the large failures of reaching self-sufficiency was the focus on seeds, fertilizer, training, and credits. This approach provided education for using new practices but did not provide tangible long-term solutions to maintain these new technologies. Although the yield was greater with adjustments in practices, Indonesian farmers were unable to sell at profitable prices for surplus rice (Djurfeldt et al., 2005). Training or knowledge for enhanced land use may stimulate higher production and profits, but these efforts must also consider farmers' needs beyond decades of yield (Rose et al., 2018a). These needs could be guaranteed buyers at competitive prices or consistent financial public support for improved agricultural techniques such as pest management that includes biological and chemical methods (Rose et al., 2018a). Providing incentives with consistency and risk management equips small farmers with abilities to practice integrated farming techniques or experiment non-invasive practices towards sustainable development goals. Using backwards thinking and behavior analysis to perceive the innumerable factors that affect farmer decision-making is most impactful when still planning the policy. This type of lens improves realistic guidelines and expectations that consider the farmer as the main audience to motivate for change that meets national goals. However, these tools are better used and executed when viewing human behavior to change through the Theory of Change.

### *A. Theory of Change in Backwards Thinking for sustainability*

The United Nations Development Group created a framework based on the Theory of Change (United Nations Sustainable Development Group, 2017) to explore interventions that lead to development change based on evidence, evaluation, and monitoring. The first step in the process includes identifying whether 1) proposed opportunities hold equity across society and 2) the government has the capacity to affect lasting change. Adopting aspects of this framework can be applied in the policy planning as well, where policymakers discuss the projects or changes that will benefit all members of the community and whether the Indian government can support proposed efforts long-term. To



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supplement this initial step, policymakers should identify root causes and reasons certain groups are left behind. This assessment would assist in understanding the differences between small and large farmers, or farmers who have many selling contracts versus those that have few to none and are not considered competitive in the market. Additionally, due to India's ongoing caste system and gender disparities, farmers with more financial means and male farmers have greater access to resources (Datta et al., 2022). These long-standing cultural pillars need to be addressed to ensure all citizens have access. After evaluating the culture and livelihood of small farmers, the next step would be to identify assumptions that are made for results. During the Green Revolution, one of the of assumptions was resources will be available long term and India could continue growing cereals without changing practices within a few decades. Another factor in the process is risk analysis, where if an assumption is made and it is not correct, then it's necessary to know potential risks that may arise. In the same example of assuming infinite resource availability in the Green Revolution, the risk is intensified for farmers using the land generations later with depleted water levels, the soil, surrounding natural habitat, and surrounding non-agricultural industries using shared water sources. The following step includes identifying partners and key actors in the system. This particular step of establishing participants connects back with the systems diagram, where a sub-system includes a map of key stakeholders and their involvement in sustainable agriculture. This is yet another tool to be used in the process to comprehend the dynamic connections between main and sub-systems.

## VII. Part 3, Understanding Limits and Barriers in Systems When Writing Policies

TABLE 2: Potential limits and barriers to implementing policies in sustainable agriculture

| Barrier | Implementation issues |
|---|---|
| Resource knowledge | Current gaps in outreach<br>Uncollaborated education efforts |
| Data collection on land management practices | Data collection is scattered<br>Federal website accessibilities |
| Resources for sustainable development | Insufficient framing of goals to include farmer incentivization and collaboration |
| Opt-out policies | Farmers as decision-makers do not have to follow sustainable methods as a requirement |

One of the most prominent issues in federal policies in India is the lack of collaboration between ministries and initiatives. A model of success includes the National Climate Change Committee in Vietnam, which works to funnel climate change into policy. There are various policies in different ministries causing policy overlap, and resulting in similar objectives without collaboration horizontally (across organizations) (Giles et al., 2021). It is necessary to understand cooperative systems and the effect regulations may have on positive relationships that already exist or the possibility of negative ones. When considering adaptation strategies in climate change policies, exploring limitations and barriers is important in decision-making focus groups. The Intergovernmental Panel on Climate Change (IPCC) and supporting research explains that limitations refer to obstacles that are absolute, where the systems cannot be modified; while barriers are obstacles that can be overcome with the power of will, creativity, support, resources, and effort (Moser et al., 2010).

Systematic land use planning (Symes et al., 2020) in conjunction with Table 2 of limitations and barriers can also be used to develop best practices for land use that serve farmers, consumers, future resources, and ecosystem services. This type of dynamic structure poses innumerable obstacles, where each stakeholder within the system must compromise. Policy-resistant systems rely on different parts of the system working towards the common and individual goal. Any time one or more part(s) of the system is intensified or diminished in its efforts, overtime, the system will become a degradation of the original system (Meadows, pp. 28, 2008). Therefore, brainstorming in the planning process the areas in the system where barriers may arise and can be overcome suppresses the resistance from policies, that do not hold power over influencing better decisions from farmers.

In order to enhance knowledge and resource availability, various organizations supported by the federal government should practice inter-coordination through similar goals (Masud et al., 2023) and horizontal cooperation between the differ agencies (Anja et al., 2012). There are several projects and initiatives, many accessible under the National Informatics Centre of India, highlighted in Fig 2.

The problem with these interventions (Fig. 2) is they work separately. Coordination of these projects and merging projects with similar goals (Masud et al., 2023) enhances the capacity, outreach, and overall impact than a scattered approach. Nationally set indicators to measure policy enforcement is a necessary factor to combat the barrier of measuring success rates. Data collection and storage becomes increasingly necessary for coordinated efforts to show success and areas for improvement.

## VIII. Recommendations to Enhance Data Collection and Improve Agricultural Planning During the Planning Process

An overlooked importance for success that would address these limitations is better data and agricultural planning. Following the theory of change framework requires intense collection of data and expertise to properly implement in the policy planning process. To ensure the projects are creating change over time also requires consistent inclusion of data scientists and collectors in policy implementation processes. A method to uncover barriers in policy implementation includes coupling backwards mapping and the theory of change frameworks to brainstorm potential trends of behaviors in farmers. Since Punjab was chosen as the region to grow rice, and was compelled to produce enough for India's self-sufficiency, the failure to use scientific and economic knowledge, expertise to maintain soil quality, climate change related data such as meteorology, water management strategies for long-term water access, and infrastructure maintenance, obstructed the success of the Green Revolution and post-Green Revolution. Punjab practices the most



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intensive agriculture, with the highest use of fertilizers, tractors, and pesticides, and even groundwater exploitation (141% average total in region) (Ahluwalia, 2003). These practices negatively affect ecosystem services such as biodiversity and ecological stability (Priyadarshini et al., 2020), but these services fail to become valuable as financial net profits are the main goal in sight for farmers. Although soil quality and water degradation may be studied and researched, the reality of addressing these concerns to farmers may seem a barrier, especially since knowledge pushes towards preservation of land ecology and sustainable land use.

| Name of Intervention | Focus area/ objective | Fund allocated | Name of Intervention |
|---|---|---|---|
| National Food Security Mission (NFSM) | Mission targets to increase the annual production of rice, wheat, pulses, Nutri-cereals, oilseeds and commercial crops | 167653.39 lakhs released in 2019 for various schemes under NFSM to various states | Pulses production: 22.95; Rice production: 110.15; Wheat production: 98.38 million tonnes achieved in 2016−17 |
| Mission for Integrated Development of Horticulture (MIDH) | Targets holistic growth of horticulture sector in India by covering fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, coconut, cashew, cocoa and bamboo | 60 % of the total outlay borne by the Centre and 40 % by the State Governments | Production of horticultural crops reached 305.4 million tonnes in 2017−18 |
| National Mission on Sustainable Agriculture (NMSA) | | | |
| Soil Health Card (SHC) Scheme | Soil health testing, crop specific recommendations for nutrient application | 2010−14: 55.95 crore; 2014−2018: 1234.97 crore | Two cycles initiated with distribution of 10,73,89,421 and 11,21,37,259 SHCs |
| Sub mission on Agroforestry | Mission targets tree plantation in an integrated manner with crops and ensures availability of quality planting material | 60:40 between Central and State governments while 90:10 for NE and hilly states; 67,48,27,000 allocated in 2018−19 | Mission has planted more than one crore trees over 21,000 ha |
| Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) | organic farming development in the NE states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim | 2016−18: 400 crore | Of the total 50,000 ha targeted 45,863 brought under organic farming |
| Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) | enhancement of precision irrigation (micro and drip) systems, aquifer recharge and sustainable water conservation practices | 2015−16: 5300 crore | A total of 11.58 lakh hectare has been brought under micro irrigation (drip and sprinkler) in 2018−19 covering an area of 257.95 thousand hectares |
| Paramparagat Krishi Vikas Yojana (PKVY) | promotion of sustainable farming practices, farmer empowerment through increase in income, adoption of organic farming, production of chemical free and nutritious food | 500 lakh for every cluster of 1000 ha | approval of 10,000 clusters for promotion of organic farming |
| National Crop Insurance Programme (NICP) | | | |

Figure 2. Policy interventions and missions related to food security
Source: Priyadarshini , P., and Chirakkuzhyil Abhilash, P, 2020

Focusing on collecting, cleaning, analyzing, and sharing data on current agricultural practices or opinions of small farmers is important to compare successes and failures. According to a literature review by Burton et al. (2013), there are a handful of requirements that indicators should fulfil. Indicators should be measurable and identifiable, where monitoring can be easily replicated and promoted. Indicators should also fit the goals of agriculture, be consistent with biodiversity or ecological goals, and should not damage or affect production, so it is necessary to focus on species or habitat importance that is worth collecting. Indicators need to reflect the effort and management strategies of farmers. These factors require a direct line of communication with farmers and farmer knowledge of the necessity of data. Overall, using these indicators to create a cohesive plan for data collection and using scientific expertise to analyze the data and determine effectiveness of projects, policies, and initiatives is another essential part of the policy planning process.

## IX. Conclusion

The purpose of this literature review and corresponding analysis is to suggest revisions and additions to the policy planning process for sustainable agriculture in India, especially policies tailored towards Punjab. The three-part process (systems thinking, backwards thinking, and identification of limits and barriers) weaves the various aspects of policy and human behavior. Punjab has remained an important state in India's food sufficiency goals in India's Green Revolution and will continue to play an important role in food security. However, future goals in sustainability and environmentally conscious land use practices require innovative thinking strategies. Creating a systems diagram of the stakeholders, processes, outcomes, resources, and entities involved in a functioning system is a beginning point for planning where policies can intervene for long-term success. However, to ensure a realistic understanding of policy enactment, it is vital to include behavior analyses such as backwards thinking and theory of change in the planning process. This perspective mitigates policy failures during the implementation and monitoring phase, where farmer behaviors are unexpected or unaligned with policy goals due to naive expectations. In conjunction with this perspective, intervention strategies can also have limits and barriers, which are important to identify in the planning phase to avoid shocks during the implementation phase. If limits cannot be overcome, then this must be another consideration in the policy, while strategies to pass through barriers can create more successful and comprehensive intervention plans. While

writing policies, including better data monitoring techniques will allow India to show various, dynamic changes over time. Complete and persistent data collection will exhibit policy intervention strategies successes and failures. This paper displays one of many combinations of brainstorming ideas during the policy planning process, but highlights small farmers as the audience, as they are the ultimate decision-makers for a sustainable future and biosphere.

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