

## **WATER AS CRUCIAL AND PROBABLY AGRICULTURE'S ULTIMATE LIMITING FACTOR IN TRANSITION TO A GREEN ECONOMY**

By

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**Abstract :** This review article identifies the contribution that water can play in assisting a transition to a green economy. First an overview of the world's water resources is discussed. After highlighting some of the more unique characteristics of water, challenges and opportunities to make better use of water and water dependent ecosystems are identified. Agricultural water use accounts for about 75% of total global consumption, therefore agriculture can play a key role in transition to a green economy. In Pakistan the agriculture is the largest sector of the economy, with primary commodities accounting for 25% of GDP and 47% of total employment, and contributes more than 60% of foreign exchange earnings. The increase in agricultural production will be achieved mainly through increases in crop yield and intensification of existing irrigation area, with only minor horizontal expansion. As the share of the industrial sector increases over time, an appropriate balance will be needed to ensure both irrigation supplies to produce the raw materials for industry, and adequate water supplies for industries themselves. Effective pollution control will also become increasingly important. While there has been continuous improvement in agricultural yields, they remain significantly lower than their potential, contributing to inefficient water use by the agriculture sector. Irrigation efficiency is low, at an estimated 40%, with good potential for conserving water through improved field application, lining of watercourses and adoption of better irrigation technologies. Crop yields must be increased significantly in order to meet the food and fibre requirements of the future. This will require a coordinated effort between agriculture agencies, irrigation agencies and the on-farm water management initiative.

### **Introduction**

Natural resources are a key factor in the transition to a green economy. At its most basic level, a green economy is one that generates increasing prosperity while maintaining the natural systems that sustain our societies and our economies. Historically, economic growth has imposed ever-greater pressures on natural systems, in terms both of demand for resources and the burden of emissions and wastes. But, as is increasingly understood, economic development can only continue in the long term if we break the link with environmental harm.

Central to the notion of a green economy is the recognition that economic activities operate within the global ecosystem and rely on it to provide resource inputs and assimilate wastes and emissions. Crucially, the Earth is a closed material system which in turn shapes the way in which economies can grow sustainably. Using resources or emitting pollutants beyond system limits damages the natural capital base, reducing its ability to provide goods and services. In this sense, ecosystems are seen as a form of

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capital. Maintaining the world's natural capital will contribute to economic output by providing valuable renewable resources and services. Over-exploiting the natural capital, for example by emitting excessive pollutants, will reduce its ability to provide further goods and services.

The transition to a green economy presents a triple challenge. First, there is a need to focus on the economy, finding ways to increase prosperity without increasing resource use and environmental impacts - put simply, being more resource-efficient. By itself, however, resource efficiency cannot guarantee steady or declining resource use or sustainability: the world could become more efficient but still put excessive demands on the environment. So the second challenge, to achieve sustainability, is the need to maintain ecosystem resilience, which is governed by the status, trends and limits of natural systems. The third element is human well-being, including health, employment, job satisfaction, social capital and equity. This also includes a fair distribution of the benefits and costs of the transition to the green economy. In balancing environmental, economic and social elements, the green economy concept evidently has much in common with some models of sustainable development, which sees the triple challenge of economic efficiency, ecological sustainability and social equity.

Shifting to a green economy requires careful management of all resources, especially water, which differs from other resources in some very important ways. Governments are encouraged to invest in sustainable agriculture and freshwater systems – for developing countries in particular, to increase agricultural investment in infrastructure for value addition and reduce water transmission losses in irrigation canals and traditional water systems, and both developing and developed countries to improve storage and water quality. With over a billion workers, agriculture continues to be the single largest sector in the world in terms of employment. It is also the sector that where the majority of the world's poor and extremely poor are concentrated. In their fiscal spending, governments are encouraged to create a level playing field for sustainable agricultural production, including organic products, through increased investment in infrastructure for production of organic farming inputs, value addition at home, storage and transportation. The sustainability of agriculture is closely linked to the supply of water. Irrigated agriculture uses 70 to 80 percent of global freshwater supplies. It is estimated that around half to two-thirds of water is lost in transit in surface irrigation. Some of the solutions lie in changing the institutional architecture of water management but there is a case for directly investing private and public capital in water systems. This is especially true for developing countries where existing canals and traditional water systems are in dire need of repairs. Such an effort would not just reduce the wastage of this precious resource but has the potential to create millions of low to medium-skill jobs in developing countries.

### **Water in Development of Green Economy**

Water in the development of a Green Economy is vital in three ways: it is an asset essential for life and a common good for human well-being, it is a production factor and economic asset essential for economic prosperity, and, integrating these two, it is a vital environmental asset essential for the maintenance and regulation of the ecosystem

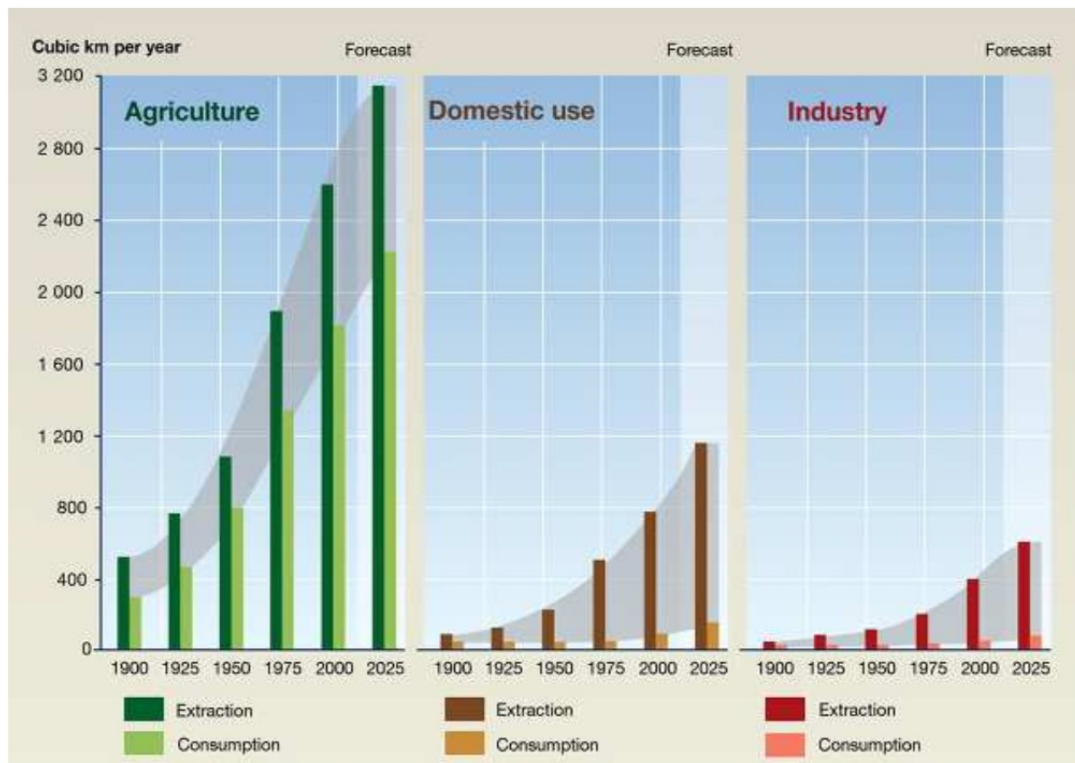
services that ensure the long-term sustainable provision of the economic and social goods and services on which prosperity depends. Human activities, combined with the natural forces affecting water resources, generate pressures that influence our planet's water systems. Many of these are highly dynamic; they change at a faster pace influencing water management strategies and policies.

Water is an essential resource for all aspects of human enterprise: for agriculture, energy production, industrial production and human health. Freshwater represents only 3% of existing water on the planet, of which 0.3% is available for humans. Yet over the past 50 years global freshwater withdrawals have tripled. Today, a quarter of freshwater use exceeds accessible supplies (MA, 2005; UNWWAP Water, 2009; OECD, 2007). By 2030, the OECD estimates that nearly 3.9 billion people will be living under conditions of severe water stress.

Agricultural water use accounts for about 75% of total global consumption; in many developing countries irrigation represents over 90% of water used. Globally, about 15-35% of irrigation withdrawals are considered unsustainable (Millennium Ecosystem Assessment). Industry uses about 20% of global freshwater withdrawals: 57-69% for hydro and nuclear power generation, 30-40% for industrial processes and 0.5-3% for thermal power generation (Shiklomanov I. A., 1999). Water used by industry is expected to reach about 24% of total freshwater withdrawal in 2025 (WWDR-3, 2009), 5% is for domestic use. It is estimated that, in developed countries, the average person uses 500-800 litres per day, about 10 times more than in developing countries. In regions with insufficient water resources, this figure may be as low as 20-60 litres per day (UNESCO, 2000). More water will be needed to produce more food for an increasing number of people, estimated to reach more than 7 billion by 2012 ; this and the increasing competition for water could limit future food production. Many developed countries need massive investment to replace the ageing infrastructure necessary to meet increasing demand and higher hygiene and water quality standards. Global economic expansion affects water through growth in the number of consumers, changes in their consumption habits, in the way goods and services are produced and in the location of activities. The global virtual water flow is 1,625 billion cubic metres a year, about 40% of total water consumption. About 80% of these virtual water flows relate to agricultural products trade (WWDR-3, 2009).

Water management will continue to have a decisive influence on the generation and distribution of wealth and well-being. Yet despite numerous reports on inefficient water use, poor harvesting and water pollution, there remains a general lack of knowledge about how water is being used across the economy, how much water is needed to support ecosystems and how much will be available in the future as a result of climate change, population growth and shifts in economic activity. Climate change is projected to cause major shifts in precipitation and seasonal patterns, and to have a major impact on physical water scarcity. Socially-induced water shortages caused by political priorities, policies and socio-economic differences could also be exacerbated by population growth, urbanisation, pollution and increased demands for high-quality water (UNFPA, 2009). Equally, the many uses of water will create pressures on the natural systems that

supply water and which themselves rely on water to function and deliver valuable services.



**Source:** UNEP/GRID-ARENDAL, 2008, Vital Water Graphics

The UNEP report 'Towards a Green Economy' (UNEP, 2011b) highlights the economic and societal opportunities that arise from adapting the water sector to the needs of 'green' and sustainable water management. For example, by investing in green sectors, including the water sector, more jobs and greater prosperity can be created. This is most pronounced in developing countries where limited access to clean water and adequate sanitation affects health, education and the well-being of citizens, limiting their contribution to a more prosperous economy.

In a similar way, maintaining and restoring ecosystems in the short term pays off in terms of the benefits these ecosystems can provide reliably and in the long term, it also avoids unnecessary restoration costs and secondary investments in health care in areas where people suffer from polluted drinking water and inadequate sanitation. Ecosystems, societies and economies all depend on water resources to exist and prosper. Ecosystems require water to function and provide ecosystem services; they therefore represent an additional major 'water user' alongside agriculture, industry, urban centres and households, leading to competition between the needs of the sectors

and the environment. But ecosystems, in turn, provide services such as ensuring water quality and flow regulation.

Growing populations and economies, changing diets, as well as climate change, are leading to increasing water use plus the associated demands on the environment (Liu et al., 2008). The allocation of water to competing but highly interdependent users and sectors will thus strongly influence the sustainability of economic growth and the distribution of wealth and well-being across societies and generations.

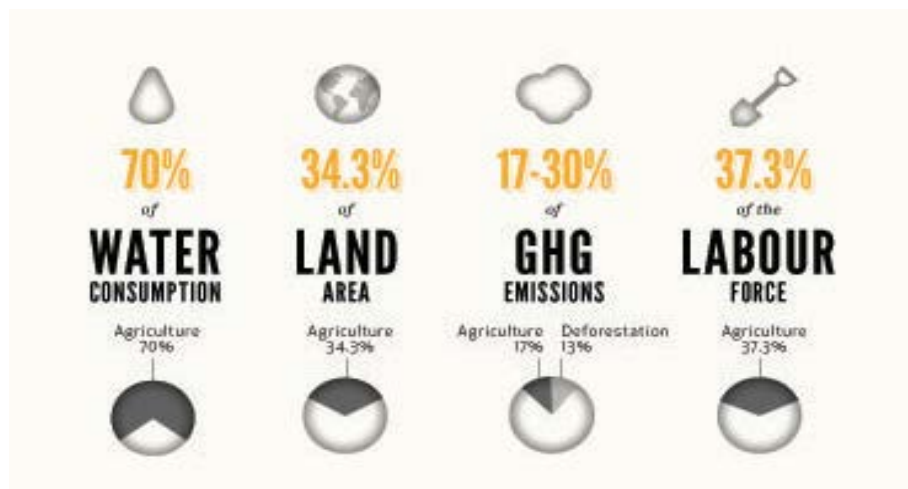
More efficient use of all resources in all sectors can help reduce water demand and water pollution, thus alleviating pressure on the environment and related ecosystem services. However, inequity in water use and allocation, when linked with social and political imbalances, risks impairing the ability of ecosystem services to deliver water and is also likely to jeopardise human well-being. Thus a green economy requires clear governance structures and carefully, perhaps differently designed economic, regulatory and normative

Water is an essential resource for virtually all aspects of human enterprise, from agriculture via urbanization to energy and industrial production. Equally, the many uses for water create pressures on the natural systems. In this context, enhanced water productivity and management is a major challenge not only for direct water users, water managers and policy makers but also for businesses and final consumers.

### **Agriculture holds the Key**

*"Unless we increase our capacity to use water wisely in agriculture, we will fail to end hunger and we will open the door to a range of other ills, including drought, famine and political instability."* Secretary-General Ban Ki-moon's Message, for the World Water Day 2012. (<http://www.unric.org/en/latest-un-buzz/27426-world-water-day-2012-water-and-food-security>)

Everyone needs agriculture. Agriculture feeds our entire population and produces fibre for clothing, feed for livestock and bio-energy. Particularly in the developing world, agriculture contributes significantly to GDP growth, leads the way in poverty reduction and accounts for the lion's share of employment opportunities, especially for women. Agriculture also has one of the highest potentials for reducing carbon emissions and helping vulnerable people adapt to climate change.



**Source:** Agriculture and the Green Economy from [www.farmingfirst.org](http://www.farmingfirst.org)

No country has been able to sustain a rapid transition out of poverty without raising productivity in its agriculture sector. Today's agriculture sector faces a complex series of challenges: produce more food of better quality while using less water per unit output; provide rural people with resources and opportunities to live a healthy and productive life; apply clean technologies to ensure environmental sustainability; and contribute in a productive way to the local and national economy. Land and water are important natural resources for mankind. The demand for food, fiber, and shelter is increasing with the continuous increase in the world's population. The introduction of new varieties and chemical fertilizers, during the green revolution of the 1960s, resulted in increase in crop yields. But, intensive cultivation, increased use of fertilizers, pesticides, conventional soil management practices, and improper use of irrigation water resulted in deterioration of land and water resources leading to poor crop yields. Large fertile areas fell prey to water logging and salinity, making small farmers more food insecure. During the second half of the 20th century, world population had a twofold increase, agriculture doubled food production and developing countries increased per capita food consumption by 30 percent.

The development community today shares the same broad recipe for poverty reduction. The recipe involves fostering pro-poor economic growth and favouring poor people's access to all the services and other factors that support poverty eradication and define an acceptable standard of living: markets, credit and income-producing assets, basic education, health and sanitation services, safe water, transport and communications infrastructure, and so on. Providing access to these basic human rights is seen as an end in itself, but it will also boost economic growth.

Growth in the agricultural sector has a crucial role to play in reducing poverty. The International Fund for Agricultural Development (IFAD) estimates that seven out of ten of the world's poor still live in rural areas. They include smallholders, landless labourers, traditional pastoralists, artisanal fishers and marginalized groups such as refugees, indigenous peoples and female-headed households. Many of the rural poor work directly

in agriculture, as smallholders, farm labourers or herders. Their incomes can be boosted by pro-poor measures, such as ensuring fair access to land, water and other assets and inputs, and to services, including education and health.

Agricultural growth spreads its benefits widely. Growth in the incomes of farmers and farm laborers creates increased demand for basic non-farm products and services in rural areas. These goods and services are often difficult to trade over long distances. They tend to be produced and provided locally, usually with labour-intensive methods, and so have great potential to create employment and alleviate poverty. For the poor, the rural non-farm sector offers a relatively easy escape route from poverty. Rural non-farm enterprise often requires little capital or training to set up and so offers many of the rural poor, opportunities to find work and raise their incomes. Non-farm activities provide 44 percent of rural jobs in Asia and 25 percent in Latin America. In rural India they provide 60 percent of the income of the poorest 20 percent of the rural population. But the rural non-farm sector cannot grow independently: agriculture must grow first, to generate the increased demand for non-farm products. There can be a general rise in local wages only when growth in both farm and non-farm activities has soaked up most of the pool of rural underemployment. And agricultural growth alone may not always produce a decline in rural poverty. If landholdings are very unequal, increased incomes from farming may accrue almost entirely to large-scale farmers or absentee landlords, who may either save it or invest it outside the rural areas, on urban or imported goods. In such cases the impact of agricultural growth on poverty may be limited, and policies to reduce inequality of access to assets such as land, water and inputs will be needed instead.

What economic policies at national level foster agricultural growth in developing countries? During the 1950s and 1960s it was widely believed that only industrial growth could deliver economic development. As a result, industry was protected while agriculture was heavily taxed or afforded low priority. By the end of the 1970s, there was increasing emphasis on the structural reform of economies. It was hoped that privatization, the liberalization of internal and external trade, lower taxes and reduced government intervention would produce higher economic growth and reduce the bias against agriculture. These measures have been widely adopted. However, there is little evidence to show that they have done much to increase growth, either in gross domestic product (GDP) as a whole or in agricultural GDP. This suggests that, badly needed though they were, these measures are not enough in themselves and need to be supplemented with other policies.

Agriculture can be a potent driver for poverty reduction. The World Bank estimates that GDP growth from agriculture generates at least twice as much poverty reduction than any other sector. In countries where agriculture represents one of the primary livelihoods, concerted efforts to improve productivity through sustainable practices could change the lives of millions. A dynamic and productive agriculture sector is also essential for the urban sector. In 2010, for the first time ever, more people lived in urban areas than in rural areas globally. Urban populations are dependent on the agricultural sector for most of their consumption, so improving local production and trade is crucial;

but it also means a world of opportunities for farmers who can reach the urban market. Making agriculture a dynamic sector will require the adoption of supportive frameworks and investment in infrastructure and markets. Farmers need to be able to access markets at the local, regional and global level in order to sustain a livelihood from their activities. In some areas, this means improving access to transport, storage and market facilities. Additionally, efforts should be increased to promote sustainable agri-food systems throughout the lifecycle.

Improving the footprint of agriculture while increasing production needs a concerted effort in two areas: first closing the up take gap of existing best practices and technologies by focusing on knowledge sharing and creating supportive extension services networks; and second investing in innovation and research to provide the solutions for tomorrow and ensure agricultural policies are science-based. Enhancing sustainable productivity must be the centre of efforts to make agriculture both environmentally sound and economically dynamic – we need to achieve more crops per drop of water, per acre of land, per measure of inputs. This is essential to ensure the surface of land under cultivation does not expand, in order to preserve biodiversity and natural carbon sinks. Producers need to be integrated in value chains and new activities need to be developed in processing and other sectors to improve rural incomes and ensure that growth in productivity translates into better livelihoods.

The transition to a green economy is fundamental for addressing the social, environmental, and economic pillars of sustainable development. As a sector, agriculture is essential to the green economy. With a predicted 9 billion people by 2050, agricultural production will have to increase to meet new demands, for food, feed, fuel and fibre. Agriculture must not only meet demand – it must also do so while minimising its environmental footprint and creating sustainable livelihoods for farmers and others along the supply chain. In a time of food insecurity and with the largest share of its population in developing countries living in rural areas, the world cannot afford to ignore the potential of agriculture to achieve the triple goals of a secure food supply, poverty reduction through improved rural livelihoods, and environmental sustainability through reduced footprint of production and climate change adaptation. Agriculture by nature represents a mosaic of solutions and practices, focused on farmer needs and knowledge sharing. Sustainability is a moving target towards which farmers in different geographies and farming systems are already moving and they will need support to continuously improve. Agriculture in a green economy means a broad-based, knowledge-centred approach to agricultural development. As a sector, agriculture is essential to the green economy.

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As global leaders prepare to meet at the Rio+20 (UNCSD) summit in 2012, they should not neglect the central role of agriculture in delivering a green economy and to the role of farmers as drivers of these changes.

Comprehensive solutions are needed for sustainable agriculture, and the Farming First Principles offer a comprehensive view of how this may be achieved. In the context of discussions on the Green Economy, Farming First supporters offer the following recommendations for incorporating agriculture into their agenda focusing on the “green economy in the context of sustainable development and poverty eradication”.

- Poverty reduction: Make agriculture a driver for poverty reduction by ensuring policies link producers to markets and enable value to be created throughout the supply chain to help create income opportunities and diversify rural activities.
- Focus on enhancing sustainable production and productivity: the world will need to produce more with less water to meet demand and reduce its environmental footprint. Increasing production and productivity should be a priority to protect habitat.
- Invest in training, knowledge sharing, extension services, as well research and development to close the uptake gap for existing tools and ensure new solutions are available for tomorrow.

### **Central Role of Agriculture in Pakistan’s Economy**

Agriculture is considered the mainstay of Pakistan’s economy. About 62% of Pakistan’s population that live in the rural areas is either directly or indirectly dependent on agriculture for their livelihood. The total geographical area of Pakistan is 79.61 million hectares (ha), of which 59 million ha have been covered by soil survey. In 2008-09, the cropped area was 23.80 million ha, of which 19.49 million ha is irrigated, while the remaining 3.51 million ha is rain fed (UN Systems in Pakistan 2000).

The *Agriculture* sector continues to play a central role in Pakistan’s economy. It is the second largest sector, accounting for over 21 percent of GDP, and remains by far the largest employer, absorbing 45 percent of the country’s total labour force. Nearly 62 percent of the country’s population resides in rural areas, and is directly or indirectly linked with agriculture for their livelihood. Pakistan has one of the highest proportions of irrigated-cropped area. The distribution of land resource is skewed. This is evident from the fact that about 40% of total farmland is in the control of 7% of the farmers. In addition, large farmers have easier access to resources like water, and credit. Small farmers suffer from resource starvation. Even within the small farmer category, there is a case for improving the conditions of the poorest of the poor i.e. those that own 1 hectare or less. Approximately 60% of all farmers in Pakistan fall into this category. Although a number of land reforms have been done in the last 50 years, they did not bring any significant changes in the land holdings. Major crops, such as, wheat, rice, cotton and sugarcane account for 90 percent of the value added in the major crops. The value added in major crops accounts for 31 percent of the value added in the agriculture.

Thus, four major crops (wheat, rice, cotton, and sugarcane) on average, contribute 28 percent to the value added in overall agriculture and 5.9 percent to GDP. The minor crops account for 10.9 percent of the value added in overall agriculture. Livestock contributes 55.1 percent to agricultural value added – much more than the combined contribution of major and minor crops (41.9%). Despite its critical importance to growth, imports incomes, and food security, the agriculture sector has been suffering from secular decline. Growth in the sector, particularly in the crop sub sector, has been falling for the past three decades. The agriculture has lost significant growth momentum as its growth slowed down to 2.7 percent in the decade of 2000s as against 4.4 percent in 1990s and 5.4 percent in the 1980s (Federal Bureau of Statistics). The structural problems and lack of mechanization remained main impediment to growth. Major crops remained the victim of natural calamities during the last few years and three out of last four years witnessed negative growth in the major crop sector. Productivity remains low, with yield gaps rising. As a result of inordinate spike in prices of major crops, an additional amount of Rs. 342 billion was transferred to the rural areas in 2010-11 alone. Contrary to this, only Rs. 329 billion were transferred to the rural areas on account of higher prices of major crops during the eight years (2001-2008). During the year 2010-11, the overall performance of agriculture sector exhibited a weaker growth mainly due to negative growth of major crops and forestry (Economic Survey 2010-2011).

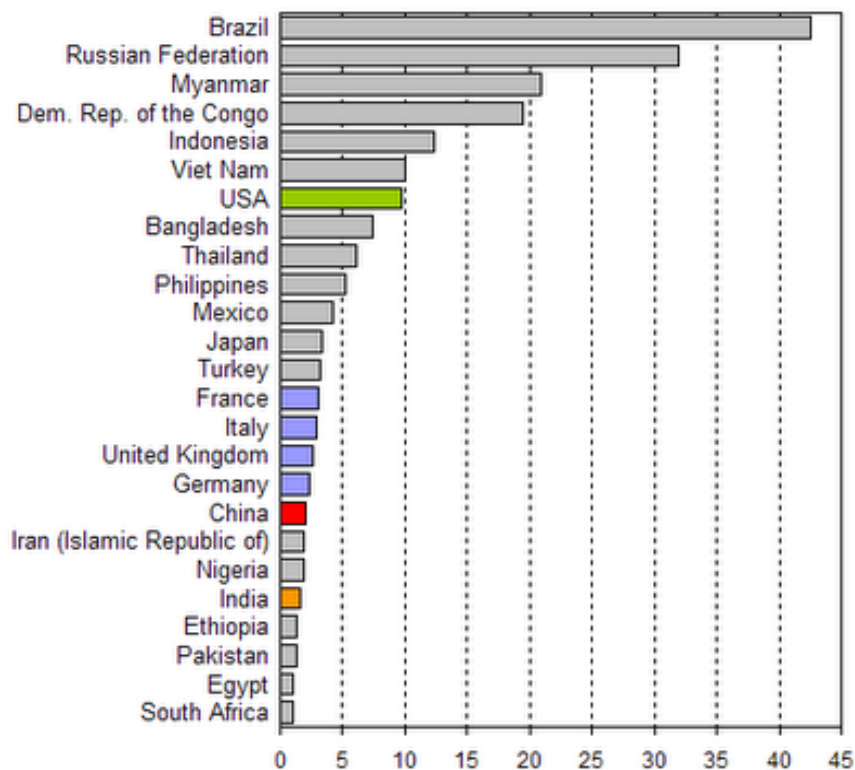
Pakistan has enormous potential to further develop its agriculture sector to which about 2/3rd of country's population is directly or indirectly depends for livelihood. However, Pakistan's economy is experiencing structural transformation and the role of agriculture in economic development is changing fast, its share in overall output of the country is declining but labour stays back, and a very small proportion of farms experiencing fast modernization, while majority of the farmers are resource poor and loosing out even the existing potential. Therefore, Pakistan has to adapt three-prong strategy, develop farm and non farm sectors as well as reducing polarization from within the agriculture sector by either helping the inefficient farmer to approach the frontier or helping them to find alternative livelihood in the non-farm sector, if so developed.

The major hurdle to develop the agriculture sector of Pakistan in general and food grains production in particular is the lack of holistic policy approach, intervening in one or more commodities leaving others on the market forces, thus resulting in frequent supply and demand imbalances. Such partial policy dynamics reduced the process of commercialization and specialization in agriculture by exploring the comparative advantage influenced by the market forces. All this resulted into slower growth in agricultural productivity, particularly in food grains. Pakistan needs to increase its food production to feed a growing population with some modest surpluses for export. The fact is that to achieve this substantial increase in crop productivity is to be targeted using lesser land and water resources than are available for agriculture today. One is not sure of achieving individual milestones in the fast changing dynamic world, but one thing is to be believed that agriculture must maintain a growth rate of more than 5% in order to ensure a rapid growth of national income, attaining macroeconomic stability, effective employment of growing labor force, securing improvement in distributive justice and a reduction in rural poverty in Pakistan.

The share of agriculture in GDP gradually shrank to 20.9 percent in 2010-11 from 25.9 percent of GDP in 1999-2000. Notwithstanding, declining share overwhelming majority of the population depends directly or indirectly on income streams generated by the agriculture sector. The agriculture sector remained the dominant sector with its job absorption ability and it still absorbs 44 percent of the country's labour force. It gives a kick-start to aggregate demand for industrial goods and services as well. Erosion of growth momentum in the sector raises some serious policy questions regarding viability of the sector. From water management to disbursement of agriculture credit, mechanization, availability of quality inputs including seeds, fertilizer and pesticides, a holistic policy package aimed at addressing structural issues is required to reap full potential of the sector. Diversification towards less weather sensitive areas like livestock can be done very easily. Revamping agriculture is critical for enhancing job creating ability of the economy.

**Integrated Comprehensive Water Management is Needed**

Among the 25 most populous countries in 2009, South Africa, Egypt and Pakistan are the most water-limited nations. India and China, however, are not far behind with per capita renewable water resources of only 1600 and 2100 cubic meters per person per year. Major European countries have up to twice as much renewable water resources per capita, ranging from 2300 (Germany) to 3000 (France) cubic meters per person per year. The United States of America, on the other hand, has far greater renewable water resources than China, India or major European countries: 9800 cubic meters per person per year. By far the largest renewable water resources are reported from Brazil and the Russian Federation - with 31900 and 42500 cubic meters per person per year respectively. While feeding the world and producing a diverse range of non-food crops such as cotton, rubber and industrial oils in an increasingly productive way, agriculture also confirmed its position as the biggest user of water on the globe. Irrigation now claims close to 70 percent of all freshwater appropriated for human use (Haq's Musings 2009).



**Source:** Haq's Musings, 2009

Pakistan possesses the world's largest contiguous irrigation system commonly called as Indus Basin Irrigation System (IBS). It commands an area of about 14.3 million hectares (35 million acres) and encompasses the Indus River and its major tributaries. The system includes three large reservoirs (Tarbela, Mangla and Chashma), 23 barrages/headworks /siphons, 12 inter-river links and 45 canal commands extending for about 60,800 km to serve over 140,000 farmer operated watercourses. Irrigated agriculture is the backbone of the national economy. Groundwater under the Indus Irrigation System is plentiful and is derived from infiltration of surface water as well as local rainfall. However, depending upon the quality, the useable groundwater is confined to an area of 10 million hectares. The development of this resource is through private tubewells and account for a gross abstraction of about 40 MAF per annum. The increasing use of groundwater extracted through small private tube-wells has changed the nature of the IBIS. Encouraged initially by the example of the massive number of SCARP-imported tube-wells which added dozens of MAF to the irrigation system, Pakistan's private farmers used local electricians to fabricate small tube-wells running both on electrical and diesel power. This in large part freed farmers from the water shortage experienced in the rabi season and enabled them to balance the system at times of canal closure. In addition, it enabled them to plant more water-intensive crops such as rice in the kharif season by using tube-wells to augment the already plentiful supply of irrigation water in this season. The groundwater extracted through tube-wells amounted to about 50 MAF in 2007/08 of which about 40 MAF was from private tube-wells, 7.8 MAF from SCARPs, and 1.73 MAF

from public tube-wells. As a result, aquifers are being slowly depleted. It is estimated that the groundwater level has dropped to inaccessible depths in 5% of Punjab (a sign of groundwater depletion) and this is expected to decline to 15% in the next decade (Shahid A. Choudhry 2010).

The level of agricultural production is directly related to the availability and effective use of water as a major input. The surface water and groundwater and all canal commands are being used in conjunctive environment. The demand for water is increasing rapidly while the opportunities for further development of water resources or maintaining their use to existing levels are diminishing. The shortage of water particularly in Rabi season has further aggravated the ongoing water crisis. The water shortage scenario in Pakistan is further aggravated with high variability of rainfall. The onset of climate change and global warming is likely to severely affect the availability of water. To aggravate the situation, after the loss of 3 major rivers, Ravi, Sutlej and Beas, to India under the Indus Waters Treaty (IIWT) 1960, India's construction of water storage infrastructure at Baghlihar and Kishanganga, is threatening to disrupt the uninterrupted flow of water downstream into Pakistan. Compounding lower availability is the issue of inadequate water storage. Pakistan stores around 40% of the world's average in terms of water storage. In comparison, the storage capacity of Colorado is 497%, Nile 347%, India 33%, while Pakistan has just 9% storage capacity. As population size increases, resources become scarce in terms of per capita the same is in case with Water Resources which are statistic in nature. According to the World Bank data, Pakistan only stores 30 days of river water, India stores 120 days, while the Colorado River System in the US has storage capacity of up to 900 days of water usage (Economic survey 2009-2010).

According to the total actual renewable water resources in Pakistan decreased from 5260 cubic meters per capita in 1951 to 1282 cubic meters in 2002, and a little more than 1,000 cubic meters per person in 2010 which puts Pakistan in the category of a high water stress country. In view of growing population, urbanization and increased industrialization, the situation is likely to get worse. If the current trends continue, it could go as low as 858-cubic meters by 2025 (Table-1).

<b>Table1 : Per Capita Water Availability</b>		
<b>Year</b>	<b>Population (Million)</b>	<b>Per Capita Water Availability (M3)</b>
1951	34	5260
1961	46	3888
1971	65	2751
1981	84	2129
1991	115	1565
2002	139.5	1282
2010	167.7	1066
2020	195.5	915
2025	208.4	858

**Source :** *Economic Survey of Pakistan 2009-10*

Food production is mainly dependant upon land and water resources. Food production requires massive amounts of water. It takes one cubic metre (1000 litres) of water to produce one kilogram of wheat and 5,000 litres of water for one kilogram of rice. Producing sufficient food is directly related to having sufficient water. Increasing

irrigation efficiency and limiting environment damage through salinization or reduced soil fertility is important for ongoing Green activities. Seventy-eight percent of Pakistan's agriculture is irrigation supported, making it the country with the second largest area of irrigated cultivation in the world. In Egypt almost 100% of agriculture is carried out under irrigation, China 47%, India 35% and the USA 11% (Table-2). Cereals are a staple element in the diet of rural communities in Pakistan, but their yields are very low in comparison to other countries. A comparison of cereal yields and water use shows that Pakistan's yield level is low, while its relative level of water use is far higher. Average yields are about 30 % lower than the yield potential of the major crops (Table-3). More than 90% of this yield gap has been linked to technological inefficiencies. The clear implication from this is that there are serious inefficiencies in the cropping system and this is reflected in the high level of poverty found even in irrigated areas. At the same time, however, these figures show that an enormous potential exists for improvement by increasing crop productivity.

**Table 2 : Irrigated Areas and Food Production**

Country	Irrigated area in million hectares	Percentage of cultivated area	Irrigated area food production as % of total
India	50.1	35	60
China	49.8	47	70
USA	21.4	11	34
Pakistan	17.2	80	90

**Source:** Ministry of Water and Power, Federal Flood Commission 2005

**Table 3 : Cereal Yields and Water Use in Selected Countries**

Sr. #	Country	Yield Tones/ha	Water use for irrigation (% of total)
1	Egypt	5.9	85
2	China	4.5	87
3	India	2.1	93
4	USA	5.1	42
5	Japan	5.9	50
6	Korea	5.8	46
7	France	6.5	15
8	Germany	5.6	20
9	Italy	4.7	59
10	UK	6.6	3
11	Pakistan	2.1	91

**Source:** Ministry of Water and Power, Federal Flood Commission 2005

The existence of such large yield gaps, in spite of the high levels of investment in irrigation and on-farm water management add further weight to the argument that much more attention needs to be given to raising crop productivity than in the past, if Pakistan is to be competitive in an open market economy and if growth in the sector so important in reducing poverty is to be achieved. A closer look at the reasons for the poor yield of major crops in Pakistan suggests that the inefficient use of water is a major problem. The projected water requirements for different sectors in Pakistan show a rapid increase

in competition for water between sectors. Water availability is diminishing with a growing population and increasing urbanization. The present average availability of water is close to the average requirements of agriculture sector. However, demand is expected to increase by some 25% in the next ten years. Within this context of anticipated water scarcity, serious consideration need to be given to agro-economic, approaches to crop production that include the development of cropping systems, technologies and management strategies that make the most efficient use of water, assuming population growth continues at the present rate. The current per capita water availability at 1066 m<sup>3</sup>/person in Pakistan puts it in the category of high water stress countries that requires concentrating on water resource development, urban and rural water supply and sanitation, industrial water supply, irrigation and drainage, hydropower and environment protection.

Senator John Kerry reported to US Senate "India has acquired the ability to store enough water to limit the supply of water to Pakistan at critical moment in the growing season". It is estimated that India has created about 40 maf of storage from its 32 number of dams and still more dams are under construction. The capability to limit the supply of water at critical times of growing Rabi crops, mean to turn the Indus Basin Canal Irrigation System, the largest in the world, non-perennial. This means to create hunger and famine in Pakistan which means India will use water as a weapon of mass destruction. This obviously shows India has equipped itself for a silent water war.

A World Bank report recommends that Pakistan needs to set up new water reservoirs on an urgent basis, citing scarcity of water to get worse in the near future. The aging and inadequate irrigation and water infrastructure deficit alone is estimated at US \$70 billion. Pakistan needs to invest almost US \$1 billion per year in new large dams and related infrastructure over the next five years. The report says that new water reservoirs will push Pakistan's economy forward. It says that a new dam can potentially add four to five percent to Pakistan's GDP. Agricultural water already is being allocated to other utility uses such as municipal supplies, environmental reserves and hydropower generation. This indicates a need for a progressive agricultural policy alongside water policy if these allocations are to be optimized in economic and environmental terms.

*Pakistan Water Sector Strategy Report 2002 says, "By 2025, Pakistan should have adequate water available, through proper conservation and development. Water supplies should be of good quality, equitably distributed and meet the needs of all users through an efficient management, institutional and legal system that would ensure the sustainable utilization of the water resources and support economic and social development with due consideration to the environment, quality of life, economic value of resources, ability to pay and participation of all stakeholders".*

Pakistan must adopt an "Integrated Comprehensive Water Management" policy which means combined processes of storage, diversion, conveyance, regulation, measurement, distribution and application of the rational amount of water at proper times and removal of excess water from the farms to promote increased production economically, in conjunction with improvement of agricultural practice and institutional arrangement. In addition, it must take steps for the safety of drinking water to improve

the health of its people and also protect its water streams from industrial pollution and sewage discharge, (*Pakistan Water Sector Strategy Report 2002*).

In order to achieve food-secure and pro-poor agricultural growth, the following represent some areas of immediate attention: it is imperative that Pakistan focus on:

- Creating additional surface storage ;
- Modernizing the 150 years old, highly wasteful, incompatible and obsolete canal irrigation system ;
- Surface water preservation particularly by lining canals in saline areas and watercourse improvement ;
- Groundwater conservation and salinity control by discouraging excessive tube-well use ;
- Encouraging general efficiency of irrigation water use through improved land management techniques including land-leveling and also by changing the kharif cropping pattern away from water-intensive rice to sunflower, soya, maize, and more cotton ;
- Yield enhancement through improved farming practices, adopting hybrid seeds, and increased fertilizer and pesticide use ; and
- Fully meeting the environmental concerns of the Indus Delta, river systems, and wetlands.

### **Concluding Remarks / Recommendations**

The transition to a Green Economy has a long way to go, but several countries are demonstrating leadership by adopting national “green growth” or “low carbon” economic strategies. And there are many examples of successful, large-scale programs that increase growth or productivity and do so in a sustainable manner, for example. Investing in several green sectors, such as renewable energy, energy efficiency, clean technology, agriculture and water.

Reducing poverty, hunger and food insecurity are essential part of Millennium Development Goals. Food security thus becomes a fundamental component of a Green Economy. Assuming that population growth continues at the present rate, tremendous efforts are needed to narrow the gap between population growth and domestic food production. In order to benefit from adoption of new agricultural technologies, the farm households should be able to finance expensive inputs and diversify their livelihoods through optimum mix of farm and non-farm sectors’ employment. There is a need for better recognition of the role of water in ensuring food for all and eradicating rural poverty. It is important to ensure water security for the people through a national water policy laying down the outlines of an integrated water management strategy that aims at



maximizing the sustainable economic, social and environmental returns on the water resource development, allocation among its competing demands, its use by consumers and safe disposal of post-use effluents. In addition to the development of new water reservoirs, serious conservation steps need to be taken to improve the efficiency of water use in Pakistani agriculture, which claims almost all of the available fresh water resources. Pakistan would have to depend more heavily on technological change and improvement of technical efficiency for the desired rapid agricultural growth in future years. Contract and corporate structures, small and large farmers' cooperatives, and other innovative marketing strategies are seen to be the answer in future.

The government needs to promote integrated and sustainable land and water management to ensure efficient and equitable use of water, proper balance between agricultural and non-agricultural uses, waste management and sanitation, and capacity to address emerging challenges, including challenges pertaining to climate change.

**i. Sustainable Agriculture:** In order to ensure food security in the short as well as the long term, there is an urgent need to shift towards sustainable agricultural practices, including integrated water management, provision of support to and enabling access to natural resources by small and landless farmers and women farmers, and enhanced investment in the protection of the natural resource base, including land, water, and biodiversity. Make agriculture a driver for poverty reduction by ensuring policies link producers to markets and enable value to be created throughout the supply chain to help create income opportunities and diversify rural activities.

**ii. Integrated Land and Water Management:** Land related problems like depleting soil fertility, soil erosion, water logging and salinity needs immediate attention to achieve yield potential of crops. The other option is to take up new lands for agriculture. At the moment there is about 4 million acres land in the riverine belt of the country which should be distributed among local landless peasants. These are virgin lands where there is no shortage of moisture. The special conditions attached to these areas, especially bio-diversity have to be taken into consideration.

The efficient and effective use of irrigation water is most crucial to the future of Pakistan. It is also necessary that the government should plan for the future needs, taking into account agricultural, domestic, and industrial demand of the future and impact on the environment. There is urgent need for the government to ensure adequate and timely availability of water for farming to enhance food production and availability. The lowering of the water table is a serious issue in Balochistan, where the installation of large number of tubewells for irrigation is the main factor. Efficient utilization will not only promote food production, but also ensure the sustainable use of the ground water. In arid areas of the country like Cholistan, Tharparker and greater part of Balochistan, efficient rainwater utilization can be done through better water harvesting techniques and more efficient use of the available water resources. In the Rod-Kohi and dry mountainous areas, rainwater harvesting, storage and management including increasing the capacity of the main reservoirs should be given higher priority.

**iii. Innovation, Research and Extension Services:** Research and Extension are essential to strengthen agricultural research and extension mechanisms and ensure that they address all three dimensions of sustainable development, these include:

- Invest in training, knowledge sharing, extension services, as well research and development to close the uptake gap for existing tools and ensure new solutions are available for tomorrow ;
- Conduct agronomic research related to water availability, soil fertility and post-harvest losses, as well as climate change challenges ;
- Conduct research into crop varieties needed by the poorest and most vulnerable regions ;
- Promote farmer-centered research in accordance with their needs ;
- Explore alternative and efficient uses for agriculture products and by-products along the value chain ;
- Support research on the nutritional quality of foods ; and
- Provide access to weather and price information and improved seeds also helps farmers grow better crops and sell at better prices.

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