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Understanding India's Green Revolution:  
A Case Study for Contemporary  
Agrarian Reform

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Understanding India's Green Revolution:  
A Case Study for Contemporary Agrarian Reform

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### **Abstract**

Faced with large-scale food insecurity in the mid-twentieth century, India adopted innovative agricultural technologies as part of the Green Revolution. While these technologies expanded agricultural productivity, this paper argues that the program was a disruptive force to Indian social, economic, and political systems, specifically in the rural setting. An analysis of outcomes of the Green Revolution reveals that inadequate attention was given to India's unique colonial history as well as to the regional differences, both ecological and socioeconomic, found within the country. Advocating for a holistic approach to global development, this paper offers a framework of policy recommendations aimed at minimizing the disruptive potential for contemporary agrarian reform. The potential for disconnect between economics and social systems is a major theme throughout.

**Keywords:** India, Green Revolution, Post-Colonialism, Agrarian Reform

## Introduction

Despite astonishing growth and modernization following economic liberalization in 1991, India currently faces widespread food insecurity alongside high rates of rural poverty and wealth inequality (Dutta, 2012). The prevalence of undernourishment<sup>1</sup> in the country, currently stagnant at 15%, is two percentage points higher than that of the average for developing countries and more than 10 points higher than that of the average for developed countries (UN FAO). In an address to the Indian Council of Agricultural Research (ICAR) in July 2015, Prime Minister Narendra Modi highlighted the need for agricultural reform and development in the country (Deogharia, 2015). Citing numerous challenges including decreasing crop yields, rural-to-urban development patterns, and increases in population, Modi asserts that contemporary India's agricultural trajectory is fraught with challenges and posits India on a path to sustained food insecurity. Modi's call for massive agricultural reform is not unique in the historical development of agriculture in India or the Global South; the mid-twentieth century saw extensive agricultural expansion and modernization in Asia, Africa, and South America under the Green Revolution, which was a package of agricultural technologies introduced by the West via regional research institutions. While the Green Revolution was successful in expanding crop yields, the program is seen as economically, socially, and politically disruptive in many of the places in which it was introduced (Shiva, 1991, 1993, 2000).

This paper argues that in the case of India, the Green Revolution's lack of regional specificities, both on a global and a national scale, is to blame for the program's disruptive outcomes; however, responsible agrarian reform is possible, so long as the appropriate

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<sup>1</sup> The prevalence of undernourishment gives "the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover his/her energy requirement for an active and healthy life" (UN FAO).

considerations are made. This argument is developed in four major sections; first, the historical context of colonialism in India is explored, followed by a brief global contextualization of the Green Revolution. Second, analyses of the specific outcomes of the Green Revolution in India are examined, with attention paid to issues of inequality, rural access, and social change. Third, the contemporary demographic, agricultural, and economic contexts of India are surveyed. Fourth, policy recommendations for contemporary agrarian reform are made, using India's experience with, and the outcomes of, the first Green Revolution as a guide within which to frame such recommendations.

## **Background – Exploring the Historical Context**

### *Colonialism and the First Green Revolution*

In the early twentieth century, India was faced with a confluence of economic, political, and demographic factors that posited the country on a path to widespread food insecurity. India's political and economic situation during this period (1900-1950) were linked in a distinct and unique way, whereby colonial systems of political control were subsidiary to those of economic control. In the preceding periods of history, India was subject to the mercantilist agenda of the British East India Company (BEIC), which first arrived in the country in the early seventeenth century and began expanding its influence in the country from the mid-seventeenth century, and later was subject to the colonialist agenda of the British crown itself. The history of the BEIC in India is convoluted and in many cases very regionally specific, but a basic knowledge of the colonial history is imperative if one is to make an appropriate analysis of the country's agricultural modernization later in the mid-twentieth century, which occurred in the context of a colonial history and not the absence thereof. The BEIC's initial interactions with India did not

assert a political dominance, but instead focused on the material extraction of value from the country, with a focus on silk, spice, gunpowder, tea, etc. (Parayil, 1992). As the BEIC's business grew over time, so did the company's claims to other, broader rights. The BEIC began tax collections, but as previously mentioned, the specifics of these programs varied widely by region (Iverson et al., 2013). What is important to note however, is that the BEIC's sphere of influence had been solidified in the country and was spreading beyond the original mission of the company. While the BEIC originally began as a trading company, its sphere of control now encompassed both political and economic dominance over the country; the company had effectively colonized and ruled India and a variety of adjacent territories.

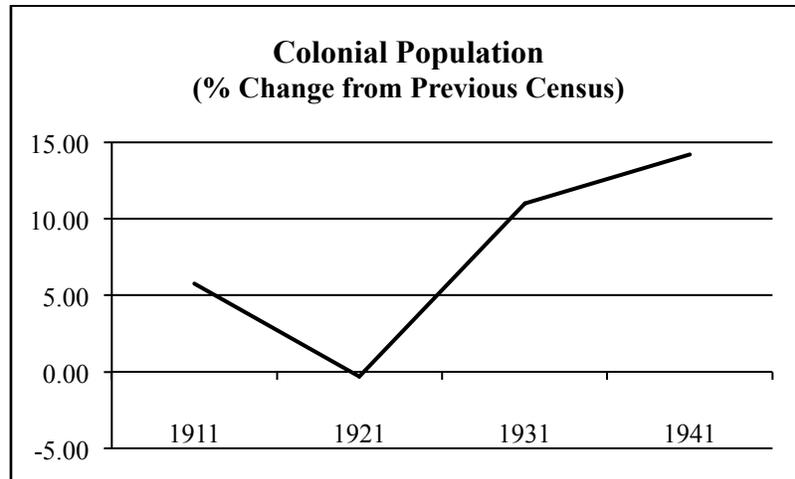
In the late eighteenth and early nineteenth centuries, the British parliament passed a series of resolutions, which established the BEIC as ultimately subservient to the British crown and divided the political and economic functions of the BEIC. Although the BEIC would retain administrative control over India and adjacent territories, the crown effectively claimed India as one of its own colonial holdings. These developments brought India closer to full, "official" colonization, but in practice, the country had already been subservient to the Western colonial project for almost two centuries to some extent. At the end of the nineteenth century, the final log was thrown into India's pyre as parliament dissolved the BEIC and established the British crown as the only legitimate ruler of the country. Queen Victoria became the first Empress of India and British control of India continued until August 1947 when the Indian National Congress raised the Indian flag over the Red Fort in Delhi. While the history of the Indian independence movement is vastly more complex than the raising of a national flag, the specifics of this movement are not requisite to achieve the aims of this paper.

India's unique colonial history, as outlined above, contributed directly to the political and economic situation that placed India at risk for widespread food insecurity by the mid-twentieth century. With a lack of strong, stable, or autonomous political control for the preceding two centuries, India lacked the ability to adequately direct policy at addressing issues of food security or rural poverty alleviation (Sharma, 1997). The political motivation for economic policymaking had all been directed at fulfilling the mercantilist and extractive agenda of the British crown and its subsidiaries. Given this objective of extraction, efforts were not made to develop the necessary infrastructure that could sustain large-scale food production to meet the needs of a growing and developing country (Sharma). While most countries facing rapid population growth would divert efforts to food production, India's agricultural output remained devoted to those cash crops that would benefit the BEIC and the Raj most directly.

As alluded to above, in the first half of the twentieth century, India's population was growing faster than was agricultural productivity, as was the case for many countries in Asia. Tabulations from the Census of India reveal that despite a decrease in the rate of population growth from 1911 to 1921, the rate of growth increased from 1921 to 1941, which was the last colonial census (see Figure 2).<sup>2</sup> Of note, changes in the rate of population growth from 1921 to 1941 show significant increases, soaring from -0.31% to 14.22%. Thus, an examination of demographics in India in the period of 1900-1950 reveals the third major factor (economic, political, and demographic) that posited India along a path towards widespread food insecurity.

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<sup>2</sup> Decennial population censuses began in 1871 under the colonial administration and were continued by the national government following independence. Colonial enumerations of population lacked consistency for a variety of reasons, but the Indian government has made attempts to correct for these inaccuracies.



*Figure 1, Source: Census of India*

While this paper specifically examines India, it is imperative to understand that the country was not a unique or isolated case. Across Asia, Africa, and other regions of the Global South, countries and regimes were facing similar situations, which contributed to a widespread and global demand for strategies and systems aimed at eliminating, or at least alleviating, food insecurity and rural poverty. A lack of investment in agricultural research and modernization meant that much of the developing world, including India, was still employing traditional, non-industrialized methods of agriculture for domestic food production. As populations grew and economies began to modernize, the food systems were not given adequate attention and thus widespread, global food insecurity as an issue moved to the forefront of international concern.

Citing an intention for international aid and goodwill, countries in the developed world began initiatives that aimed to provide meaningful agricultural research to improve the productivity of food systems in the Global South. The developments resulting from these initiatives are collectively referred to as the Green Revolution. Backed by many major, private organizations in the United States (e.g. the Ford and Rockefeller Foundations), the Green Revolution is seen by some as a neo-colonialist project whose main aim was the integration of agriculture into a global economic system (Shiva 1991, 1993, 2000). Nevertheless, the Green

Revolution did in fact boost crop yields and provide for the basic nutritional needs of some those who would not otherwise have received it (explored more fully below; see Figure 2). However, the scheme wrought havoc on a previously healthy and almost self-correcting environmental system and did little to provide equitable economic outcomes for all players in the agricultural sectors of individual countries (Shiva).

Of particular importance to understanding the Green Revolution in Asia is the establishment of the International Rice Research Institute (IRRI) in the Philippines in 1960.<sup>3</sup> The institute was founded with the financial support of the Ford Foundation, the Rockefeller Foundation, the Food and Agriculture Organization of the UN, the International Bank of Reconstruction and Development, the UN Development Program, and others. It is important to keep in mind the possible motivations and interests of the stakeholders when considering the actions of the IRRI.

The IRRI's central mandate was, and still is, to conduct research on rice agriculture in an effort to generate effective and feasible solutions for maintaining food security in rice-producing countries. The IRRI essentially created the Green Revolution for Asia, with the release of high-yield varieties (HYVs) of rice that had the potential to be immensely more productive than pre-existing varieties. The most notable of the HYVs released was IR8, which is also known as "Miracle Rice." IR8, introduced in 1966, was a semi-dwarf variety, whose shorter plant height meant that the plant was sturdier and that the "rice density" of a single plant was greater. In other words, there was a greater yield relative to the size of the actual plant. HYVs required

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<sup>3</sup> Emphasis is placed on cereals crops given that, culturally and historically, rice and a select few other cereals, such as wheat or millet, have traditionally been the predominant staple crops across Asia. Additionally, India's large vegetarian population increases the importance of cereals.

substantially greater inputs; IR8 required the use of chemical fertilizers, pesticides, herbicides, and an increased usage of water in order for the full potential of the variety to be realized.

Despite these additional costs for both producers and the environment, IR8 and the other HYVs introduced at this time proved to accomplish their goal of increasing cereal crop yields across Asia. Looking at the case of India, we see the same to be true. A simple analysis of crop yields for the country as a whole reveal that, on average, yields increased as a direct result of the introduction of HYVs and other Green Revolution technologies (see Figure 2).<sup>4</sup> When interpreting this figure, we must look at broad trends, as yearly variations are likely to be a reflection of confounding factors, such as climatic or macroeconomic variation (e.g. drought, unseasonal rain, recessions which affect supply or demand, etc.). From 1961 to 1967 we see a relatively flat trend in rice yields, whereas from 1967 to 2013, we see a trend of increasing rice yields. In the period from 1961 to 2013, rice yields expanded from 15,419 hectograms per hectare to 36,231 hectograms per hectare, an expansion of nearly 135%. Similar patterns are seen in aggregate cereal yields, with an expansion of 212% from 1961 to 2013 (UN FAO).

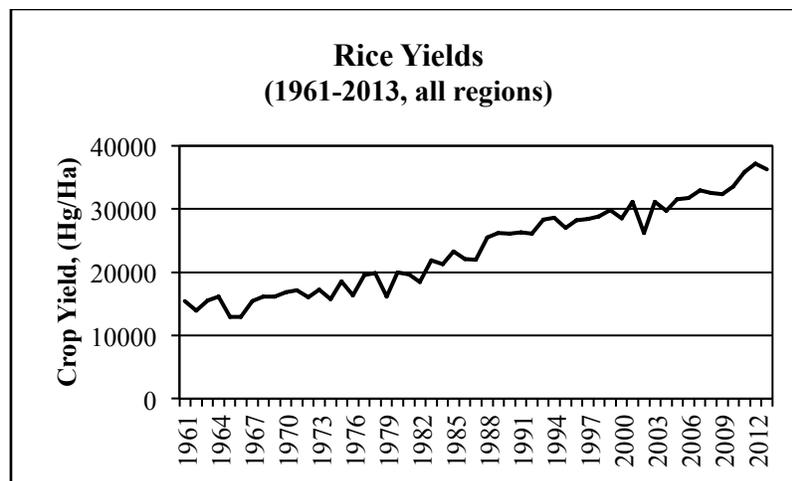


Figure 2, Source: UN FAO

<sup>4</sup> Using the measure of crop yield, denominated in hectograms per hectare directly measures the productivity of crops and is resistant to changes in confounding factors such as average plot size, the size and composition of agricultural producers, and land usage patterns.

## **Analysis – Outcomes and Related Case Studies**

While a preliminary analysis of the first Green Revolution has already been presented, the following sections serve to more fully develop an exploration of those outcomes related to issues of inequality, rural access, and social change. These issues will be developed across diverse themes, including: geographical disparities, firm-size disparities, rural access to financial capital and credit, rural access to public goods, shifts in producer-laborer relations, and labor migration. All themes are considered to have equal importance to this analysis, with the exception of geographical unevenness, which has had an especially profound impact in the Indian context and is thus given a particularly heavy emphasis. Ultimately, a discussion of results will attempt to synthesize the findings from the individual analyses; this synthesis will be used to generate policy recommendations for contemporary agrarian reform.

### *Issues of Inequality – Understanding Geographical Unevenness*

Within the literature examining outcomes of the first Green Revolution in India, the topic of geographical unevenness is arguably one of the most widely discussed topics (see Banerjee et al. 2005, Byres 1983, Dutta 2012, Das 1999, Gartrell 1977, Iversen et al. 2013, Patnaik 1986, Poleman 1993, Singh 1999, Yapa 1993, and others). The extent to which existing studies examine geographical unevenness, in addition to the theoretical approaches used, varies widely. Das suggests that three major frameworks can be derived from existing literature: the ecological approach, the spatial diffusion of innovation approach, and the state and social structure approach. To this list, I add a fourth approach, which I call the colonial remnants approach. The following analysis attempts to synthesize a cohesive argument that explains the source of geographical unevenness.

The approach with the least traction within existing literature is the colonial remnants approach. This approach attempts to explain regional variations in Green Revolution successes as a function of regional variations in colonial-era policy implementation and the remaining vestiges still observed from these policy decisions. This approach is, at the least, logically plausible, given the extent to which contemporary Indian society, culture, economics, and politics have been shaped by remnants of colonial-era institutions. Colonial remnants are widespread, from the social institution of tea (chai, anyone?) to a deeply entrenched Indian bureaucracy.

Specifically, the colonial remnants approach argues that district-level differences in landlord revenue systems under the British have led to corresponding regional differences in economic success as an outcome of the Green Revolution (Banerjee et al., 2005). As previously discussed in the section on colonial contexts, the British colonization of India was a slow and dynamic process which led to widely divergent systems of political rule in different regions of the country. Banerjee and others categorized colonial districts as having either landlord-based or nonlandlord-based revenue systems and used this as an independent variable in regressions predicting a given district's levels of agricultural investment and productivity in the period from 1956 to 1987. Banerjee and others find significant results suggesting that contemporary agricultural success is lesser in districts where colonial property rights were given to landlords (landlord-based revenue systems) than it is in districts where colonial property rights were given directly to cultivators (nonlandlord-based revenue systems).

Others who have revisited the Banerjee study struggle to find comparable results (Iversen et al., 2013). Iversen and others argue that while the methodology and theoretical underpinnings of the Banerjee study are sound, the classification of districts into landlord-based or nonlandlord-

based revenue systems is flawed. Using colonial documents and archival research, the Iversen study re-categorizes districts under what they deem to be more accurate criteria and use this updated data to re-run the regressions presented in the Banerjee study. Contrary to Banerjee's conclusions, Iversen and others find that the agricultural success is no different in districts where colonial property rights were given to landlords (landlord-based revenue systems) than it is in districts where colonial property rights were given directly to cultivators (nonlandlord-based revenue systems).

The second approach that is examined is the ecological approach, which is one of the most dominant within the literature. The ecological approach asserts that regional ecological differences, such as soil type, climate, or elevation, act as a constraint on the potential success of Green Revolution technologies in a given region (Das, 1999; Patnaik, 1986). Simply put, rice and wheat are not suited to all regions in India and thus we should expect to see geographical unevenness. Given its logical appeal, the ecological approach has been casually adopted by many scholars when attempting to explain the source of geographical unevenness in the Indian agricultural context.

Das (1999) argues that this approach may be part of the cause of geographical unevenness, but that it does not fully explain the phenomenon. While the ecological constraint must be considered as a factor, the ecological approach in its full form, where the constraint is seen as the only factor responsible for regional variations in agricultural success, undermines the nuances and complexity of the situation. To accept the ecological constraint as the only significant factor flattens the multidimensional context of the situation and eliminates the validity of structural biases which have also contributed to regional inequalities.

The third approach, the spatial diffusion of innovation approach, argues that the most crucial element necessary to the adoption of Green Revolution technologies is access to resources such as credit, irrigated land, transportation infrastructure, etc. (Das, 1999). The approach further asserts that given the high cost of resources, only those with sufficient wealth and a high probability of success (i.e. a small ecological constraint) will adopt new technologies (Patnaik, 1986; Yapa, 1979; Farmer, 1993). In this way, the spatial diffusion of innovation approach elaborates upon the ecological approach, further nuancing it with the inclusion of a resource constraint. Later analysis in this paper will further explore the idea of a resource constraint (see Issues of Rural Access). Das claims that although this approach is favorable compared to the ecological approach on its own, it still oversimplifies the problem of geographical unevenness.

Under the spatial diffusion of innovation approach, the resource constraint is seen as a causal factor of geographical unevenness, but it is better viewed as a symptom of the geographical unevenness (Das, 1999). In other words, it is correct to argue that agricultural success after the Green Revolution and the magnitude of the resource constraint in a given region are negatively related (i.e. lesser success is seen in regions with larger resource constraints and vice versa), but it is incorrect to assume causation between the two factors. The bigger concern is why capital formation has been limited to some states and not others. Das notes that some regions which are highly suitable to agriculture (i.e. small ecological constraint) have received little to no agricultural investments, eventually yielding a large resource constraint (Das). Thus, the spatial diffusion of innovation approach does little to explain the more general source of geographical unevenness, which is some factor that is creating a resource constraint in a given region, holding all else equal.

The final approach, the state and social structure approach, is introduced by Das in an attempt to more accurately describe the source of geographical unevenness (1999). Das, synthesizing all preceding approaches for us, argues that the emergence of Green Revolution technologies put pressures on large and small producers alike to adopt the new inputs, but their actual adoption of the technologies is contingent upon ecological, historical, and political conditions (Das). In the state and social structure approach, emphasis is placed on the political condition, while still recognizing the ecological and historical (colonial remnants) constraints.

The state and social structure approach to geographical unevenness argues that the ecological constraint played a major role at the start of the Green Revolution and thus set in motion a spatial inequality that was further exacerbated by the approach's other two conditions (Das, 1999). For example, scholars under this approach note that given rice's widespread cultivation in India, across varied ecological conditions, the development of regionally specific HYVs of rice was not plausible (Byres, 1972). It would be simply too monumental of a task to develop regionally specific crop strains and furthermore, would not yield large enough financial returns to justify the investment in such a task. Thus, we see that the ecological constraint played a role in favoring certain regions that were best suited for the preliminary HYVs of rice and wheat that were released. As the Green Revolution progressed, notably in the mid-1970s, regional HYVs were developed, but a spatial inequality had already been formed by that point in time (Das).

The state and social structure approach's examination of the historical condition goes beyond the colonial remnants approach, which focuses on patterns of land revenue collection, and places greater emphasis on patterns of land distribution. Under the colonial period, changes in personal property laws redefined land as an "alienable commodity," which meant that land

could be bought, sold, or repossessed (Tomlinson, 1993). This development shifted the opportunity cost for various rural transactions. Rural poor who were unable to afford agricultural inputs now had the option to simply sell their land instead of cultivate it, a potentially appealing prospect. Furthermore, rural debt instruments could now be collateralized, meaning that those who defaulted on loans would lose their land. These developments concentrated the holdings of land to a select few individuals in a given rural community. This unequal distribution of land created what Das refers to as a “rent-usury barrier to the development of productivity” (Das, 1999). In regions with concentrated landholding classes, landowners can earn high returns from usury and land rents, and thus are not adequately incentivized to increase agricultural productivity (Das; Bhaduri, 1973; Patnaik, 1986). Thus, we can see that under the state and social structure approach, the ecological and historical constraints are seen as giving certain regions unequal footings at the start of the Green Revolution and thus contributing to later spatial inequalities.

The state and social structure approach considers a third and final factor, the state. Specifically, the state’s role in attempting to remove or eliminate the constraints set forth by the ecological and historical conditions is considered (Das, 1999). Under this approach, Das asserts that the state has intervened in the economy in order to alter property relations and productive forces (Das). Thus, the state and social structure approach considers the historical and ecological constraints themselves to be one major causal factor of spatial inequality of the Green Revolution, but additionally, the state’s spatially uneven success at eliminating or minimizing these constraints has become a contributing factor itself as well. The state has taken actions to remove constraints, but regionally-specific political and economic climates have been a source of geographical unevenness. For example, anti-landlord programs aimed at eliminating the rent-

usury barrier to the development of productivity were unsuccessful in some regions given tenants' financial inability to repurchase land from landowners or due to political opposition to anti-landlord developments.

As shown in the preceding analyses, scholars have taken four major approaches to understanding geographical unevenness in the outcomes of the Green Revolution in India. These four approaches are: the colonial remnants approach, the ecological approach, the spatial diffusion of innovation approach, and lastly the state and social structure approach. From our analysis we see that, although separate, the four approaches are not exclusionary of one another. It is instead revealed that the colonial remnants, ecological, and spatial diffusion of innovation approaches look at singular factors related to the spatial inequalities, but in some instances mistake causal factors with correlated factors. The final approach, the state and social structure approach, synthesizes all three of the previous approaches and asserts that geographical unevenness is the result of historical and ecological constraints, in addition to a spatial inequality in the success of state-sponsored programs to eliminate such constraints.

#### *Issues of Inequality – Structural Barriers for Small Firms*

While the previous section analyzes inter-regional inequalities, this section attempts to explore intra-regional inequalities amongst producers. Specifically, this section will be examining structural barriers for small firms. While the creators of the Green Revolution lauded HYV technology as being scale neutral, it is not found to be the case in real-world applications (Das, 1999). Scale neutrality was argued given the divisibility of seeds and chemical inputs. Suppose a large farmer used 100 units of seed and 200 units of chemical inputs, a farmer half the size could simply use 50 units of seed and 100 units of chemical inputs. While it is true that,

under the divisibility definition, HYVs are scale neutral, farmers of different sizes face differing opportunity costs associated with pursuing the implementation of Green Revolution technologies.

As was previously mentioned, the colonial-era in India saw a change in personal property laws, which allowed land holdings to be bought and sold. Given this development, small farmers, at the onset of the Green Revolution, were faced with two options: 1) purchase costly inputs in order to reap the benefits of HYVs or 2) sell off land to larger landholders and face no learning curve in production. Many small farmers chose the latter option, or some form thereof, leading to a phenomenon that some scholars refer to as “reverse tenancy” (Dutta, 2012). In the traditional system, tenancy flowed in the opposite direction, sharecroppers rented land from landlords or similar tenancy patterns were agreed upon. In this new system, landholdings are concentrated amongst a few landed, rural elites and smaller landowners are left without a livelihood.

The shift from tenancy to reverse tenancy, or the widespread decision of small farmers to collect rents on their land versus cultivate it themselves, is a result of the shifts which occurred in the forms of crop production. Whereas prior to the Green Revolution, agriculture was fragmented and predominantly sustenance-based, the introduction of HYVs shifted agriculture to a centralized and capitalistic system (Iversen et al., 2013). Large-scale production processes were employed that differed from traditional systems, and given large, up-front investments, farmers were more focused on ensuring high crop yields.

Thus, we see that intra-regionally, inequalities exist amongst producers of varying sizes. While HYVs were purported to be scale neutral when held to a strict definition of input divisibility, the reality is that the technology is far more accessible to large firms. This exclusion of small firms from Green Revolution technology shifted patterns of land use, from tenancy to

reverse tenancy, in ways made possible by colonial-era policies. The outcome of this alteration to traditional patterns of land use is the further concentration of land amongst a rural elite and the displacement of small landholders within the job market (Bardhan & Bardhan, 1973).

### *Issues of Rural Access – Finance for the Mighty*

As explained in the previous analysis, although the creators of the Green Revolution lauded their system as being scale-neutral due to the divisibility of inputs, the reality does not support this idea. Small landholders were forced to choose between production or reverse tenancy, many opting for the later (Dutta, 2012). For any size landholders who wished to continue production with the Green Revolution technologies, it was necessary to seek credit. Large up-front costs could not be afforded by any sized landholders given their cash flow pattern, and thus all producers had to turn to credit; seeds are planted in one month, but producers will not be able to sell the products for a few months (Bardhan & Bardhan, 1973).

Rural credit systems relied heavily upon collateralization of landholdings following the colonial shift in personal property rights that has already been discussed. Institutional credit from reputable sources required relatively large landholdings as collateral, and thus many small and medium sized producers were forced to turn to less formalized village credit systems (Dutta, 2012; Sharma, 1997). Interest rates in these systems were far above those of the institutional system and would be considered by many to be usurious. Borrowers were afforded few protections under these systems and landholdings were at constant risk of repossession. The high cost of financial capital incentivized small and medium sized landholders to produce as much as possible, with as much efficiency as possible in order to repay debt obligations (Sharma). Unfortunately, in order to repay previous debt obligations, producers needed borrow additional

money to produce more product. Thus, small and medium sized producers were sent into debt spirals, which ultimately left them landless and broke (Dutta; Sharma).

In many instances, especially in Punjab, farmers committed suicide in order to escape debt obligations to village credit systems (Dutta, 2012). This left widows and children with no means of supporting themselves. Noticing these developments, the government of India established a program that paid those widowed by suicide a generous sum of money (Dutta). This in turn further incentivized at-risk borrowers in the non-formal credit system to commit suicide, thus eliminating the debt obligation and leaving money for their family behind. Thus, we can see that a lack of accessible credit instruments that producers of all sizes could purchase in turn eliminated small and medium landholders from the formal financial systems, and segregated them to the informal market for credit. Not only did this serve as a barrier to realizing the full potential of Green Revolution technologies, but given usurious interest rates and altered personal property laws, sent producers into debt spirals which were often ended by suicide.

We can conclude then, that the availability of safe credit for producers of all sizes not only secures a given producer's ability to participate in the Green Revolution technologies, but it buffers the risk of debt spiraling. While on its own, high rates of credit defaults are undesirable, in the case of rural India, there came the added baggage of a variety of social implications as outlined in the previous analysis.

### *Issues of Rural Access – Public Goods for Everyone?*

Related to our discussion of geographical unevenness is the issue of rural access to public goods, specifically irrigation and transportation infrastructure. According to the spatial diffusion of innovation approach to geographical unevenness, it is asserted that access to resources is vital

to the adoption of Green Revolution technologies (Yapa, 1993). Central to realizing the full productive benefits of Green Revolution HYVs is the availability of abundant and reliable irrigation systems. As already discussed in great detail, there is an unevenness in the government's distribution of public infrastructure investments on a regional basis. The source of this spatial inequality, according to the state and social structure approach is the government's inability to implement programs in all regions, given regionally specific social and political constraints.

Ramakumar (2012) argues that large-scale public investments lead to subsequent investment in private capital. The logic behind this argument is that as firms observe the construction of public infrastructure projects in their region (irrigation systems, irrigation networks, etc.), they are more willing to make private investments with the knowledge that these investments are more likely to be successful with the additional government-funded support. Thus, beyond a geographical unevenness in public works projects, there will be a subsequent regional inequality in private agricultural investment.

In terms of rural access, large-scale public investment can be viewed as a primer, or even a prerequisite, to private agricultural investment. Given this perspective, limiting the breadth of rural public goods is in reality limiting the access of rural communities to Green Revolution technologies. As previously established, HYVs are relatively capital intensive when compared to other varieties and thus impediments to capital formation restrict access. In this way, the inability to extend public works projects to a given region not only deprives those communities of the public work itself, but also of the benefits associated with Green Revolution technologies.

*Shifts in Social Systems – Complications in Traditional Labor Relations*

As previously mentioned, the introduction of Green Revolution technologies into rural India marked a shift in the cultivation system from one of sustenance to one rooted in capitalist ideologies (Sharma, 1997). Cost structures incentivized producers to be more efficient and productive than before and to do so, producers altered the traditional labor systems that had existed for many years as a self-correcting system in rural India (Bardhan & Bardhan, 1973). Within rural India, there exist a variety of labor arrangements and common to all of these is an element of the patron-client relationship, in which benefit is mutually shared between laborer and producer. Traditionally, cultivation has operated under one of two systems, either the *khudkasht* system of self-cultivation or a tenant-based system of sharecropping (Dutta, 2012). In the *khudkasht* system, “farmers undertake all the agricultural operations and occasionally depend on hired labourers” (Dutta, 233). In this system, farmers may hire *naukar* – servant – laborers who perform the majority of agricultural tasks (Dutta). In return for their labor, producers provide *naukars* with financial payments (35,000 rupees annually in 2010) as well as payments in kind such as meals (Dutta). Labor relations such as these are part of the *jajmani* payment system, which relies on cooperation between classes and reflects a patron-client ideology in that payment is provided in cash and in kind (Dutta).

The development of a more capitalist model of agriculture has severely restricted the social safety net for laborers provided under the *jajmani* system. Of the Green Revolution, it is noted that “apart from enhancing social polarization in the landlord tenant or landlord-labourer relationships, the new technology may also generate forces leading to economic polarization in the community of cultivators and labourers” (Bardhan & Bardhan, 1973, 287). The *jajmani* system has been altered in favor of producers, whom have control over labor relations. While

laborers in certain arrangements, for instance, were historically paid partially in kind and partially in cash, they are now paid fully in cash. This has allowed producers to take advantage of inflation and thus lowered real wages or contributed to their stagnation (Bardhan & Bardhan, 1973). In other situations, the duties of laborers extended beyond what was normally required as producers attempted to maximize all inputs, including human capital. Laborers have been “increasingly entrusted with many different jobs with a diversity of skills” and furthermore laborers now “also help their landlord in various household works” (Dutta, 2012, 238).

Thus, we can see that the adoption of Green Revolution technologies forced producers to alter traditional labor relations. In many instances, these relations formed the foundations of rural social systems and thus altering these relations had much more profound and widespread impacts than what would have been expected. It has been noted that “in the extremely inequitable institutional framework of India’s rural economy, the Green Revolution [has] ... accentuat[ed] the sense of relative deprivation on the part of the poor” (Bardhan & Bardhan, 1973, 291). Arguably, these effects could have been minimized if consideration had been given to the potential outcomes of a shift to capitalist ideology within the context of traditional labor relations, such as the *jajmani* system.

#### *Shifts in Social Systems – Labor Migration and Social Unrest*

A further elaboration from the previous analysis, the shift to a capitalist agricultural system forced producers to seek more efficient and productive labor inputs in order to fully recognize the benefits of the Green Revolution technology (Sharma 1997). Contrary to traditional practice, many producers sought migrant laborers as a source of human capital that was cheaper than labor available in a given region (Dutta, 2012). Producer-laborer relations prior

to the introduction of the Green Revolution more closely resembled a patron-client relationship, in which benefit was mutual (Bardhan & Bardhan, 1973). While laborers provided obvious benefits to the producers, producers would also offer social protections to laborers. In addition to a wage, other compensation was given, including housing, food, or other items depending on the specific labor agreement. The introduction of industrialized agricultural systems tended to “loosen some of the customary ties and obligations” within the traditional social institutions of labor (Bardhan & Bardhan, 291).

Thus, migrant laborers were seen as viable sources of cheap labor that did not require the additional maintenance of a patron-client relationship or the associated costs. On a primary level, the importation of labor displaced existing laborers, which in itself shocked the status quo (Bardhan & Bardhan, 1973). Local laborers were forced to find new jobs or in some cases move to urban centers. As has been a theme for most of this paper, the primary effect of labor displacement, lead to the secondary effect of social unrest (Bardhan & Bardhan). Those laborers whose employment was displaced saw migrant laborers as taking jobs and furthermore as depressing wages in the region. This is what caused many to move to urban cores; not only was it difficult to find a job, but if one succeeded, the wages were low. Thus, the importation of labor “encourages a kind of tension and conflict...[with]...many instances of violent clashes between these two groups of labourers [migrant and local] (the migrants being supported by the local employers)” (Bardhan & Bardhan, 291).

Thus, the transition from sustenance to an agricultural system based in capitalist ideology necessitated the importation of migrant labor in many regions. While on a primary level this displaced local laborers, it also had the effect of disrupting balanced social relations, developing animosity between groups who were not previously hostile. It is argued that these trends will

continue, with “the economic disparities and conflicts of class interests...likely to become much sharper and add to the already simmering socio-political tensions” in areas where the Green Revolution has taken hold (Bardhan & Bardhan, 1973, 292).

### *Discussion of Results – Synthesis of Analyses*

Examining the impacts of the Green Revolution in India, we have generated a list of problematic outcomes within rural Indian society that have occurred as a direct product of this period of intensive agricultural expansion. While these outcomes are varied over three major topics including issues of inequality, rural access, and shifts in social systems, two broad themes emerge that allow us to synthesize our understanding of outcomes of the first Green Revolution. First, it should be noted that the ultimate source of each of the disruptive outcomes listed above is a lack of regional consideration on the part of Green Revolution programs. This is despite the fact that regional specificities are cited as being prerequisite to successful agricultural reform (Singh, 1999). On a global level, this is seen as an inability for the development program to adapt to the specific historical and colonial legacies in India; whereas on a national level, it is an inability to distinguish unique socioeconomic and ecological constraints within each state in the country. Second, and related in many ways, is a lack of consideration for all appropriate stakeholders within the system. Harwood (2013) emphasizes the unique experiences of smallholders in rural agricultural systems, differentiating them from larger actors. The Green Revolution prioritized real agricultural expansion without making holistic considerations of the potential effects of the program on smallholders, laborers, the environment, and a variety of other actors (Shiva, 1991, 1993, 2000).

Thus, while the analyses presented in the preceding sections reveal six specific disruptive outcomes of the Green Revolution, we can view these as being the result of the two major factors discussed above. First, the Green Revolution lacked regional specificities; and second, failed to consider all appropriate stakeholders. In our application of the first Green Revolution to contemporary agrarian reform, these are the two primary considerations that must be made.

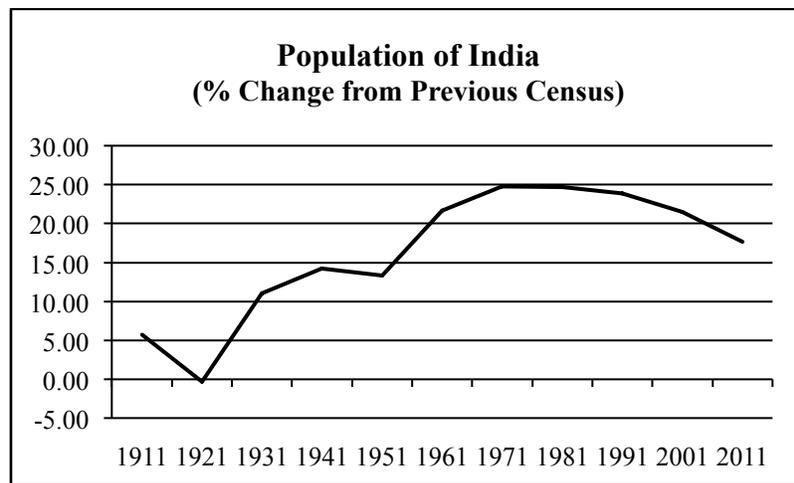
### **Renewed Calls for Agrarian Reform**

#### *Survey of the Contemporary Indian Context*

While the Green Revolution did expand crop yields, as previous mentioned, India is faced with a confluence of factors that is yet again positing the country on a path to widespread food insecurity. That is not to say, however, that India is in the same position that it was in following liberation from colonial oppression. While the social and demographic contexts are similar, the contemporary economic and politic situation is very different. The following sections will explore India's contemporary demographic, social and economic contexts.

India's population post-independence and following the Green Revolution has seen continued growth. India's population immediately preceding the Green Revolution was approximately 440 million (1961 census), whereas the most recent census taken in 2011 calculated a population of just over 1.2 billion (Census of India). This is an increase of just over 175%. Figure 3, below, shows the population growth rate from 1911 to 2011. Although the plot shows that the percent change varies widely, the overall trend seems to be positive. Interestingly, the growth rate has been decreasing since the 1971 census, which may be indicative of a long-run trend seen in most developing countries whereby economic growth is followed by decreases

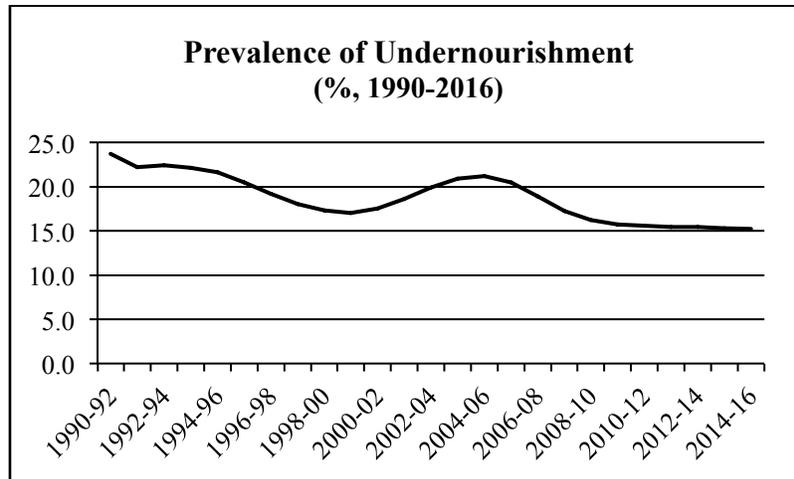
in population growth. Nevertheless, it is still undoubted that India is facing rapid population growth rates, which are made even more significant given the country's massive population.



*Figure 3, Source: Census of India*

India's population growth post-independence has been a contributing factor to food insecurity in the country, just as it was in the period preceding the first Green Revolution. This can be observed in an analysis of India's prevalence of undernourishment, calculated using three-year averages, spanning from 1990-1992 to 2014-2016 (Figure 4). Over this period, the trend has been a decrease in the prevalence of undernourishment, but at a relatively slow rate.

Furthermore, starting from 2009, we observe the trend flattening out and remaining at a value around 15%. For reference, the prevalence of undernourishment on average for all developed countries, as defined by the UN FAO, is less than 5% and for all developing countries is approximately 13%. Thus, we see that India's food system is already straining to deliver the nutritional needs to its population and given its trajectory for future population growth, this insufficiency can only be expected to worsen.



*Figure 4, Source: UN FAO, Food Security Indicators*

Whereas prior to the first Green Revolution, India's economic policies and programs were still focused on the colonial and mercantilist projects left behind by the BEIC and the British Raj, India of the present has pivoted towards a focus on technology and high-value industries. Perhaps aligning itself with the Washington Consensus, which asserts a linear and universal development path that focuses on economic liberalization, India has chosen an economic focus that seems to associate development and modernization with advanced industries and, in the process, has begun to shy away from agricultural reform or rural poverty alleviation (Sharma 1997, 268). This is very troubling, given that 68% of the Indian population lives in rural areas and that agriculture still employs about 50% of the population (FAO 2014). Furthermore, in the year 2012, agriculture accounted for only 14% of India's gross domestic product (GDP), despite the disproportionately high percentage of the Indian population that depends on the industry for employment.

Thus, looking at the contemporary challenges and contexts that India faces, one recognizes a clear and irrefutable need for agricultural policy reform, a Second Green Revolution, to revitalize the country's rural populations and ensure food security on a widespread scale across the country for years to come. Trends in population and agricultural

yields show that despite having more mouths to feed, India's food production systems are not providing sufficient increases in output to match the new demand. Beyond a simple need to provide food to its people, India must consider the impacts that agricultural reform could potentially have on its economy as a whole. With such a high concentration of India's population dependent on primary agriculture and other related secondary industries, agricultural reform has the potential to improve the economic status and wellbeing of a large percentage of the Indian population.

The dire need for agricultural and rural policy reform has not gone unnoticed by others. Within academia, there exists a body of literature that attempts to offer recommendations for India's second Green Revolution, but the works fall short against a variety of metrics. For one, a majority of the works are outdated, having been published in the 1960s and 1970s as a direct response to the first Green Revolution. The India we see today, in addition to the global environment, is radically different in comparison to that which was observed in the mid twentieth century. As a result of this, the policy recommendations are not appropriate in a modern context or fail to take into account the contemporary issues that India now faces. Perhaps most detrimental to this body of literature is the fact that it is extremely shallow; despite repeated attempts to find scholarly articles suggesting policy recommendations for the second Green Revolution, only a small handful could be found. The following paragraphs will examine a selection of these works more carefully to better understand what has already been suggested in the literature.

The first paper in the literature is the proceedings from a seminar hosted by the Indian Council of Social Science Research, North-Western Regional Centre, Chandigarh that allowed for prominent academics to present research related to the implications of the first Green

Revolution (Hansra & Shukla, 1991). Seminar participants ultimately generated recommendations aimed at improving Indian agrarian and rural policy. The major themes that emerged from these recommendations are: instill a sense of ownership for small stakeholders in the rural agrarian-system, diversify crop production, improve education at a variety of levels, increase government investment in public goods (personal health, production infrastructure, subsidizing inputs), and increase funding for agricultural research (Hansra & Shukla). As compared to other works, these scholars make generally appropriate and potentially feasible policy recommendations. Nevertheless, some of the specifics of their policy recommendations are irrelevant in the modern context. Furthermore, some language in the report makes inappropriate normative judgments with reference to rural cultural practices; for example, it is asserted that “people need to be educated for minimizing the wasteful expenditure on social ceremonies with particular reference to marriages and dowry” (Hansra & Shukla, 10).

The next paper argues in favor of strong public support of agricultural research and projects, noting that the “centrality of the role of government in driving agricultural growth is well argued in the literature” (Ramakumar, 2012, 92). Central to Ramakumar’s argument is his analysis of both public and private investment in agriculture; specifically the study examines trends in agricultural investments from the 1950s to the 2000s. Ramakumar first notes that following independence from British colonization, India lacked sufficient infrastructure (specifically irrigation and flood control systems) and that even small investments in infrastructure would yield large differences. Next, it is argued that public investment in goods such as irrigation ditches often promotes private investment in fixed capital that is used as a complement to the public investment (Ramakumar). Lastly, Ramakumar claims that public investment in agriculture research often yields products and techniques that are accessible to a

wider range of audiences whereas private investment in agricultural research often yields specialized goods and techniques that are best suited for “capital-intensive” production and only benefit larger firms.

Lastly, Sinha (1997) suggests that “traditional” knowledge about agriculture, combined with modern scientific advancements will be the key to responsible outcomes. Sinha makes six major recommendations: increase crop biodiversity, adopt natural methods of pest control, revert to the use of rainwater irrigation, increase the use of biofertilizers and biopesticides, and begin a search for alternative, genetically engineered crops. Sinha offers limited evidence for his choice of each recommendation and in most instances uses only limited case studies to support his claims. Furthermore, his range of recommendations contradict one another; at once he is promoting natural pest control via the application of herb oils to crops, while also suggesting the use of genetically modified crops in which “resistance capacity against pests...has to be developed” (Sinha, 1995). Lastly, the recommendations made by Sinha seem to ignore the reality of the present context into which these policies would be implemented. For example, a reliance on rain-fed irrigation given global climate change patterns seems unreliable. Sinha does little to show that his policies will have any real effect on crop yields, which is vital given the pressures that population growth is putting on the Indian agricultural system.

From these studies, one can see that while policy recommendations have been made in the literature, the applicability to the contemporary context is weak. As previously mentioned, it is this body literature’s shallow depth and outdated analyses that establish a need for updated examinations of potential policy actions for Indian agricultural development. Furthermore, the shortcomings of this specific segment in the literature establish a gap within the broader Indian development discourse that this paper, in part, attempts to fill.

*The Second Green Revolution – Defining Responsible Outcomes*

As this paper attempts to synthesize preceding analyses of the outcomes of the first Green Revolution and India's historical and modern context into meaningful policy recommendations for contemporary agrarian and rural reform, it is important to present a metric to which future policy outcomes may be compared. This paper has argued that the first Green Revolution exacerbated social and economic inequalities in rural India, as well as placed a focus on economic outcomes versus environmental protectionism, and thus, the policy recommendations made herein aim to minimize these effects in the current wave of reform. It must also be recognized, however, that given India's dire situation in terms of food insecurity as outlined in the previous section, considerable attention must be paid to the expansion of real agricultural productivity and the equitable distribution of food within Indian society. Given these considerations, policy recommendations made in this paper will attempt to generate outcomes that minimize the expansion of socioeconomic inequalities or environmental negligence, while also promoting agricultural and rural growth. It is hard to quantify these goals, but what is most important is that a holistic approach is taken, considering all reasonably possible outcomes and potential stakeholders in decisions that are made.

Using a framework that contrasts with the Washington Consensus, Indian political actors must be given agency in developing uniquely "Indian" agrarian and rural reform policies. That is to say, while India should look to other examples of development within the global sphere, it should not be constrained by what has already been done. Thus, Indian stakeholders, and not global hegemony, must determine the appropriate balance between agricultural expansion and both socioeconomic equality and environmental justice. The policy recommendations made in

the following sections operate under the assumption that this balance is skewed towards the preservation of the latter.

### **Application of Findings - Policy Recommendations**

#### *Regional Expansion with a Focus on the Marginalized*

As previously mentioned, the two key failures of the first Green Revolution were a lack of regional specificities, as well as an insufficient consideration of all appropriate stakeholders within the rural system. Thus, the policy recommendations for the Second Green Revolution made below (Table 1), attempt to address these two issues. Eight potential policies are recommended, each with a corresponding objective and explanation. The first recommendation is arguably the most pertinent, in that it addresses the issue of regional specialization. The policy calls for a reorganization of ICAR into regional branches as opposed to its current crop-based organization. Parayil (1992) asserts that “proper institutional and bureaucratic reforms are essential for successful technology transfer” (755). As PM Modi has tasked ICAR with creating and managing the Second Green Revolution, it is of utmost importance that regionalism is stressed. It should be noted, that this policy provides a framework within which Indian actors retain agency to develop the specifics of these agrarian reform policies.

Of relatively lesser importance, recommendations two through eight are aimed at providing appropriate supports to rural stakeholders that were overlooked in the first Green Revolution. Specifically, recommendations two through five attempt to support smallholders by providing public infrastructure, accessible credit programs, access to economies of scale, and stabilizing land reforms that curb reverse tenancy. Recommendation six aims to restore a focus

on environmental protectionism, by limiting the reliance on monocropping.<sup>5</sup> Recommendation seven attempts to disincentivize labor migration and thus lower the potential for social unrest amongst laboring classes. Lastly, recommendation eight aims to alleviate food insecurity caused by inequitable food distribution systems within the country. These recommendations (two through eight) should be viewed as a broad framework that is intended to be ultimately altered by Indian stakeholders, so as to retain their political agency.

<b>Policy Action</b>	<b>Objective / Explanation</b>
1. Consolidation of ICAR branches into regional versus crop-based divisions	<ul style="list-style-type: none"> <li>• Limit bureaucratic inefficiency</li> <li>• Regional adaptation of policy</li> </ul>
2. Expansion of public infrastructure to rural areas	<ul style="list-style-type: none"> <li>• Increases in public investment yield increases in private investment</li> </ul>
3. Expansion of rural credit programs	<ul style="list-style-type: none"> <li>• Allow small farmers to access stable financial systems</li> </ul>
4. Establishment of small farmer cooperatives	<ul style="list-style-type: none"> <li>• Expand access to economies of scale</li> <li>• Expand large-scale bargaining power</li> </ul>
5. Land reforms	<ul style="list-style-type: none"> <li>• Codification of land use practices to maintain historically harmonious relationships</li> <li>• Prevent marginalization and exploitation</li> </ul>
6. Diversification of HYV development and individual cropping decisions	<ul style="list-style-type: none"> <li>• Shift away from mono-cropping</li> <li>• Incentivize individual producers</li> </ul>
7. Establishment of alternative livelihood programs	<ul style="list-style-type: none"> <li>• Disincentivize labor migration</li> </ul>
8. Demand-side programming to expand system of food distribution	<ul style="list-style-type: none"> <li>• Expansions in supply does not necessarily yield equitable distribution to consumers</li> </ul>

*Table 1, List of Policy Recommendations*

<sup>5</sup> See the work of Vandana Shiva, specifically *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology* (1993).

### *Trajectories of Development*

As a final note, it should be clarified that these policy recommendations are made under the assumption that Indian development will continue to place value on sustaining rural systems. One must understand, however, that it is often the case that economic modernization is followed by outflows from the rural social system as citizens of a given country find better employment in industrialized, urban centers. This has at least been true for much of the Western world, which saw decreases in agricultural employment following the Industrial Revolution. Thus, it is not the intention of this paper to subscribe to the agrarian myth, whereby rural actors are stripped of their agency and subjected to cycles of poverty at the expense of the urban elite's fascination with times gone by. If Indian development follows the Western model, and agriculture is heavily industrialized so that massive urban inflows occur, then so be it. However, the author of this paper would argue that given India's colonial history and present demographic trends, its development is unique in that the country has a massive population and faces a difficulty in consolidating land ownership and food production for a variety of reasons (e.g. pre-existing social systems as outlined above). Only time will tell the developmental trajectory that the Indian citizenry elect to follow.

### **Conclusions**

#### *Suggestions for Future Research*

In its attempts to answer questions regarding historical and contemporary agrarian reform in India, this paper has revealed additional topics for future research. Of most interest, is the inability to reproduce data that corroborates declining cereal crop yields, which many scholars claim is occurring in the country. This paper finds that yields for rice in India seem to be

following a trend that is increasing at a steady or increasing rate (Figure 2). Similar results are found when examining crop yields for all cereals in India (UN FAO). More research is necessary to understand the discrepancies between the finding of this analysis and that of those scholars who find decreases in the rate of growth of cereal yields over the past decade or two.

As highlighted previously, there is a gap in the existing development literature for India in regards to the Second Green Revolution. This paper has begun to fill this gap, if even just by calling attention to it and surveying the limited scholarship that does exist. With food insecurity again coming to the forefront of Indian development as a major impediment, greater academic resources must be directed toward developing a new, responsible set of agricultural technologies. It is imperative that these studies come from within India or, if not, make careful considerations of the specific social and cultural contexts of rural India.

Finally, the author of this paper calls for new field studies that survey the contemporary social situation in rural India. Topics which should be explored include: small firms perceived access to both public and private resources, perceived relations between producers and laborers (considering both perspectives), and finally, the prevalence and perceived impacts of migrant laborers. While existing literature suggests, as does this paper as well, that these factors are problematic outcomes of past agrarian reform that must be corrected, it is imperative that we understand how these factors are actually functioning at present. From these suggested surveys, economists and policymakers alike would be better armed with the necessary tools to make data-driven and informed decisions in determining second-wave agrarian reform policies for India.

*Final Conclusion*

As established in this paper, the Green Revolution's introduction into India via multinationally-sponsored research institutions (e.g. IRRI, etc.) acted as an environmentally, economically, and socially disruptive force. Despite the programs' successes in expanding crop production, an inattention to regionally specific institutions and contexts, both globally and nationally, wrought havoc on once balanced social and environmental systems. The research institutions and their financial backers who gave birth to the Green Revolution viewed global development, whether knowingly or not, in accordance to the stadial theory and thus used a "one size fits all" model across a variety of distinct global regions. Flattening the historical, cultural, and social narratives of spaces, the Green Revolution vastly underestimated the importance of regionally-specific contexts and demonstrates the potential for economic disconnect with preexisting social systems.

Employing a four-fold approach that explores India's historical and contemporary contexts, outcomes of the first Green Revolution, and recommendations for agrarian reform, this paper has shown that the Green Revolution's lack of regional specificities is to blame for the program's disruptive outcomes. Nevertheless, it has also been shown that the Second Green Revolution has the potential to yield responsible and equitable outcomes, so long as a holistic approach is adopted that accounts for all stakeholders. The applicability of a holistic approach is not limited to the case of agriculture in India and it is advocated that such an approach is adopted in a variety of global development contexts. In such a framework, India's historical agricultural development serves not only as case study for contemporary agrarian reform in the country, but also for development projects on a global scale.

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