

**FROM NEW DELHI TO DAKAR:  
THE QUEST FOR FOOD SELF-SUFFICIENCY  
AND ITS IMPLICATIONS FOR SMALLHOLDER FARMERS**

by

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## **Abstract**

This paper explores the potential for Green Revolution-type agricultural intensification to occur in Sub-Saharan Africa, as well as possible socio-economic, environmental and human health consequences which could result from such growth. An historical comparative analysis is developed using evidence from India, preceding and during its agricultural Green Revolution, and applied to the case of Senegal, a country in West Africa that, in many ways, typifies the historical and contemporary agricultural experience in Sub-Saharan Africa. The analysis reveals that, despite divergent conditions, Senegal and, by extension, Sub-Saharan Africa, could be poised to realize agricultural growth similar to that in India; but this may also be accompanied by similar consequences for smallholder farmers and the environment.

**Keywords:** Agriculture; Agricultural Development; Farming; Food Self-Sufficiency; GOANA; Green Revolution; India; Senegal; Sub-Saharan Africa.

## **Dedication**

This work is dedicated to those who have inspired and encouraged me during the course of my studies at SFU. To friends and family who have pushed me to achieve and held me up when I did not think it possible to do so. It is also a testament to the grace of my Heavenly Father, who daily strengthens and sustains me by his great love.

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# I. Introduction

Agriculture is the lifeblood of Africa<sup>1</sup>. Across the continent, between 60 and 80 per cent of the population resides in rural areas, within which the agricultural sector plays a vital role. According to the World Bank, apart from South Africa, agriculture's contribution to GDP across the region in 2004 was approximately 40 per cent while, at the same time, accounting for 65 per cent of all employment (World Bank 2007). In addition, seventy per cent of the continent's poor are engaged in agricultural activities and it has been argued that, despite the multi-causal origins of both hunger and poverty, poor agricultural performance lies at the heart of both of these problems (Haggblade et al. 2010). Productivity in the agrarian sector is generally low (NEPAD 2001) and, since the 1960s, food-crop production has consistently failed to keep pace with population growth (IDRC). Development of the agricultural sector is desperately needed in order to improve the lives of a majority of the continent's poor; but how can this be accomplished?

An example of agricultural development that is often cited as a success is the so-called "Green Revolution" which began in India in the mid-1960s. Food-crop production increased significantly with the introduction of modern

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<sup>1</sup> Throughout this paper, the term "Africa" will be used to denote the region commonly referred to as Sub-Saharan Africa - that region of the continent which extends from, and including, the country of South Africa up to the southern boundary of the Sahara Desert.



agricultural inputs, including high-yielding varieties of seed (HYVs), chemical fertilizers, pesticides and irrigation (Chakravarti 1973). By the 1990s, India had successfully made the transition from a net importer to a net exporter of both wheat and rice (Mittal and Krishnan 1997). However, efforts to increase agricultural production were accompanied by a variety of consequences for both rural smallholder producers and the environment. Socio-economic disparities were aggravated, farmers' health was negatively impacted, and overuse of fertilizers and groundwater irrigation led to soil degradation and water table depletion (Ninan and Chandrashekar 1993; Mohan 1987; Murgai et al. 2001).

It is from both the successes and consequences of agricultural intensification in India that lessons for agricultural development in Sub-Saharan Africa and, more specifically, for the country of Senegal, will be drawn. This paper will attempt to address two related questions: **(1)** What is the potential for Green-Revolution-type agricultural growth to occur in Senegal; and **(2)** What are the possible socio-economic, environmental and human health consequences which could occur as a result of this type of growth?

The research in this paper will employ a comparative historical analysis to examine the causes of agrarian crisis in India and Senegal and the policies and programmes implemented to address them. The lessons learned from these initiatives to bring about agricultural development will then be employed to determine how successful Senegal's most recent initiative, the *Grande Offensive Agricole pour le Nourriture et l'Abondance* (GOANA - the Great Offensive for

Food and Abundance), will likely be in achieving a greater measure of national food self-sufficiency. This will be followed by an examination of potential consequences which could result from agricultural intensification under the programme.

The case of India provides a particularly good example for the development of a comparative historical analysis of agricultural intensification in Senegal, and Africa in general. As with many countries in Sub-Saharan Africa, India is a democratic society with a history of significant government intervention in the agricultural sector (Corbridge and Harriss 2000; Kohli 2004). Additionally, in both India and Sub-Saharan Africa (including Senegal), a majority of the population resides in rural areas (72 per cent in India; 60-80 per cent in Sub-Saharan Africa; 58 per cent in Senegal) where agriculture is the predominate form of employment. This is contrasted with an overall decline in the share of the agricultural sector in national gross domestic product (GDP) and the fact that, in both India and much of Sub-Saharan Africa, a majority of the poor are found in rural areas (World Bank(a); World Bank(b); World Bank 2007; Haggblade et al. 2010). The use of India as a comparative case is also merited by an abundance of both historical and contemporary literature on the agrarian sector and, for the purposes of this research, the causes, nature and consequences of the Green Revolution.

In developing a comparative study of India and Sub-Saharan Africa, the case of Senegal is presented to highlight both the commonalities and differences between agriculture in India and that in Sub-Saharan Africa. Similar to other countries in the region, agricultural production in Senegal has experienced significant volatility accompanied by low rates of overall growth in food-crop production. Modes of production are characterized by land-extensive, rather than input and labour-intensive agricultural systems, as productivity-enhancing technologies have, by and large, failed to take hold (Evenson and Gollin 2003; IFAD 2005; Austin 2008; Jerven et al. 2008; Breisinger 2009). Environmental factors, such as fragile nutrient-poor soils and a reliance on rain-fed irrigation, have been compounded by low levels of infrastructure development and distorted or non-existent markets (input, marketing and credit). These have served to create an environment in which farmers lack the incentives to intensify agricultural production (Breisinger et al. 2009; Haggblade et al. 2010; IFAD 2005).

The first part of this paper will examine the nature of agrarian crisis in India and Senegal and initiatives designed to address them. The historical roots, as well as the characteristics, of agrarian crisis will be compared to highlight similarities and differences between the two cases in an attempt to determine the factors contributing to the outcomes observed in both India and Senegal. These outcomes, or "lessons learned", will then be used to analyse if the Government of Senegal's most recent initiative for agricultural development - GOANA - is likely

to succeed. Does GOANA reflect efforts to learn from past attempts to bring about greater food self-sufficiency in Senegal? Does the programme incorporate aspects of agricultural development which have, historically, been shown to be successful in other cases? Are the interventions proposed within GOANA viable in light of available resources and current conditions in Senegal's rural sector?

The second part of this research will explore the various socio-economic, environmental and human health consequences resulting from agricultural intensification in India during the Green Revolution. Causative factors which led to these consequences in India will be examined and then placed within the context of conditions in Senegal to determine if similar outcomes could be expected from implementation of the GOANA programme. Are the factors which led to the observed socio-economic, environmental and human health-related outcomes in India present in Senegal and, if not, are they likely to develop as a result of the GOANA programme?

In answering these questions, this research seeks to expand the discourse surrounding agricultural development in Senegal and, by extension, in Africa as a whole. Initiatives such as the African Union's New Partnership for Africa's Development (NEPAD) have made much of the need for reform and development of agrarian sectors across the continent. NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP) presents an extensive list of objectives to achieve increased production and greater productivity (higher yields per unit of land and/or labour utilized) in African agriculture (NEPAD 2001).

However, despite the inclusion of goals to mitigate the environmental effects of agricultural intensification and to provide an economic "safety net" for smallholder farmers, there is a marked lack of discussion as to how these farmers might be adversely affected by agricultural intensification. It is hoped that this research will serve to provide a greater understanding of both the factors contributing to agrarian crisis and successful policies to address it. It is also the intent to shed light on the potential consequences of agricultural intensification for smallholder farmers in Africa, in order that greater attention be paid to these outcomes in the design and implementation of policies and programmes to effect agricultural development.

## **II. Theoretical Approaches to Agricultural Development**

There has been much debate within development theory concerning the role of agriculture in overall economic growth. Focussing on the role of labour within the economy, W.A. Lewis postulated that the traditional agricultural sector, which was characterized by a high degree of inefficiency and a large surplus of disguised unemployment, could act as a 'pool' from which surplus labour could be drawn to work in the modern industrial sector at a cost only marginally above the subsistence wage. For Lewis, the importance of the agricultural sector lay in its ability to regulate changes in labour requirements brought about by the modernization process. However, Lewis did hold that, at least within a closed economy, there existed a symbiotic relationship between industrial and agrarian revolutions, in which one was needed in order that the other could be achieved (Lewis 1954).

Theorists such as Robert Bates have argued that the state has actively constrained the agricultural sector, through the use of marketing boards, to create more favourable economic conditions for those in urban areas where, it was thought, the engine of economic growth was located. Agriculture was seen merely as a means by which to procure the necessary resources, both financial and agricultural, to appease the urban populace and to spur growth and

modernization. As such, investment in agriculture was generally restricted to those sub-sectors, primarily cash-crop production, seen as contributing most effectively to these goals (Bates 2005).

Others have sought to establish a link between growth in agriculture and the overall development process, not only in terms of agriculture's role in providing resources for the 'modern' industrial sector, but also in its ability to act as an engine of economic growth itself; contributing to the development of those directly engaged in it and creating growth-promoting linkages with other sectors of the economy. There is evidence to suggest that the agricultural sector has the highest growth multiplier effect within an economy and that causality runs from agricultural growth to growth of the overall economy (Breisinger et al. 2009). Additionally, low agricultural productivity can substantially delay industrialization, as productivity growth in the agricultural sector tends to have a much more significant impact on economic growth in the short-term than comparable increases in productivity in non-agricultural sectors. Much of this is due, not to migration of surplus labour to urban industry, as in the Lewis model, but rather, to a release of labour from the agricultural sector as productivity gains decrease the amount of labour required for increased production (Gollin et al. 2002). Thus, investments in agriculture and, specifically, agricultural productivity are integral to creating a developmental environment which will encourage sustainable long-term growth.

Yet, despite the fact that theories promoting the importance of agriculture in development have existed since the middle of the last century, in practice, much of Africa has yet to experience the productivity gains in agriculture which could lead to more widespread economic development (Jorgenson 1961; Breisinger et al. 2009). This is no less true in Senegal, where the agricultural sector has become increasingly characterized by low levels of investment and stagnation in output. Yield growth in sorghum and millet production - two of the most important indigenous food-crops - has been declining (Camara et al. 2006) and overall annual per capita food production has been falling in recent decades as output has failed to keep pace with continued population growth (Morgan and Solarz 1994; FAOSTAT; World Bank(b)). This has been evidenced by the fact that, in 1987, domestic production accounted for 55 per cent of national cereal consumption but, by 2005, domestic capacity had decreased to 40 per cent, with fully 91 per cent of rice consumption derived from imports (IFAD 2003; Oya 2006).

The constraints faced by agricultural producers in this environment of declining production include economic, political and environmental factors which have served to disincentivize investment in the agrarian sector. These include weak or non-existent government provision of support services, exposure of small-scale domestic producers to global competition due to trade liberalization, weakly organized commodity markets, a lack of access to information, low and



increasingly erratic rainfall and natural resource degradation (IFAD 2003; USDA 2010). In light of this, it must be asked, "what steps have been taken to address these constraints and how successful have these efforts been?"

### **III. Agricultural Intensification in Senegal and India's Green Revolution**

Policies relating to agricultural intensification in Senegal, for the purpose of achieving food self-sufficiency, have been introduced by the national government at various junctures in the post-Independence period. In the early 1980s, a balance of payments deficit and structural adjustment resulted in the creation of the *Nouvelle Politique Agricole* (NPA; New Agricultural Policy) which sought to liberalize the agricultural sector and increase food-crop production from 50 to 80 per cent of national requirements (Boone 1991; Martin and Crawford 1991). This initiative largely failed, due to factors outlined below, and was followed by a period of declining per capita food production as output failed to keep pace with continued population growth (Morgan and Solarz 1994; FAOSTAT; World Bank(b)). More recent attempts to achieve a greater measure of food-self sufficiency have been embodied in the *Grande Offensive Agricole pour le Nourriture et l'Abondance* (GOANA) (GOANA(d)). This programme, which was introduced in 2008 by Senegalese president Abdoulaye Wade in the midst of the international food price crisis (Bobenrieth and Wright 2009), lays out specific targets to substantially increase production of various food and cash-crops through increases in both productivity (yield) and area under cultivation (GOANA(c); NEPAD-CAADP(b)).

Agricultural intensification to achieve food self-sufficiency began much earlier in India, starting in the mid-1960s. Fiscal and resource constraints led to the adoption of productivity-enhancing agricultural technologies such as irrigation, chemical fertilizers and high-yielding varieties (HYVs) of wheat and rice (Corbridge and Harris 2000) in order to address a growing food shortage and reliance on foreign food aid (Mosley 2002; Kohli 2004). Private and public investment in irrigation and agricultural inputs, facilitated by increased provision of credit and public subsidies, worked to dramatically increase the production of staple food crops in what became known as the Green Revolution (Mittal and Krishnan 1997).

The failure of Senegal to spur food-crop production in the 1980s, contrasted with the success of India in achieving food self-sufficiency through the Green Revolution provides a good baseline in the examination of more recent attempts by the Senegalese government, namely the GOANA programme, to spur agricultural development. The experiences of both countries will be used to analyse if the GOANA programme will likely be successful in allowing Senegal to achieve a similar level of agricultural growth and food self-sufficiency as that seen in India.

## **Why Were Policies for Agricultural Intensification Introduced?**

Implementation of the NPA in Senegal was the result of a growing fiscal constraint resulting from a large balance of payments deficit. Forced to turn to the International Monetary Fund (IMF) and World Bank for assistance, the national government undertook a significant restructuring and liberalization of the economy under the auspices of a Structural Adjustment Programme (SAP). Given that the overall economy has, historically, relied rather heavily on the agricultural sector (by the mid-1960s, agriculture accounted for 80 per cent of export earnings, 25 per cent of GDP and employment for three-quarters of the active population (Youm 1991; Bonnefond and Couty 1991)) the balance of payments deficit faced by the country in the 1980s can be directly linked to conditions in the agrarian sector, which was facing a crisis of its own during this time.

The roots of both the fiscal and agricultural crises that forced Senegal to enter into structural adjustment can be traced to policies and practices undertaken prior to and during the colonial period; policies and practices which were largely carried over by the post-Independence government of Leopold Sedar Senghor. Prior to the advent of colonialism, trade policies established by the French in what is modern day Senegal promoted the export of groundnuts and groundnut oil to metropolitan France and the importation of relatively cheap rice from French colonies in Southeast Asia (IMF 2008). This, combined with protection for relatively uncompetitive French imports, meant that both

consumers and producers in Senegal were effectively shielded from market price signals, leading to an inefficient allocation of resources within both Senegal and the French metropole. With the advent of French colonialism in West Africa at the end of the 19th century, a system of tariffs and preferential trade policies favouring French commercial interests led to a pattern of trade which effectively discouraged capital accumulation and industrial development in Senegal. This was largely due to the influence of powerful French merchant capital and a colonial power which sought to spur its own economic development through the use of captive markets (Gellar 1976; Boone 1992). As a result, agriculture in Senegal, while dominated by the groundnut export sub-sector, took on a land-extensive, rather than intensive, nature, as low levels of investment necessitated that new land be opened up in order to increase production in the absence of productivity-enhancing technologies (Boone 1992).

Many of the extractive colonial policies in the agricultural sector were carried over by the post-Independence government, which relied heavily on agricultural exports to generate much needed foreign currency. This was done by manipulating producer prices, particularly for groundnuts, allowing the state to protect its share of the profits from the agricultural sector (Boone 1992; Mackintosh 1989). The resource drain caused by distortionary state interventions in agricultural markets was exacerbated by several other factors, both internal and external. The lack of widespread development and scarcity of capital in the agricultural sector was compounded by the unique position which

Senegal held amongst France's West African colonies. As a 'favoured' colony and the locus of colonial administration and industry in West Africa, Senegal evolved to attain a rather unusual population distribution, with a large government and service sector, located in Dakar, relative to total population. By the time of independence in 1960, the urbanized population accounted for 32 per cent of the total; nearly twice the average for Sub-Saharan Africa and much larger than could be economically supported. The structure and excessive size of the bureaucracy was largely carried over by the post-Independence government of Senghor, creating a considerable strain on state finances (which already relied heavily on revenues from the agricultural sector) and a much smaller agrarian workforce (IMF 2008).

Climatic factors also played a role in the agrarian crisis. The droughts experienced in the early 1970s had a significant negative effect on production (Oya 2006; FAOSTAT) and were followed by a period of declining rainfall. Time-series data collected from the Lower Casamance region shows that annual precipitation in the years following 1960 has consistently been several hundred millimetres below that in decades prior to 1960 (Linares 2002).

The transition to input intensive agriculture in India, beginning in 1966, can be attributed to a similar set of factors as those experienced by Senegal. The agrarian sector in India during this time was characterized by low levels of both public and private investment and highly inegalitarian landlord/tenant relationships (Kohli 2004). Food shortages in 1965 and 1966, and a growing

reliance on food aid from the United States, were exacerbated by a related foreign exchange crisis, leading to calls, both domestically and internationally, for the adoption of productivity-enhancing agricultural technologies (Corbridge and Harriss 2000; Kohli 2004; Mosley 2002). A growing scarcity of cultivable land also necessitated a transition from traditional modes of production, which tended to be land-extensive, to systems which promoted increased yields (Chakravarti 1973).

As in the case of Senegal, the roots of agrarian crisis in India can be traced to policies and practices prior to Independence from Britain in 1947. However, the colonial administration (known as the British Raj) in India was much more effective than that in Senegal in exploiting caste and class differences to realize colonial ambitions. The system of administration instituted by the British in India was characterized by indirect rule, in which the Raj came to rely heavily on powerful local landlords, known as *zamindars*, to collect land revenues from local peasants and to control landholdings (Corbridge and Harriss 2000). The powerful politico-economic relationships forged between the colonial administration and the *zamindars* were designed to create a system of colonial agrarian production which could effectively satisfy the needs of a rapidly industrializing Britain (Kohli 2004). This was somewhat different from the system of agricultural production established in Senegal during the colonial period, in

which powerful French trading firms directly organized and controlled much of the production within the agrarian sector, particularly with respect to groundnuts (Brooks 1975).

The agrarian sector in India during the British Raj could be broadly characterized by three predominant themes. There were minimal changes in the system of agricultural production and, thus, in productivity; however, with a concurrent increase in land taxes, imposed by the colonial administration, control of land favoured those who had access to capital. This resulted in a growing incidence of absentee landlordism, as many wealthy non-agriculturalists were able to gain control of productive farmland (Kohli 2004).

The colonial period also saw the development of a system of exchange whereby Indian primary products were traded for British manufactures. This led to changes in agricultural production, as some peasants abandoned food-crop production in favour of more profitable cash-crops, such as cotton. It also resulted in the demise of many small-scale, household-based, Indian manufacturers, who faced increasing competition from cheaper British imports - particularly with respect to textiles (Kohli 2004). The consequence of these for the agrarian sector was that, with the exception of a few commercial crops, productivity stagnated - possibly even declining - during the inter-war period. Much of this stagnation was attributable to low levels of investment in irrigation



and inequitable distribution of land (an estimated 35 per cent of peasants were tenants at Independence, many of them sharecroppers) (Corbridge and Harriss 2000).

A final theme during the colonial period related to investment in infrastructure, which saw the creation of a national railway system and concomitant integration of various regions of India into a more unified market (Kohli 2004).

These themes also emerge in an examination of the causes of agrarian stagnation and crisis in Senegal. While absentee landlordism was never a significant issue in Senegal, a reliance on land-extensive methods of production, both during and after the colonial period, meant that yield productivity (growth in output per unit of land) did not increase significantly (Haggblade et al. 2010). The ability to increase production by opening up new land provided little incentive to invest in more expensive productivity-enhancing technologies. In addition, widespread promotion of cash-crop production, which was facilitated by distorted trade policies, created a culture of dependency by discouraging local capital accumulation while, at the same time, encouraging the importation of cheap food-crops (primarily rice from Southeast Asia) (Boone 1992; Mackintosh 1989, Tosh 1980). While this system of production and trade worked to concentrate resources in the hands of French merchant capital, it effectively discouraged private investment in the agrarian sector which would have increased productivity.

Following Senegalese independence in 1960, the state largely took over the agricultural marketing role previously filled by the French trading firms and continued to employ extractive policies in a bid to guard its share of agricultural revenues (Boone 1992). The development of transport links, particularly roads, extending into the interior of Senegal served to integrate a growing number of producers into a national system of agricultural production. As these farmers were exposed to a more commercialized form of agriculture, many abandoned food-crop production in favour of more profitable cash-crop cultivation (Mackintosh 1989).

The result of resource reallocation from food to cash-crop production, both in Senegal and India, led to a significant decline in regional food-crop production. This was compounded by a lack of capital accumulation in the rural private sector - due to extractive policies employed by both colonial and post-Independence administrations - and contributed directly to the agrarian and, by extension, the fiscal crisis experienced in both cases.

### **Characteristics and Outcomes of Agricultural Intensification**

Although the historical factors contributing to agrarian crisis in Senegal and India share striking similarities, the characteristics of efforts to address the crises, via agricultural intensification, were widely divergent. In Senegal, stagnating agricultural production and the terms of structural adjustment resulted in implementation of the aforementioned *Nouvelle Politique Agricole*. The NPA sought to increase cereals self-sufficiency from a level of 50 per cent, in 1984, to

80 per cent, and to transfer certain activities, previously the domain of the state, to the private sector. (Martin and Crawford 1991). This production goal was thought to be achievable through a combination of market liberalization, input and commodity price deregulation, improved market information systems and a campaign to promote the consumption of locally-produced cereals (Oya 2006). However, the reduced role of parastatals, mandated by the conditions of structural adjustment, meant that producers were no longer able to rely on public agencies, such as ONCAD (*Office National de Coopération et d'Assistance pour le Développement*; the state agricultural marketing agency), for the provision of agricultural inputs and credit (Benoit-Cattin 1991). Instead, they were forced to turn to private traders, who either lacked the capital to provide adequate resources to farmers, or were simply reluctant to invest in risk-prone agriculture-related activities (Martin and Crawford 1991). This was compounded by a significant increase in the price of chemical fertilizers due to the removal of state subsidies. The resulting constraints faced by producers under SAP and NPA resulted in a decrease in the use of modern inputs, which fell to a post-Independence low by the mid-1980s (Kelly and Delgado 1991). The consequences of this decline were reflected in agricultural output volumes, which fluctuated widely during the 1980s without experiencing significant growth in output of either groundnuts or the major staple crops of millet and sorghum (FAOSTAT).

Like Senegal in the 1980s, India faced a growing agricultural and fiscal crisis in the 1960s, necessitating the implementation of policies to bring about greater food self-sufficiency. However, unlike in Senegal, the interventions in India were much more state-directed in nature. In 1966, under the leadership of C. Subramaniam as Minister of Agriculture, a new agricultural policy was formulated which moved away from the previous institutional approach and emphasized technological change and price incentives to spur large-scale investment in modern inputs, especially chemical fertilizers, and high-yielding varieties (HYVs) of wheat and rice (Corbridge and Harriss 2000). This set of policies, and the resultant outcomes, came to be known as the "Green Revolution".

Introduction of HYVs to Indian agriculture resulted in a major shift from labour-intensive farming to a system of cultivation which took on an increasingly capital-intensive character (Saini 1976). HYVs, and associated inputs (chemical fertilizers, pesticides and irrigation), presented the opportunity for small-scale and marginal producers to take advantage of increased productivity due to their scale-neutrality and favourable input-output cost ratios (the latter, largely the result of substantial government subsidies) (Ninan and Chandrashekar 1993; Corbridge and Harriss 2000). The effect of these interventions in the agrarian sector in India was nothing less than dramatic. The area seeded to HYV cultivars of paddy rice, wheat, maize, jowar (sorghum) and bajra (millet) increased from 1.89 million hectares (or 2.2 per cent of total cultivated land) in

1966/67 to 9.30 million hectares (10.4 per cent) in 1968/69 (Chakravarti 1973). Green Revolution technologies spread steadily across India in both food-crop and non-food cultivation so that, by the 1990s, most farming households in India had adopted these technologies (Vakulabharanam and Motiram 2007). So successful has the Green Revolution been that, since 1966, when HYVs and associated technologies were first adopted, India has increased its production of food-grains such that it has made the transition from a net food importer to an exporter of cereals (FAOSTAT; Mittal and Krishnan 1997).

Given that the factors leading to agrarian crisis in both India and Senegal were rather similar, what accounts for the divergent outcomes of efforts to bring about agricultural development? One of the primary differences to emerge in efforts to bring about agricultural development was the level of public sector intervention, which proved decisive in determining the outcomes of the NPA and Green Revolution. In Senegal, the 1980s were marked by disengagement of the state from the agrarian sector, as the country entered into structural adjustment. This coincided with a push to achieve greater food self-sufficiency under the NPA, but the removal of credit facilities and subsidies for agricultural inputs at the behest of the IMF was not counterbalanced by a corresponding increase in private sector involvement, as some private traders lacked the resources to provide to farmers, while others were simply averse to investing in what were perceived to be high-risk agricultural activities (Martin and Crawford 1991). The co-ordination failure between the public and private sectors essentially left

farmers to fend for themselves in the face of adverse climatic conditions, fluctuating world market prices and a general lack of access to information. This was particularly true of rice cultivation, where an historic reliance on imported rice meant that competition from cheaper rice sourced from Southeast Asia made indigenous rice cultivation unprofitable (IFAD 2003; Camara et al. 2006).

In India, by contrast, much of the success of policies implemented during the Green Revolution can be attributed to direct interventions by the state in the agrarian sector. The high rates of adoption and rapid dissemination of productivity-enhancing agricultural inputs, as well as the development of irrigation infrastructure, can be attributed, in large part, to input subsidies and institutional credit provided by both the national and state governments (Dorin 2000; Vakulabharanam and Motiram 2007). These, along with public investment in irrigation and extension services, encouraged the uptake and utilization of agricultural packages - consisting of HYVs, fertilizers and pesticides - by reducing the costs of cultivation and the risks associated with investments in infrastructure (Omvedt 1981; Lawrence 1988; Mosley 1994). The provision of public marketing services also served to reduce risk for farmers by shielding them from market volatility and providing a guaranteed outlet for agricultural production (Omvedt 1981; Vakulabharanam and Motiram 2007).

## **The Potential for Agricultural Intensification in Senegal**

In light of the success of India's Green Revolution policies to increase agricultural output and the general failure of the *Nouvelle Politique Agricole* in Senegal, what lessons can be taken from these in an attempt to analyse the outcomes of recent initiatives by the Government of Senegal to increase national food self-sufficiency?

The GOANA programme aims to take up the challenge of achieving food self-sufficiency through various sub-programmes targeted at both producers and markets (NEPAD-CAADP(b)). These include support for producers of maize, niébe (cowpeas), manioc and other cereals; self-sufficiency in rice production; development of the dairy industry; and investment in rural infrastructure and land development. The GOANA programme is complemented by a "Forestry Action Plan" which aims to reverse trends in environmental degradation and encourage the participation of actors from the private sector in natural resource management (NEPAD-CAADP(b)). GOANA lays out specific targets to substantially increase production of various food and cash-crops through increases in both productivity (yield) and area under cultivation. These will be achieved through interventions by both the public and private sector to develop irrigation infrastructure, increase access to agricultural credit, subsidize inputs, improve access to high-quality seed and promote the use of high-yielding varieties (HYVs) of cultivars, ensure provision of equipment for harvesting and processing and improve the rice marketing system (GOANA(a)).

Analysis of the GOANA programme, and its implications for agricultural development, will draw on three themes which were important determinants of the success of policies implemented during the Green Revolution in India: (a) land (in the case of India it was a scarcity of cultivable land), (b) improved cultivars (HYVs) and yields, and (c) policies.

## **Land**

A growing scarcity of cultivable land in India toward the middle of the last century was an important factor in the adoption of productivity-enhancing, Green Revolution technologies (Chakravarti 1973). According to Paul Mosley, as land becomes more scarce relative to other factors of agricultural production, it becomes economically rational to transition toward production techniques which employ, relatively intensely, the factors of production that have become less expensive (Mosley 2002: 9). As suitable agricultural land became increasingly scarce in India, there was a fundamental shift in the relative price of more costly land-intensive technologies compared to traditional land-extensive methods of production. This shift in relative costs made it much more attractive to adopt the land-intensive technologies, particularly HYVs, and encouraged their dissemination across the country (Vakulabharanam and Motiram 2007).

The current land situation in Senegal is somewhat different from that which India faced in the 1960s. Estimates place the amount of land utilized for major food and cash-crop production at about 1,870,000 hectares, or 22 per cent of land available for agriculture (GOANA(c); FAOSTAT). This has meant that



farmers have been able to continue to employ less costly land-extensive methods of agricultural production. The nature of land tenure in Senegal has provided a further incentive for expanding output through the opening up of new land. Unlike in India, where private ownership of land and land scarcity have resulted in the development of land markets (Omvedt 1981), land in Senegal falls under the purview of the *Loi Relative au Domaine National* (LDN), the national land law, which states that most land (95 per cent) within Senegal is owned by the state, but is entrusted to municipalities for administration. The municipalities are to give a current tenant formal rights to land, provided that the tenant uses the land to engage in productive activities (Tzeutschler 1999). This allows farmers to expand production extensively or, alternatively, they are able to move existing production onto new land once the soil in their current perimeters is exhausted. The effect of land availability in Senegal is to essentially reinforce the relative cost of productivity-enhancing technologies compared to traditional land-extensive technologies, making the former much more cost-prohibitive and discouraging their adoption by smallholder farmers.

The issue of land abundance discouraging the adoption of productivity-enhancing technologies is indirectly addressed by the GOANA programme. One of the objectives within the programme is to increase the area being cultivated for major food and cash-crops to 3,871,550 hectares by 2015 (GOANA(c)). This would effectively consume all of the cultivable land in the country, leading to a situation much like that in India prior to the Green Revolution, where a scarcity of

land resulted in the aforementioned shift in relative costs of input-intensive and land-extensive modes of production.

### **Cultivars and Yields**

While extensive growth in agricultural output can partially satisfy domestic demand in Senegal, a long-term strategy will invariably necessitate the adoption of some Green Revolution-type technologies if the GOANA programme - and its target to significantly increase agricultural output - is successfully implemented. The current nature of the agrarian sector, with its labour-scarce, land-extensive modes of production, will be increasingly pressed to keep up with demand as the country's population continues to take on a more urban composition (urban population, as a per cent of the total population, has steadily increased from 23 per cent in 1960 to 42 per cent in 2008 (World Bank(b)). Increasing climatic and environmental pressures will also serve to make conditions more difficult for smallholder farmers (IMF 2008).

The development of improved cultivars, particularly HYVs of wheat and rice, was one of the cornerstones of the Green Revolution in India. The scale-neutrality of HYVs, and the fact that they made use of the factor of production which smallholder farmers possessed in relative abundance - labour - meant that the majority of producers were able to directly benefit from their use (Mosley 2002). By promoting the adoption of HYVs, and the associated package of productivity-enhancing inputs, the Government of India was able to overcome the

growing land constraint, significantly increasing agricultural yields while at the same time providing economic benefits to India's many smallholder farmers.

In Sub-Saharan Africa, including Senegal, the development and propagation of improved varieties of staple crops has not, historically, enjoyed the same success. The lack of adoption of HYVs in Africa during the 1960s and 1970s was largely attributed to the failure of national and international programmes to identify indigenous crop varieties from which new cultivars could be developed that were suitable for local conditions. Instead, they sought to 'short-cut' the process of varietal improvement by introducing unsuitable varieties of various crops from Asia and Latin America (Evenson and Gollin 2003).

However, this has changed, somewhat, in recent years, due to collaborative efforts between national research systems and international agricultural research institutions to develop improved varieties of staple crops. Research undertaken by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in collaboration with national partners, has resulted in the development of improved varieties of sorghum and millet that have demonstrated higher yields and improved resistance to pests and disease, while at the same time being adapted to drought-prone environments (Camara et al. 2006). Studies conducted using improved varieties of both millet and sorghum in various West African countries suggest that yields could be increased by as much as 63 per cent, in the case of millet, and 85 per cent, in the case of sorghum (Camara et al. 2006). Likewise, research involving cassava has had a significant impact

on cassava production in several Sub-Saharan countries. This is especially true of Nigeria and Ghana, where the development of new cultivars with improved yields and resistance to pests has resulted in a marked increase in cassava production (Nweke and Haggblade 2010). Rice, too, has benefited from research to develop improved cultivars that can be grown in agro-climatic conditions unique to Sub-Saharan Africa. Since the early 1970s, the Africa Rice Centre has worked to develop hybrid rice varieties that combine the improved yields of Asian varieties of rice with the disease resistance and hardiness of indigenous African species (ARC).

Targets laid out in GOANA seek to increase both area under cultivation and yields of all major food crops in Senegal, including millet, sorghum, rice and, to a lesser extent, cassava (GOANA(c)). The Government of Senegal has also stated the need to promote the use of high quality seed and to encourage the uptake of HYVs (GOANA(a)). But will extension services and campaigns to promote the use of HYVs be enough to effect their widespread adoption by smallholder farmers? Evidence from India suggests that this, alone, is not sufficient and that other economic policies and public interventions in the agrarian sector are required to make cultivation of HYVs more attractive to smallholder farmers (Corbridge and Harriss 2000; Dorin 2000; Vakulabharanam and Motiram 2007). This is particularly true given that farmers in Senegal do not face the land constraint that farmers in India did in the 1960s, which necessitated the adoption of productivity-enhancing technologies.

## **Policies**

The widespread adoption of HYVs and associated inputs in India was facilitated by the provision of institutional credit and large subsidies for agricultural inputs. During the period 1981 to 1993, subsidies for credit, irrigation, electricity and fertilizers averaged between 9 and 12 per cent, annually, and, by 1993, accounted for over 2 per cent of national GDP (Murgai et al. 2001). The decreased cost of agricultural inputs as a result of these subsidies created much more favourable input-output ratios for farmers which meant that they were able to retain a larger share of their earnings; as a given amount of production was now possible with a lower monetary investment in inputs (Corbridge and Harriss 2000). The use of subsidies, combined with public investment in rural infrastructure - particularly for irrigation - and the provision of credit enabling greater private investment in agriculture, served to reduce the risk to farmers who were able to realize the gains from productivity-enhancing technologies and practices while avoiding having to make a significant investment in unfamiliar and, to them, unproven technologies.

In drawing up its most recent initiative for agricultural development the Government of Senegal appears to have learned from past failures and the successes of programmes such as India's Green Revolution. Rather than leaving the provision of inputs and credit to the private sector, as was the case in the 1980s under the NPA, the government has taken a more interventionist approach under GOANA, much as India did beginning in the 1960s. Issues

which GOANA seeks to address include the development of irrigation infrastructure, improving rural access to credit, subsidization of inputs, the use of HYVs, and the provision of extension services to improve agricultural techniques and natural resource management (NEPAD-CAADP(b); USDA 2010); all of which were crucial to the success of the Green Revolution.

The Government of Senegal has shown that it is not merely content to formulate plans, but has demonstrated a commitment to follow its own rhetoric by significantly increasing public investment in agriculture. According to work done by the International Food Policy Research Institute (IFPRI 2005), Senegal is one of several countries in Sub-Saharan Africa which has been able to attain the targeted agricultural expenditure of 10 per cent of national government expenditures, as laid out in the Comprehensive Africa Agriculture Development Programme under NEPAD (NEPAD-CAADP(a)) - in 2007, the share of agriculture expenditures in total government expenditures was about 14 per cent (Omilola and Lambert 2009). This increased investment was followed by a noticeable rise in output in the agrarian sector, as the annual agricultural growth rate in 2008 was 12.7 per cent - well above the CAADP target of 6 per cent (NEPAD-CAADP(a); Omilola and Lambert 2009).<sup>2</sup>

While it is too early to tell if the GOANA programme will meet with success, one of the most binding constraints to its implementation could prove to be access to sufficient foreign funding. With the programme requiring an

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<sup>2</sup> This statement is made with some caution, as agricultural output is highly dependent on climatic factors in addition to levels of investment.

increase of about 13.5 per cent in official development assistance, its successful implementation could very well be determined by the government's ability to convince international donors - who already provided 23 per cent of overall government expenditures in 2007 (U.S. Dept. of State) - to increase their financial commitments in order to fund a sector of the economy which has, historically, performed poorly.

In light of the evidence and analysis presented in this chapter, what conclusions can be drawn concerning the comparative experiences of agricultural development in India and Senegal, and the potential for Green Revolution-type agricultural intensification to occur in Senegal? The land-extensive modes of agricultural production which predominated prior to colonialism were effectively exploited by the British Raj, in India, and both the French colonial administration and private French trading firms, in Senegal, to benefit merchant capitalist interests in the respective colonial metropolises. The integration of indigenous producers into regional production markets and promotion of cash-crop cultivation resulted in a reallocation of resources from food to cash-crop production and subsequent stagnation of food-crop production. This was exacerbated by relatively low levels of investment in the agrarian sector and cheaper food imports, effectively disincentivizing local farmers from investing in the cultivation of food-crops. The result of this was that, by the mid-1960s, in India, and the early 1980s, in Senegal, both countries were facing agrarian crises characterized by stagnating agricultural production.

Policies implemented to address these crises had widely differing outcomes due to the nature of the initiatives themselves. In India, heavy state intervention, in the form of input subsidies, provision of institutional credit, extension services and investments in rural infrastructure led to widespread adoption of productivity-enhancing technologies and allowed India to become self-sufficient in the production of major cereal crops. In contrast, the strictures imposed by the IMF's structural adjustment programme in Senegal led to a disengagement of the state from the agrarian sector at the same time that the state was attempting to increase food self-sufficiency through the NPA. Many of the activities previously the domain of the state, including provision of inputs and credit and marketing of agricultural output, were left to the private sector which was too risk-averse and capital-poor to meet the needs of farmers. The consequence of this was continued stagnation in the agrarian sector, as many farmers were unable to move beyond subsistence production.

This leads to the conclusion that, in the face of a weak private sector and low rates of investment, it is necessary for the public sector to intervene in order to mitigate risk for the private sector to such an extent that there is a clear and assured benefit to investing limited resources. With respect to the agrarian sector, this meant that the Indian government needed to provide input subsidies and institutional credit, and to invest in the development of public goods - namely irrigation - in order that smallholder farmers would be willing to invest their meagre resources in, what were to them, unknown technologies and practices.



It appears that this lesson has been learned by Senegal as it seeks to bring about development of its agrarian sector through the GOANA programme. Policies laid out in the programme include significant state intervention in the form of input subsidies, institutional credit, extension services and investments in rural infrastructure. These plans have been followed by increased public expenditures in the agricultural sector, since 2007, and a concomitant increase in the annual rate of growth in output within the sector. Two issues of import that the Government of Senegal will need to address are the significant level of external funding required to implement GOANA and the provision of the right set of incentives to encourage smallholder farmers to adopt more expensive productivity-enhancing technologies rather than continuing to rely on much lower cost land-extensive practices to increase agricultural production.

## **IV Lessons Learned: Consequences of the Green Revolution and Implications for Senegal**

India's journey to food self-sufficiency has not been without consequence. The impressive gains in both productivity and output in its agricultural sector have been lauded as a success yet, as early as the 1970s, it began to emerge that the Green Revolution was having significant negative effects on the agrarian economy and the environment. Several studies pointed to the fact that agricultural intensification, and the associated capital requirements, were leading to environmental degradation, as well as having socio-economic and human health consequences (Saini 1976; Omvedt 1981; Mohan 1987; Ninan and Chandrashekar 1993; Dorin 2000). Many of these effects have persisted into the present and continue to pose problems vis-a-vis rural and agricultural development.

This, then, begs the question of what might be the consequences for Senegal as it implements policies to realize national food self-sufficiency. Is it likely that efforts to bring about agricultural development through intensification will have similar socio-economic, environmental and human health consequences for smallholder farmers as those observed in India?

## **Socio-economic Consequences**

The emergence of a capitalist class in rural India - a result of the landlord-tenant relationships dating to the pre-colonial and colonial eras, and the commercialization of agricultural input and production markets during the Green Revolution - has had a profound effect on smallholder farmers, and has led to a number of socio-economic consequences (Omvedt 1981). Prior to Independence in 1947, there existed only a few pockets of capitalist farmers in certain regions of the country; however, this changed significantly in the 1950s with the passing of the Zamindari Abolition and Tenancy Acts, which sought to effect land redistribution (Omvedt 1981). Redistribution of land from traditional large landowners to rich rural peasants, known as *kulaks*, led to the rapid growth of a rural capitalist class throughout India (Omvedt 1981). The economic power of the *kulaks* was greatly enhanced by government programmes, during the Green Revolution, aimed at increasing productivity in agriculture. Public investment in irrigation and dam-building, as well as the promotion of improved cultivars, tended to disproportionately benefit the landholding *kulaks*, who were able to access a greater share of government resources than smallholder farmers (Omvedt 1981). The result was a rise in socio-economic disparities between the land-owning rural elite and smallholder and marginal producers (Chakravarti 1973). This was exacerbated by a shift in absolute advantage brought about by the transition from traditional labour-intensive modes of production to modern capital-intensive farming. Whereas smallholder farmers

were previously able to utilize surplus labour in order to effect gains in production - and, therefore, minimize the land and income inequalities, vis-a-vis large landowners - the capital-intensive technologies introduced during the Green Revolution allowed those with access to capital to leverage a broader resource base to gain an advantage over small farming households (Saini 1976).

The conditions faced by smallholder farmers in Senegal are somewhat different from those in India, however, the potential for similar consequences to develop in Senegal warrants comparison. Under the LDN, land ownership in Senegal falls under the purview of the national government, while local councils mediate land usage rights to guarantee access by those in the local community able to utilize it productively (Tzeuschler 1999). As such, land usage rights are, at least in theory, much more egalitarian in Senegal than in India. The growing land scarcity which accompanied the Green Revolution in India worked to "crowd out" many of the resource poor smallholder peasants, who were unable to effectively compete with more wealthy peasants and landowners. The wealthier farmers, or *kulaks*, were able to gain an advantage as growth in agricultural output became increasingly reliant on intensive cultivation, following the mid-1960s. This served to disadvantage smallholder and marginal peasants who had traditionally relied upon labour-intensive, land-extensive methods of farming (Corbridge and Harriss 2000; Saini 1976). Faced with an inability to expand production by traditional methods, many small and marginal farmers were forced to sell their land and turn to wage labour in order to repay mounting debts

incurred through the use of newer, input-intensive technologies. The resulting growth in proletarianization within the rural population had the effect of further exacerbating already significant inequalities within the agrarian sector (Lawrence 1988; Deshpande and Nagesh 2005).

It is also clear that land tenancy in India has become more capitalist in nature, resulting in the development of land markets (Omvedt 1981). While this can be seen as a necessary development, enabling farmers to utilize land as collateral to secure credit, in India, it had the effect of increasing the concentration of land ownership (between 1961/62 and 1970/72, land ownership by the top 10 per cent of farming households increased from 58.7 to 61.8, and possibly higher) (Omvedt 1981).

Unlike India in the 1960s, Senegal is not currently facing a constraint with respect to overall cultivable land (GOANA(c); FAOSTAT). As such, smallholder farmers will continue to be able to increase production through land-extensive means. The GOANA programme aims to capitalize on this availability of land by encouraging both extensive and intensive cultivation of major food and cash-crops. A target has been established to increase total cultivated land from 1,869,442 hectares in 2008 to 3,871,550 hectares in 2015. With an estimated total area of 3,804,900 hectares suitable for cultivation, the target set out in GOANA means that Senegal will be facing a scarcity of cultivable land within the next few years (GOANA(c)). A consequence of this would be that smallholder farmers would lose their production advantage (due to traditional land-extensive

methods of cultivation) compared to larger commercial farmers. The ability of larger farmers to disproportionately gain from capital-intensive methods of cultivation presents the prospect of a growth in rural inequality, as was witnessed in India (GOANA(c)).

Increasing commercialization of the agrarian sector, as indicated by government attempts to promote private sector investment in large-scale irrigated rice projects (GOANA(b)), could also have negative consequences, as growth in the demand for land could result in land alienation and marginalization of smallholder farmers. Irrigated rice is cultivated along the Senegal River, in the north of the country, and along the Casamance River, in the south. In the Senegal River valley, much of the irrigated land cultivated by small farmers is leased from large landholders and, lacking adequate capital, these poorer farmers must rely on those with access to resources, including the state, to obtain credit for rice cultivation. As well, due to its capital-intensive nature, the construction of new flood-protection levees for rice cultivation, particularly in the most fertile *waalo* areas, is often left to those with sufficient resources. Many times, these are outside entrepreneurs or foreign agri-businesses (Tzeutschler 1999).

These factors are complicated by the nature of land tenure under the LDN. While access to land is administered by municipal councils, who are to provide formal land rights to those able to productively use it, the councils themselves are often entrenched in traditional patron-client relationships involving the state,

political parties, and the religious elite (Tzeuschler 1999). These economic and social relationships have the potential to significantly disadvantage smallholder farmers, particularly in light of the GOANA programme's objective to commercialize rice production (GOANA(b)). A push toward private-sector investment and the development of large-scale irrigated rice projects could result in land alienation, leading to proletarianization and large inequalities within populations in rice-producing regions. This assertion is supported by historical evidence from Senegal, as well as Nigeria, where state promotion of large-scale agricultural irrigation projects has been accompanied by significant turmoil for small farmers. This turmoil has been manifested in significant social upheaval (due to the dissolution of traditional structures of production and relocation of villages), land alienation and increased proletarianization of the rural population (Adams 1979; Adams 1988; Ocheje 2007).

In addition to competition for land, smallholder farmers could face increasing competition for agricultural resources from new entrants into the agricultural sector. The previously mentioned promotion of large-scale rice cultivation projects is intended to provide the right incentives for wealthier (and often politically connected) individuals to take up farming (GOANA(b)). With greater economic and political resources at their disposal, this new rural elite, along with the traditional elite - Muslim religious leaders known as *marabouts* - would be able to out-compete small resource-poor farmers for institutional credit and agricultural inputs. In India, smallholder farmers found themselves

increasingly at the mercy of the *kulaks*, who were able to access a disproportionate share of inputs and also exercise control over poorer farmers through the provision of informal credit in the absence of adequate institutional credit (Omvedt 1981; Lawrence 1988).

The transition to more commercialized farming tended to increase the vulnerability of smallholder farmers in India to market uncertainty and volatility, due to an increased reliance on market-sourced inputs and market-oriented production (Ninan and Chandrashekar 1993). Input markets became increasingly monetized during the Green Revolution, as fertilizer consumption and institutional credit provision grew. During this period of increased commercialization, the proportion of private to total gross capital formation in agriculture increased from 67 per cent, in 1960-61, to 77 per cent, in 1992-93, indicating growing investment in agriculture by the private sector. Evidence suggests that commercialization of agriculture, particularly since the 1980s, has not had a noticeable effect with respect to changes in the size of landholdings. A study of 15 villages in three Indian states showed a positive correlation between poverty reduction and increased levels of commercialization. However, the same study showed that inequality, through the mechanism of proletarianization, tended to increase with commercialization (Nadkarni and Vedini 1996).

Farmers in Senegal first experienced exposure to market fluctuations with the withdrawal of French price support for groundnuts in the mid-1970s (Gray 2002); however, this exposure increased significantly with the implementation of



structural adjustment in the early 1980s. The reduced role of the state, necessitated by liberalization policies under SAP, and the inability of private traders to fill the gap left by the state, meant that farmers were increasingly subject to market forces (Martin and Crawford 1991). Increased commercialization of agriculture under GOANA could further aggravate this by increasing the vulnerability of farmers to unknown and, at times, volatile market forces. The promotion of increased productivity through access to credit, subsidized inputs, the use of HYVs, and better equipment for harvesting and processing would necessitate increased investment on the part of smallholder farmers; however, greater access to credit would have the effect of increasing the debt burden on these farmers (USDA 2010). Within the GOANA programme, provision has been made for the extension of social security and insurance to smallholder farmers, but it is difficult to determine if this would be sufficient. The potential for farmers to incur unmanageable debt levels, with the expectation that the state will intervene on their behalf if necessary (as was the case following a series of droughts in the 1970s (Gray 2002)), could leave them vulnerable to predatory lenders, including wealthy landowners. This has been observed in India in recent decades, where many poorer farming households have been forced to turn to the informal sector for credit. This credit is often extended at usurious rates of interest and with conditions attached that facilitate coercion on the part of moneylenders (Ramachandran and Rawal 2010).

## **Environmental Consequences**

The socio-economic consequences in India were compounded by an increasing environmental toll exacted by agricultural intensification. The immediate effects of intensification, which included waterlogging, salinity and alkalinity in irrigated areas and soil erosion, declining water tables and desertification in more arid regions (Ninan and Chandrashekar 1993) also served to make agriculture more susceptible to long-term climatic and biological pressures such as adverse weather and plant pathogens (Omvedt 1981).

The environmental impacts of the Green Revolution can largely be attributed to widespread public development of irrigation and subsidization of inputs and credit (Murgai et al. 2001). During the period 1981 to 1993, subsidies for credit, irrigation, electricity and fertilizers averaged between 9 and 12 per cent, annually, and, by 1993, accounted for over 2 per cent of national GDP (Murgai et al. 2001). The subsidization of inputs, and the resulting depletion of groundwater sources and soil degradation, represent a classic case of negative externalities. By encouraging rapid development of irrigation in the absence of adequate state regulation, and by failing to remove subsidies following widespread adoption of modern inputs, the government effectively distorted the decision-making process for producers, allowing them to reap the economic rewards - in the form of increased yields - of increased irrigation and fertilizer use, without incurring a proportionate share of the environmental consequences - water resource depletion and soil degradation (Ninan and Chandrashekar 1993;

Murgai et al. 2001; Vakulabharanam and Motiram 2007). The heavy promotion of modern inputs also had the effect of inducing farmers to move away from traditional, environmentally sound agricultural practices by advocating these modern inputs as substitutes, rather than complements, to traditional systems of cultivation (Ninan and Chandrashekar 1993).

Intensified use of modern inputs, subsidies for fertilizer and public development of irrigation, as outlined in GOANA, could result in a similar scenario in Senegal - with increasing levels of soil degradation and groundwater resource depletion (USDA 2010). Soil erosion, salinization and disappearance of vegetation are recurring themes which have compounded the inherent problem of low levels of organic matter in Senegal's soils (CIDA; McClintock and Diop 2005). As in the case of India increased use of fertilizer, encouraged by government subsidies, and a failure to observe fallow periods as a result of the push to increase production (USDA 2010), could result in further degradation of Senegal's already fragile soils. As soils in Senegal are much more prone to leaching and both mechanical and water erosion than those in India - particularly South India - intensification of input use and cultivation methods would likely see a much earlier onset of soil degradation in Senegal than was observed in India (Gunnell 1997).

The promotion and development of irrigation projects, in the absence of appropriate state regulation, could also have a significant negative effect on the environment, vis-a-vis Senegal's freshwater resources. While water utilization for

agriculture is much lower in Senegal than in India (5.3 per cent of total water resources in Senegal compared to 29.4 percent in India), overall water resources - which include both surface and groundwater - are over three times greater in India than in Senegal (4,305 m<sup>3</sup>/ha/yr. in India compared to 1,340 m<sup>3</sup>/ha/yr. in Senegal) (AQUASTAT; FAO(a); FAO(b)). A marked increase in irrigation under GOANA could result in depletion and/or salinization of water tables, as groundwater is consumed at a faster rate than it can be replenished.

The evidence presented suggests that subsidized agricultural inputs and the provision of institutional credit within the GOANA programme could lead to a similar situation as that in India, whereby farmers do not fully internalize the environmental costs of increased input use and irrigation. Avoiding the pitfall of these environmental externalities will require a concerted effort, on the part of the government, to ensure that measures within GOANA to promote local management of communal water resources are enacted, and that local actors are actively encouraged to jointly manage land and water resources (NEPAD-CAADP(b)). It will also require that the government effectively manage input subsidies in a way that increases their uptake by smallholder farmers while, at the same time, guarding against their politicization. In the case of India, a failure to phase out subsidies after they had accomplished their intended purpose meant that they increasingly came to be relied upon for income-support; and their politicization made their eventual removal even more difficult (IFPRI 2005). It is imperative that the Government of Senegal work closely with farmers and

producer groups to ensure effective implementation of subsidy programmes, but to prevent these programmes from being extended beyond the point at which they cease to be of an overall net economic benefit.

## **Human Health Consequences**

The use of productivity-enhancing inputs was integral to the success of the Green Revolution in India; however, use (and often overuse) of these inputs has caused growing unease with respect to their impact on human health. Of particular concern is the use of pesticides, an important component of the agricultural input packages introduced during the Green Revolution (Chakravarti 1973). Pesticide use in industrial agriculture is shown to be associated with an elevated risk of cancer for both agricultural producers and consumers and has also been linked to endocrine disruption and reproductive dysfunction (Horrigan et al. 2002). Studies conducted in India have demonstrated a relationship between Green Revolution technologies, particularly the use of modern agricultural machinery and pesticides, and the incidence of amputations and physical deformities. Statistics gathered by the National Sample Survey Organization of India in 1981 suggested a significant positive correlation between the intensity of pesticide application, per hectare, and congenital physical deformities (Mohan 1987). This is supported by work done by the India Veterinary Research Institute, which demonstrated an association between the

presence of DDT and BHC - two commonly used pesticides - in fish, meat, and eggs and reports of cancer, stunted growth, deformities and blindness (Mohan 1987).

In addition, there are the acute dangers posed by the use of pesticides. The United Nations has estimated that approximately 2 million poisonings and 10,000 deaths result from pesticide use each year, with three-quarters of these occurring in developing countries (Horrihan et al. 2002). A study of acute pesticide poisoning amongst cotton farmers in the Indian state of Andhra Pradesh revealed that over 80 per cent of study participants reported at least some form of acute pesticide poisoning. Of particular concern was the fact that smallholder and marginal farmers were six times more likely to experience severe pesticide poisoning than medium-sized farmers, and over ten times as likely to be severely poisoned than large farm owners. Evidence suggested that levels of formal education were, at least in part, responsible for the degree of pesticide exposure (Mancini et al. 2005).

The consequences of agricultural intensification in Senegal for human health are unclear, being speculative at best. The dearth of information on pesticide use in developing countries makes it difficult to compare usage patterns between India and Senegal; however, data from the Food and Agriculture Organization of the United Nations indicates that pesticide application rates are as much as 2-3 times higher in India than in Senegal (India: 27,405 tonnes; Senegal: 346 tonnes - 2002) (FAOSTAT).

Within the GOANA programme, 13,019,000 FCFA (about US\$31,000) has been allocated for the provision of pesticides, which translates into approximately US\$4,400 per year (2008 US\$) over the course of the programme (GOANA(a)). A lack of data on private-sector expenditures on pesticides under GOANA makes it difficult to gauge the overall effect of agricultural intensification on pesticide use and, thus, the potential consequences of their use for human health. It is likely that the ability to mitigate the effects of pesticide use on both human health and the environment will largely be contingent on efforts made by the Government of Senegal to implement agricultural extension and training programmes. As previously indicated, evidence shows that education has played a role in how pesticides in India are handled and the resultant levels of exposure to them (Mancini et al. 2005). This suggests that intensification of chemical pesticide use in Senegal will need to be combined with extension services that provide adequate training and education to smallholder farmers in order to prevent the emergence of pesticide-related human health consequences in Senegal.

## V. Conclusions

The historical roots of agrarian crisis in India and Senegal show distinct similarities despite the fact that the structure of the agricultural sectors in each country was, and continues to be, quite different. The crisis that India experienced in the 1960s, and Senegal in the 1980s, can be traced to the land-extensive modes of production that predominated prior to the colonial period, which provided little incentive to invest in productivity-enhancing technologies or practices. These extensive methods of cultivation were effectively exploited by colonial administrations and private commercial interests to satisfy the growing demands of rapidly industrializing Britain and France. The promotion of cash-crop production, limited investments in infrastructure (with the exception of transportation links), and distorted trade policies (which involved the trade of primary products from the colonies for manufactures from the colonial metropolises), firmly entrenched producers in a system of production that saw a reallocation of resources from food-crop to cash-crop cultivation. The result of this reallocation was that, by the mid-1960s, in India, and the early 1980s, in Senegal, food-crop production had effectively stagnated and both countries were facing a growing fiscal and agrarian crisis.



Initiatives to address these crises (the Green Revolution in India and the *Nouvelle Politique Agricole* in Senegal) had widely divergent outcomes that can be largely attributed to the level of state intervention in each case. In India, the provision of state subsidies, institutional credit and public investments in irrigation infrastructure led to widespread adoption of productivity-enhancing technologies and allowed the country to become self-sufficient in food-grain production. This is contrasted with the withdrawal of the state in Senegal (due to conditions imposed under structural adjustment) from the agricultural sector in the 1980s and the subsequent failure of the NPA, as smallholder farmers were left to rely on a resource-poor and risk averse private sector for the provision of inputs and production marketing services. This strongly suggests that state intervention plays an important role in sectoral development within an economy when the private sector is unable, or unwilling, to provide the resources necessary to spur development.

The GOANA programme, recently introduced by the Government of Senegal, appears to take into account past failings and the successes of initiatives such as the Green Revolution. Policies within the programme include state subsidies for agricultural inputs, the provision of institutional credit and investments in rural infrastructure, including irrigation. These initiatives, combined with a policy to increase agricultural production through increasing the area under cultivation, and the availability of higher yielding varieties of seed developed specifically for local conditions, hold the promise that Senegal will be

able to achieve a much greater measure of food self-sufficiency within the next few years. However, in implementing GOANA, the government will need to address the problem of securing a significant increase (around 13.5 per cent of current levels) in official development assistance to fund the program. It will also need to provide the right package of incentives in order to encourage smallholder farmers to adopt more expensive productivity-enhancing technologies rather than simply increasing production through less costly land-extensive practices.

Agricultural intensification in India brought with it various socio-economic, environmental and human health-related consequences. The historical land tenure system and a growing scarcity of land by the 1960s disadvantaged most smallholder producers, who relied on land-extensive, labour-intensive modes of agricultural production. The ability of the rural elite - the *kulaks* - to disproportionately benefit from public resources due to their greater economic and political power led to growing economic inequalities and increasing proletarianization within the agrarian sector. This was compounded by increased commercialization within agriculture which left many smallholder farmers vulnerable to market forces and predatory lending in the informal sector. In Senegal, land availability means that smallholder farmers will be able to continue to increase production through land-extensive practices. However, as land becomes increasingly scarce through the implementation of GOANA, smallholder farmers will likely find it more difficult to maintain their landholdings as they face competition from both new entrants into the sector and the traditional rural elite -

the *marabouts* - who are often politically connected and, generally, have more resources at their disposal. Increasing commercialization in the agricultural sector could also disadvantage smallholder farmers who will have to compete with the aforementioned rural elite (both old and new) for public and private resources. As in the case of India, this may lead to growing indebtedness, as poorer farmers are forced to turn to the informal sector for credit and the provision of inputs.

The environmental consequences witnessed in India following the onset of the Green Revolution can be attributed, in large part, to government subsidies for agricultural inputs and public investment in irrigation. Failure to phase out these input subsidies after they had served their stated purpose and lack of government oversight for natural resource use allowed many producers to effectively externalize the environmental costs of input intensification (including soil degradation and water resource depletion). The same policies within GOANA designed to encourage adoption of productivity-enhancing technologies - namely input subsidies and development of agrarian infrastructure, including irrigation - could also allow farmers to externalize the environmental costs of input intensification. In light of the fact that soils are more fragile in Senegal and water resources more scarce, the onset of these negative externalities would likely be much sooner than was witnessed in India.

With respect to human health, evidence shows a strong correlation between agricultural intensification in India - particularly with respect to chemical pesticide use - and an increased incidence of cancer, birth defects and acute poisoning. The resources allocated for pesticide use under GOANA are fairly limited and data on pesticide use in Senegal is rather limited. This makes analysis of the effect of agricultural intensification on pesticide use and, thus, on exposure to them, somewhat difficult; however, just as with other inputs, it is probable that implementation of GOANA will result in more widespread use of pesticides. Research has indicated that levels of education have played a role in the handling of and subsequent exposure to pesticides in India, which leads to the conclusion that promotion of pesticide use in Senegal will need to be accompanied by appropriate education and training programs to mitigate their effects on the health of smallholder farmers.

In light of similarities in traditional systems of production, historical trends (or lack thereof) in agricultural production and conditions within the rural sector, the preceding analysis of Senegal - and the conclusions therein - can be extended to efforts across the continent to achieve greater food self-sufficiency through agricultural intensification. By securing the necessary funding and utilizing available resources, as well as implementing appropriate policies of natural resource management, extension and training, and social security, these countries may be able to realize agricultural development while avoiding some of the negative outcomes experienced in India. The adoption of systems which

incorporate sustainable agriculture and integrated natural resource management (NRM), as promoted by the Consultative Group on International Agricultural Research, could further serve to mitigate the negative effects of agricultural intensification through improved management techniques and more efficient use of local natural resources and purchased inputs (Lee 2005). As Senegal - and Africa - pushes forward in its pursuit of food self-sufficiency, it can learn lessons from countries such as India, affording it the opportunity not simply to achieve substantial agricultural growth, but to do so in a manner which promotes more equitable and environmentally sustainable development.

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