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The Africa Green Revolution, Achievements, and Challenges in Agriculture

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Abstract
After the second Agricultural revolution in England, the third green revolution was started in India between 1955 to 1960s to increase food production and feed the millions of malnourished people throughout the nation and quickly spread to other countries. Green revolution emerged because of thinking about populations and the problem of hunger in very particular ways. Many Asian and other countries were immediately adopted the green revolution and accelerated the growth and poverty reduction dramatically. Africa has the potential for a green revolution but due to too late acceptance of the green revolution yet the yields are far below their potential and the use of modern inputs such as fertilizer and high-yielding varieties of seeds is extremely low. Therefore, to increase productivity and eliminate poverty from the people the focus of the Green Revolution for developing countries, especially for Africa is mandatory.
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1. Introduction

The Green Revolution was initiated in India in the 1960s to increase food production and feed the millions of malnourished people throughout the nation and quickly spread through the developing world, including the states of India (Hardin, 2008). In 1960, IRRI was established in the Philippines to focus on rice in Asia and before the Green Revolution in Asia, the average rice yield was 1.9 t ha^{-1}. That could only be obtained during the wet season, but there was no production in the dry season. The Green Revolution increased the yield to 5 t ha^{-1}. CIMMYT, in 1966 in Mexico, focused on wheat and maize globally; IITA, in 1969 in Nigeria, focused on maize, rice, cassava, plantain, yams, sweet potatoes, and sustainable production systems for Africa (Dezi, 2003).

In recent years, the green revolution type of agricultural development is, therefore, is increasingly seen as one of the most important opportunities to accelerate growth and poverty reduction in Africa. Continent-wide initiatives such as the Comprehensive African Agriculture Development Program (CAADP) have set concrete growth and public spending targets for agriculture. Many national policymakers have committed to increasing investment in agriculture and emphasized the role of agriculture in their national development strategies (e.g., NDPC 2005; NNPC, 2007). The need for a green revolution type of agricultural growth has been further boosted by the recent world food price crises that added to the voices advocating measures to facilitate supply-side responses in Africa (von, 2008; FAO, 2008; World Bank, 2008).

One of the most important features of the Green Revolution is the use of agrochemicals (fertilizers, pesticides, herbicides), a feature that was non-existent before then (Fitzgerald and Parai, 1996). Potentials for a green revolution exist in Africa. yet the yields are far below their potential and the use of modern inputs such as fertilizer and high-yielding varieties of seeds is extremely low (Evenson, 2003; Evenson and Rose grant, 2003; Johnson *et al.,* 2003). Therefore, this literature review aimed to look at the Green Revolution of Africa and to review the achievements, limitations, and challenges of a green revolution in Africa.

2. Methodology

This review paper was taken from different works of literature, books, websites, and scientific journals which are related to the Africa green revolution.

3. Africa and Green Revolution

The term “Green Revolution” was first used by William Gaud (USAID administrator in the late 1960s) to point to the improved yields in Asian, Middle, and South American countries through the use of new technologies in the agricultural sector. “Developments in the field of agriculture contain the makings of a new revolution. It is not a violent Red Revolution like that of the Soviets, nor is it a White Revolution like that of the Shah of Iran. I call it the Green Revolution” (Speech to the Society for International Development in 1968). The original Green Revolution emerged because of thinking about populations and the problem of hunger in very particular ways. Capitalism and the liberal state meet these problems pre-constrained by the sanctity of private property and the desirability of ‘individual free enterprise’ (Scott, 1998; Angus and Butler, 2011). The Green Revolution was a

solution to a problem framed by the geopolitics and ideologies of the early part of the twentieth century.

From 1965 onwards, new trends (or revolutions) in agriculture in rural Asia, and to a lesser extent, Latin America (collectively termed, by some, as the "Green Revolution") began to emerge. It entailed the introduction of high-yield varieties of rice and wheat, combined with other 'modern' technologies (e.g., irrigation, mechanization, etc.), and had profound economic, social, and political ramifications. Views differ, however, on the overall desirability of the revolution's accomplishments. Though many applaud its achievements in terms of output growth, there are critics of its distributional effects (Griffin, 1979).

Since the late 1990s, the development discourse in Africa has been dominated by the mantra on the "New Green Revolution in Africa". The call has been trumpeted by no less than the United Nations, hailed by governments in Africa and beyond, funded by moneyed private philanthropic foundations, and supported by agricultural transnational corporations. Like its predecessor in Asia half a century ago, the New Green Revolution in Africa is collectively being pushed by a myriad of players all claiming to be committed to Africa's development. Unsurprisingly, the push for a New Green Revolution in Africa is being led by the same players that pioneered the original concept in Asia, with new allies adding strength to the effort. The Rockefeller Foundation leads the pack, with the full support of the African arms of the Consultative Group on International Agricultural Research (CGIAR), an institution created by the Rockefeller Foundation to provide the scientific and technical backbone for the Green Revolution in Asia.

Duplicating the example set in Asia, the Rockefeller Foundation's admission into Africa is akin to that of a "Trojan horse" paving the way for entry by transnational agrochemical, fertilizer, and agricultural biotechnology companies to peddle their wares. As in Asia, the New Green Revolution in Africa has implications that go far beyond agriculture, its key platform. The development direction of Africa, currently dependent on subsistence agriculture, will be shaped by the processes and outcomes of this so-called revolution, as had happened in Asia five decades ago where the rural economy, social relations, agrarian policies, and rural development were mounded by the first Green Revolution. Despite the "new" tag added to its name, the Green Revolution prescribed for Africa follows the same formula used in Asia a technology package for agriculture involving the use of external inputs, massive agricultural infrastructure, and modern seeds, but with a twist of genetically modified seeds added into the equation to respond to the environmental consequences caused by the old formula. It is striking that none of those at the forefront of the revolution is African. No different from the colonial project in Africa, this new revolution is created and most ardently advocated by white men claiming to fight for the emancipation of Africans from the clutches of hunger and poverty (Elenita, 2007).

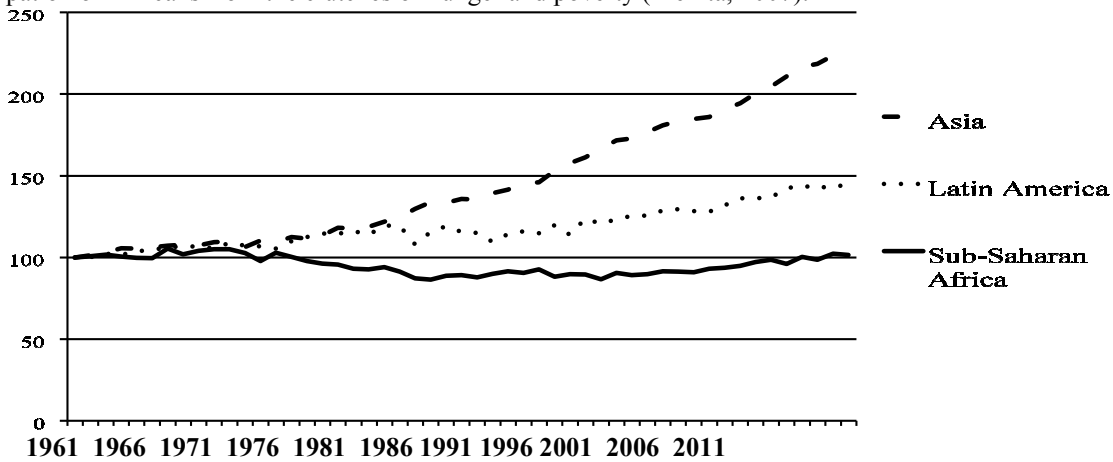

Figure 1. The per capita production of food in Asia, Latin America, and Africa, 1961-2011 at the national level for selected countries between 1961 and 2008. Source: FAOSTAT 2013

3.1 . Achievements of Africa Green Revolution

3.1.1. Alliance for a Green Revolution in Africa

Seven years after the launch of its high-profile Green Revolution in Africa initiative, the Rockefeller Foundation won an important in boosting the much-needed finances into its pet project. It allied with the Bill and Melinda Gates Foundation, publicly announced on 12 September 2006. The marriage of two of the world's largest philanthropic foundations gave birth to the Alliance for a Green Revolution in Africa (AGRA), with the Gates Foundation committing an initial amount of US$100 million and another $50 million from the Rockefeller Foundation. These sums are in addition to the $150 million already spent on the project since it was initiated in 1999. The alliance is considered a breakthrough for the Gates Foundation, which has hitherto been focusing most of its philanthropy on global health and medical projects, and "working to reduce inequities and improve lives around the world", guided by its core belief that "every life has equal value" (http://www.gatesfoundation)

AGRA has been established as a public charity aimed at reducing hunger and poverty in Africa through agricultural development. In line with the "Doubly Green Revolution" vision espoused by Gordon Conway and supported by the Rockefeller Foundation, AGRA's primary goal is to increase the productivity and profitability of small-scale farming using technological, policy, and institutional innovations that are environmentally and economically sustainable. A supporting organization, Program for a Green Revolution in Africa (ProGRA), was also created to implement initiatives under the auspices of AGRA. ProGRA is operationally headed by Dr. Joseph DeVries, another veteran at the Rockefeller Foundation AGRA, and ProGRA is managed by separate Boards of Directors comprised of top officials and trustees of the Gates and Rockefeller Foundations. AGRA's Board of Directors include (http://www.africangreenrevolution.com/en/green_revolution 23)

The Rockefeller Foundation aims to replicate its experience with the first Green Revolution in Latin America and Asia, basically following the same formula involving a combination of philanthropy and close collaboration with governments. It hopes that while Africa's version of a Green Revolution may not be as immediate and sweeping as its predecessor in Asia, it could be just as profound, with consequences every bit as life-saving. Since 1999, the Foundation has supported the development and release of more than 100 new crop varieties, dozens of which are already in use, including new strains of rice called the "New Rice for Africa" (NERICA), cultivated on 300,000 acres across the continent. The Foundation estimates that over 10 years, 400 more improved crop varieties and work in 20 African countries can contribute to eliminating hunger for 30 million people and move 15 million out of poverty (Lisa Harris, 2001).

3.1.2. Agricultural Industry

Agricultural growth in Africa has accelerated in recent years, yet most of this growth has been driven by land expansion. Since the further expansion of cultivated agricultural land is reaching its limits in the process of rapid urbanization and population growth in many countries, the need for a shift towards productivity-led agricultural growth becomes urgent in Africa. The Green Revolution experience in Asia has demonstrated that rapidly increasing agricultural productivity is possible in a relatively short period (Hayami and Ruttan, 1985; Hazell and Ramasamy, 1991; Bautista, 1997; Evenson and Gollin, 2003).

Global food production increased by 58% between 1970 and 1990 (World Bank, 2010). On the other hand, Patel *et al* (2009) point to the fact that increased food production was not merely the result of technological progress; another major explanatory factor was the extension of cultivated land. And the question as to whether the Green Revolution during the 1960s and 1970s has contributed to poverty reduction is even more heavily debated. Already in 1979, Griffin (1979) noted that "the new technology has not revolutionized production but it has often helped to worsen the distribution of income." He argues that a lot of the technical changes in the green revolutions of Asian, Middle, and South American countries were biased in favor of larger farmers, with perverse consequences for the well-being of the majority of small-scale peasants. In most parts of the developing world, per capita, staple food crop production has increased steadily over the past four decades. This increase is largely the result of Green Revolution technologies, including high-yielding crop cultivars, irrigation, fertilizers, mechanization, pest, and disease control, supported by enabling government policies (Hazell and Wood, 2008). Sub-Saharan Africa (SSA) is the only region where per capita production has barely changed (Hazell and Wood, 2008; Jaeger, 1992). While populations continue to grow, yields of major crops remain very low in SSA with average cereal yields of less than 1-t ha^{-1} compared to averages of 3-t ha^{-1} in Latin America and South Asia (Hazell and Wood, 2008).

3.1.3. Syngenta

Syngenta is the world's third-largest seed company, with total sales of $1.239 billion in 2004, and the second-largest agrochemical firm, with total sales of $6.030 billion in the same year. The company's "humanitarian" face in semi-arid areas, such as Sub-Saharan Africa, is the Syngenta Foundation for Sustainable Agriculture (SFSA), which was established in 2001 with the lofty goal of contributing to sustainable food security for small-scale farmers. The Foundation implements projects in the semi-arid regions of Brazil, India, and, of course, Sub-Saharan Africa, particularly in Eritrea, Mali, Uganda, and Kenya. It claims to work in partnership with local communities, national academic and research institutions, non-government organizations, and international development organizations. It takes pride in "its ability to bridge the private sector and the international development community worlds through its understanding of livelihood concerns, the drivers of the rural economy, its flexible and proactive approach and its unique ability to build on the business DNA that is prominently available at Syngenta (Syngenta Foundation, 2006).

The Syngenta Foundation's project strategies are focused on increasing productivity and reducing risks of crop failure through water conservation, use of drip irrigation, intercropping and sustainable land management systems; increasing the ability of crops to cope with drought and the ravages of pests and diseases by breeding varieties adapted to local environmental and social conditions and that suit local needs; identifying and developing market-based solutions to poverty elimination among smallholder farmers; linking farmers with market information; and helping to develop small and medium rural enterprises (www.syngentafoundation.org/review.2006). Apart from implementing projects, the Foundation also sponsors

scholarships for African students and conducts symposiums and lectures around the world geared towards its thrusts. The Syngenta Foundation's projects in Eritrea, Mali, and Kenya were inherited from the Novartis Foundation for Sustainable Development, which has since trained its attention on the health sector to perform its "corporate social responsibility" function for Novartis. Novartis is a sister company of Syngenta and one of the world's top 10 pharmaceutical giants. The Syngenta Foundation's project in Eritrea is centered on improving soil and water management and capacity-building. This is being done in collaboration with the University of Asmara, the National Agricultural Research Center, the Center for Development and Environment in Switzerland, the Swiss Agency for Development and Cooperation (SDC), and Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) as partners.

The project in Uganda focuses on the dissemination of market and agronomic information to local farmers and is being implemented with the Uganda National Farmers Federation and a host of other national government agencies. Its Cinzana Agricultural Research Station project in Mali aims to improve the local food security situation by enhancing the productivity of pearl millet, in partnership with local farmer organizations in the Segou region, the Ministry of Agriculture, ICRISAT, and the Novartis Foundation for Sustainable Development. The most publicized of the Syngenta Foundation's projects in Africa is the Insect-Resistant Maize for Africa (IRMA). IRMA is implemented by the Syngenta Foundation in collaboration with the Kenya Agricultural Research Institute (KARI), the International Maize and Wheat Improvement Centre (CIMMYT) and the Rockefeller Foundation (http:// www.syngentafoundation.org/short_profile.pdf 71 ibid). The project aims to develop and deliver to farmers maize varieties that are resistant to stem borer species. While the use of genetic engineering in developing corn borer-resistant maize varieties is not explicitly mentioned, IRMA's goals include the "enhancement of Kenya's biosafety review program" (Eugene, 2006).

3.1.4. Seed Industry

According to FAO and World Bank figures, less than 10 percent of smallholder farmers in Sub-Saharan Africa use improved seed varieties in their farms, and this is largely attributed to the poor infrastructure, weak capacity in seed research and development, and inefficient seed distribution. The World Bank also estimates that in 60 percent of African countries, governments and para-statal entities control the national seed industry, although the number has been steadily decreasing over the years largely because of pressures from the Bank to privatize national seed industries. The World Bank began to devote attention to developing the national and regional seed industries in Africa in the early 1990s, through its initiative on Sustainable Seed Systems in Sub-Saharan Africa. A project report published in 1994 shows the World Bank advocating for the deregulation of the seed industry in Africa, strengthening of extension services, and linking the national agricultural research systems and the international agricultural research centers to African farmers to facilitate access to improved seeds, as well as improve seed quality control and registration.

The World Bank encouraged the informal seed system to exist in the absence of subsidies, which the Bank regarded as inhibiting private sector involvement in the seed industry (World Bank,1994). The Bank has since funded several national and regional projects in Africa focusing on the reform and restructuring of the seed industry, seed production and multiplication, improving seed quality control and monitoring, and improving seed delivery systems and credit access of farmers. The World Bank's efforts in deregulating Africa's seed industry and paving the way for the entry of transnational seed companies are evident. By the late 1990s, most African countries claimed to have their seed industry, some with well-established seed industry associations at the national level, such as in South Africa, Zambia, and Kenya where para-statal entities have given way to the entry of private domestic and transnational companies. In 2000, the African Seeds Trade Association (AFSTA) was formed, with support from the American Seeds Trade Association, to serve as a lobby group for transnational seed interests in the region (GRAIN,2005).

3.1.5. Fertilizer Industry

The fertilizer industry is undoubtedly one of the most active business sectors that have been mobilized in support of the call for a New Green Revolution in Africa. With the imperative to improve soil fertilizers in Sub-Saharan Africa at the top of the "Doubly Green Revolution" agenda, the fertilizer industry is eyeing handsome profits in the package. The central players involved in the African Green Revolution scheme, led by the Rockefeller Foundation, instigated the Africa Fertilizer Summit in Abuja, Nigeria in June 2006. The Summit was hosted by the New Partnership for Africa's Development (NEPAD) and brought together 40 African governments which made commitments to promote the removal of taxes and tariffs on fertilizers, support an emerging network of agro-dealers and create a program through the African Development Bank to finance the production and distribution of fertilizers (http://www.rockfound.org/about_us/history/2000).

The agenda and language of the Summit were unquestionably consistent with the New Green Revolution in Africa venture. Aside from the Rockefeller Foundation, others who pooled their resources to make the Summit happen included international financial institutions such as the World Bank and the African Development Bank; regional banks such as the United Bank for Africa and the Nigerian Fidelity Bank; and representatives from the fertilizer industry such as the Arab Fertilizer Association (AFA), International Fertilizer Industry Association

(IFA) and Notore Chemical Industries (formerly National Fertilizer Company of Nigeria or NAFCON). Also included in the long list of sponsors were bilateral donor agencies such as the UK's DFID, the Netherlands' DGIS, and USAID; and multilateral agencies like the FAO, IFAD, and the UN Economic Commission for Africa (UN-ECA). Since the fertilizer industry is closely dependent on fossil fuel production, it is no surprise that Shell-Canada also contributed some resources to the Summit (http://www.africafertilizersummit.org/Donors/index.htm).

3.1.6. New Rice for Africa (NERICA)

The Consultative Group on International Agricultural Research (CGIAR), formed in 1971 by the Rockefeller and Ford Foundations specifically to lead the implementation and promotion of the Green Revolution in Asia, continues to play a role in the New Green Revolution in Africa. The CGIAR was beset with a funding and credibility crisis in the 1990s for various reasons associated with the Asian Green Revolution. In 2003, it allocated 45 percent of its funds, equivalent to US$180 million, to projects in Sub-Saharan Africa, up from 43 percent the previous year (http://www. wardaorg/ warda aboutus.asp). The CGIAR's silver bullet for the Green Revolution in Africa follows the same trajectory taken by Asia, this time in the form of NERICA. The improved NERICA varieties were developed in the 1990s by mostly African scientists at WARDA, a CGIAR Centre which was renamed the Africa Rice Center in 2003, using another culture to cross the high-yielding Asian rice with traditional African rice. The result is a new plant type that looks like African rice during its early stages of growth with the capacity to shade out weeds but becomes more like Asian rice as it reaches maturity, thus giving higher yields with few inputs (Gordon and Gary, 1999).

Scientists depended on molecular biology to speed up the breeding process and to overcome sterility, which is a key obstacle in the breeding process. The marker-aided selection was used to breed rice containing two or more genes for resistance to the same pathogen, thus increasing the durability of the resistance, and accumulating several different genes contributing to drought tolerance (http://www.africasciencenews.org/_ disc1/00000016.htm). WARDA released an initial batch of seven NERICA varieties mostly in Western Africa, where it was projected to be cultivated on more than 200,000 hectares with a production of up to 750,000 tons per year by 2006, thus saving countries nearly US$90 million in rice imports. Beyond the glossy projections, however, NERICA has yet to make a clear contribution to food security and poverty alleviation in Western Africa despite the high level of publicity that it has received so far. With NERICA, WARDA hopes to start a rice-based Green Revolution in Africa, where rice is considered a staple, particularly in Western Africa. NERICA has been cited as one of the world's major agricultural research breakthroughs of the last 30 years and, as stated above, delivered the World Food Prize in 2004 to Dr. Monty Jones, a former senior plant breeder at WARDA who led the team that developed NERICA (Seed Quest, 2007).

Dr. Jones has since become the Executive Secretary of the Forum for Agricultural Research in Africa (FARA), a consortium of various stakeholders in agricultural research and development in the continent. He was also recently named as a member of the Board of Directors of the Rockefeller and Gates Foundations' ProGRA. While NERICA is the CGIAR's main contribution to the Green Revolution in Africa scheme, the other players have also performed major roles in making this supposed silver bullet a reality. The Rockefeller Foundation provided substantial funds for the biotechnology-aided breeding approaches used by WARDA scientists in developing NERICA. Japanese donor agencies, the Canadian International Development Agency (CIDA), and the World Bank invested heavily in the project, which involved the collaboration of CGIAR scientists with various research institutions from China to France and the US. In 2002, these players launched the African Rice Initiative (ARI) to coordinate the NERICA Consortium for Food Security in Sub-Saharan Africa. (http://www.warda.cgiar.org/ARI/).

3.2. Challenges of Green Revolution in Africa

Agricultural systems in Africa are severely challenged by various drivers of change such as increasing population growth, increasing demand for food and livestock products, and climate change (IAASTD, 2009; Jones and Thronton, 2009). Cereal yields in Africa are lower than half the world average. The average fertilizer (N+ P2O5) consumption is 16.24 kg/ha (2010, FAO) which is 1/6th compared to the world consumption of 98.20 kg/ha. Increasing productivity of the smallholder farmers, bridging the yield gaps by providing appropriate inputs along with improved technologies such as stress-resistant and high yielding varieties will be a step towards agricultural transformation in Africa. The most significant contextual factor that constrained and thus delayed the Green Revolution in Africa is the complex traditional farming systems and particularly the traditional shifting cultivation and range grazing pastoral livestock systems. In these systems, a farmer clears a piece of land by slash and burn from fallow and cultivates it for two to four years. When the soils are exhausted, the farmer moves to another land. This system is adapted for low population density and is not compatible with the application of the Green Revolution technologies (Dezi, 2003).

In many African countries, there were large estates of government parastatals foreign settlers, or experimental sites where improved high-yielding crops were being grown. There, the intensive monoculture

farming systems existed side by side with the traditional shifting cultivation and subsistence farming system. Even where some of the farmers were trained and/or came into contact with the improved system, the two distinctive systems still existed side by side. In some countries, when farmers tried to plant improved seeds and applied fertilizers, they did so in insufficient/low quantities, so that they did not reach the critical levels of the Green Revolution and the urgency to cause land reforms. Closely related to complex farming systems is the problem of high population pressure on the land. In some communities, the traditional rule for the inheritance of land is that the present family land is subdivided among either the wives or the surviving sons. The sharing of such land follows a topographic location. That's one piece located in the bottom valley, on the hillside and hilltop. After two successive generations, the sharing of land results in serious land fragmentation, which is uneconomical to operate and incompatible with the improved technologies of the Green Revolution. Moreover, the land tenure systems in Africa are either communal or under tenancy arrangements. Countries like Kenya and Zimbabwe who have attempted land reform programmers still left a large number of poor landless farmers uncaptured for. In this respect, there are very few African countries that have succeeded in making meaningful land reforms (Dezi, 2003).

The third major contextual constraint of the Green Revolution in Africa is the dramatic changes in the weather/rainfall patterns. In the last twenty-five years, the rainfall pattern in Africa has greatly changed. The absolute amount of rainfall has declined and the timing of the rains has become very unpredictable in all the agroecological zones of Africa. This makes rainfed agriculture extensively risky. The rainfall duration has shortened, making many of the crop cultivars grown by the farmers subject to post-flowering drought and giving very low yields or even crop failure. This makes it uneconomic to grow improved crop varieties since they cannot produce at their full potential under such risky rainfed agriculture. The rainy seasons are characterized by intermittent rains, which are punctuated by prolonged dry spells. Under these uncertain circumstance farmers are hesitant to grow new crop varieties that require the use of purchased inputs like inorganic fertilizers and seeds. The fourth contextual constraint of the African Green Revolution is the poor state of the infrastructural network. The poor state of roads and inaccessibility to certain rural areas due to inadequate or lack of feeder roads make transportation costs in Africa very high. Most farmers are unable to market their farm produce, and whatever they can sell is bought at prices close to or below the production cost. Such people could not adopt new crop varieties (Dezi, 2003). And livestock has been neglected by most agricultural designers for Africa (Ngambeki *et al.,* 1991).

3.4. Green Revolution Limits

One of the most important features of the Green Revolution is the use of agrochemicals (fertilizers, pesticides, herbicides) a feature that was non-existent before then. Agrochemicals are used because High-yielding varieties (HYV) were constructed to be responsive to chemical fertilizers and were more susceptible to pest outbreaks. In developing countries, these chemicals are costly. And, over a few years, more chemicals have to be used to achieve the same yield. In Indonesia, the application of fertilizers in rice production between 1975 and 1990 rose from under 25 kg/ha to over 150 kg/ha (Fitzgerald and Parai, 1996). Thus, the increase in yields is offset by the increase in cost associated with the increased use of chemicals. In the Central Plains of Thailand, yield increased 6.5 percent but fertilizer use increased by 24 percent and pesticides by 53 percent. In West Java, Indonesia the 23 percent increase in yield was virtually canceled out by 65 percent and 69 percent increases in fertilizers and pesticides respectively (Rosset *et al.,* 2000, cited in lim, 2009).

Agrochemicals not only increase production costs but also have health and environmental impacts, whose costs have not been properly internalized in the calculation of yields and production costs under the Green Revolution system. For example, the costs associated with agrochemical pollution of water systems and soils have never been taken into account. Accidents and even deaths, of farmers and agricultural laborers due to lack of knowledge on the safe use of chemicals have also been underreported. A study showed that poisoning episodes occur largely during spraying, mixing, and diluting of pesticides or due to the use of malfunctioning or defective equipment among agricultural workers (Jeyaratnam, 1993). Most farmers are not well educated on this and not enough information has been given to them on the safe handling of the chemicals. At the consumer level, pesticides have contaminated food, leading to health problems. In Indonesia, Dicloro-Difenil-Tricloroetan (DDT) residue was found even in mother's milk (buchory, 1999, cited by Jhamtani, 2008). The price paid for chemical contamination thus goes far beyond the agriculture fields to our daily die

4. Conclusions and Recommendation

Green Revolution was initiated in India in the 1960s to increase food production and feed the millions of malnourished people throughout the nation and quickly spread through the developing world especially in Africa since the late 1990s. Seven years after the launch of the Green Revolution in Africa the two of the world's largest philanthropic foundations gave birth to the Alliance for a Green Revolution in Africa (AGRA), with the Rockefeller Foundation through the use of new technologies in the agricultural sector.

Green Revolution achievements in agriculture in rural Asia, and to a lesser extent Latin America were the introduction of high-yield varieties of rice and wheat, combined with other 'modern' technologies (e.g. irrigation, mechanization, etc.), and had profound economic, social and political ramifications. Agricultural growth in Africa has accelerated in recent years. This increase is largely the result of Green Revolution technologies, including high-yielding crop cultivars, like New Rice for Africa" (NERICA), irrigation, fertilizers, mechanization, and pest, and disease control, supported by enabling government policies. But agricultural systems in Africa are severely challenged by various drivers of change such as increasing population growth, increasing demand for food and livestock products, dramatic changes in the weather/rainfall patterns, rainfed agriculture and traditional farming system, climate change, and poor state of the infrastructural network were delayed the Green Revolution in Africa.

One of the most important features of the Green Revolution is the use of agrochemicals (likes, fertilizers, pesticides, herbicides), but the cost of chemicals especially in developing countries and health and environmental impacts, have never been taken into account under the Green Revolution system. Therefore, in this 21 century of the global world, alarmingly increasing population density and urbanization but decreasing of arable land led to use intensive and sustainable farming technologies and Green Industrial Revolution, especially for African Agriculture is important.

5. Conflict of Interest Statement

The author declares that the paper was reviewed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

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