

6. Agriculture: Food, Water and Land

Our vision is an efficient and competitive sustainable agriculture ensuring food security and with ability to contribute to the economic development and poverty alleviation in Pakistan.

Few people would have accepted that Pakistan would be able to feed its growing population which increased from around 34 million in 1947 to 156 million in 2006. Not only has this been achieved, but rice has been exported nearly every year, and even wheat occasionally. Pakistan has diverse agro-climatic conditions, good natural resource base (land and water) and large network of irrigation system suitable for diversified and intensive agriculture production system. Agriculture sector, comprising mainly of crops and livestock sub-sectors in almost equal proportions, provides livelihood for two-thirds of country's population living in rural areas, contributes 22 per cent to GDP, 60 per cent to exports and 45 per cent to employment of the labour force.

In the last three decades of 20th century, Pakistan witnessed an unprecedented technological and economic transformation. It was able to achieve food self-sufficiency, triple its agricultural exports, reduce poverty, increase income levels, and improve quality of life for its people. The transformation started in the late sixties with the advent of green revolution. The key elements in improving food production during this period were the combination of a technology package (high yielding varieties of rice and wheat – water - fertilizer); improved policy environment; incentive structure in the form of input subsidies; and investment in agriculture infrastructure, including irrigation, research and extension. As a result, by the end of 20th century, almost all of the irrigated wheat and rice area in Pakistan was cultivated under high yielding varieties irrespective of farm size. Similarly, there was tripling of cotton and doubling of sugar production. Cereal production more than doubled on the same area under wheat and rice as in 1970. In other words, had cereal yields stayed at the 1970 levels, it would have now taken twice the area to produce the same amount.

Inspite of an impressive increase in agriculture production, it has not resulted in improving the living standards of the rural population to the extent desired. One

of the factors is the relationship of the rural population with land. Since independence Pakistan has tried thrice to implement land reforms by limiting land ceilings and giving land to the tillers. All these efforts had a very limited effect on redistribution of land.

Pakistan's average national crop yields compare reasonably with world averages, with yields in progressive farms much higher. However, a major part of arable land is cultivated by small farmers, with 86 per cent of the total number of farms comprising less than 12.5 acres. The small farms are continuously increasing because of land division due to inheritance. This is impacting agricultural productivity, as small farmers are generally resource poor and need greater attention.

Comparison of national average yields of Pakistan and other countries

Comprehensive and wide ranging strategies have recently been initiated to

Country	Average yield (kg / hectare)				
	Wheat	Cotton	Rice	Maize	Sugarcane
World	2,720	1,788	3,916	4,343	65,802
India	2,770	7,54	2,915	1,705	68,049
China	3,885	3,978	6,266	5,022	66,802
Egypt	6,006	2,654	-	-	119,838
Mexico	5,151	-	-	2,437	74,746
France	7,449	-	-	9,914	-
Pakistan					
• National Average	2,262	1,867	2,882	1,768	48,056
• Progressive farmer	4,500	2,890	4,580	7,455	106,700

mobilize small farmers. These include an intensive participatory outreach approach to make available key inputs such as credit, certified seed, training, small-farm equipment, veterinary coverage for livestock, milk collection, and establishment of a revolving fund for financing operations by the local communities through legally constituted Village Organizations (VOs). Such VOs will be the backbone of our agriculture production. These will develop into

corporate entities and a conduit for transfer of technology. Together with Farmer Field Schools (FFS), the VOs will help reduce the vast productivity gap between progressive farmers and resource poor small farmers.

6.1 Major Challenges

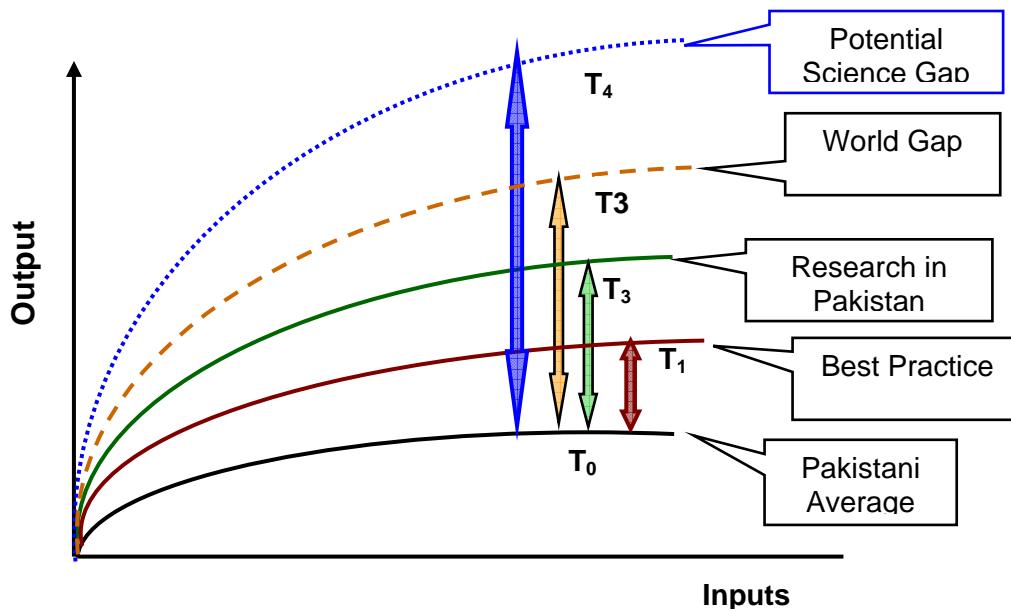
Several challenges that have now emerged are being addressed. These include increasing water scarcity, degradation of land resources (water logging and salinity), inefficient use of agricultural inputs (specially unbalanced application of fertilizer and inefficient water application), ineffective transfer of technology to the farmers, lack of coordination between research and extension, post-harvest losses, and marketing infrastructure.

Pakistan will need to increase its production of major agricultural products (food, feed, fiber, sugar, edible oil, meat, milk, poultry, and fish) to feed its growing population and also generate some modest surpluses for export by 2030. This would need to be done with lesser land and water resources than are available for agriculture today. This presents several challenges for agriculture in the 21st century, including:

- Accelerated increase of production of crops, horticulture, livestock and fisheries exclusively through productivity increases;
- Diversification into high value agriculture and value added products.
- Private sector-led growth through investments in value added products both for the domestic and export markets, such as floriculture using hydroponics technology for export oriented high-value vegetables/flowers.
- Export competitiveness and globalization
- Sustainable management of natural resource base and protection of environment;
- Public investments in rural infrastructure and institutions including water management, research and extension, education, health, water supply and sewerage
- Improving the nutritional quality of staple foods to provide essential nutrients such as iron, vitamins, amino acids and proteins;

- Production of renewable biomass suitable for production of bio-fuel that could be used as a substitute for fossil fuel (biomass from wastelands, castor, jatropha);
- Mitigating the impact of climate change.

The response to these challenges were unthinkable ten years ago, but is a reality now with the advances in science and technology and widespread application of molecular biology, genetic engineering, and other biotechnology tools.... *and these tools are available within Pakistan.*



Notes: The relevant gap that can be narrowed is represented by T₁

6.2 From Green to Gene Revolution

The Green Revolution has essentially run its course and its achievable potential has been largely realized. The emergence of post-green revolution problems, especially pests and diseases, declining water resources, land degradation coupled with high population growth are now posing threats to food security and environmental sustainability of the current production systems. When we couple this with the looming water shortages, *we believe that it will be difficult for Pakistan to support a population of 230 - 260 million in 2030, with current technology and current best possible practice alone.* Biotechnology will play the

critical role in meeting agricultural targets during this century, leading to higher production, better resistance, and lower costs of production.

The global planting of transgenic crops is rising annually at a rapid rate from 1.7 million ha in 1996 to 81 million ha in 2004. By the end of 2004, transgenic crops were grown in several developed and developing countries; two-thirds of the world's transgenic area and more than 90 per cent production is located in developed countries. Pakistan has entered this sector by developing transgenic cotton varieties which will drastically reduce use of pesticides.

The issues with 'Gene' Revolution is access of the beneficiaries (farmers, scientists etc) to new technology. Biotechnology is generally knowledge intensive (use of DNA technology) and because of intellectual property rights research stations in Pakistan would not have easy access to the technology. Either such technology would be extensive to avail, or the research stations would need major upgrading to develop the new transgenic crops. The outcome of green revolution – embodied in improved varieties of seed – was more easily transferred to farmers, while the outcome of gene revolution is often a private good and the seeds developed are expensive to adopt. Furthermore, there is apprehension that biologically modified seeds and their output may have serious effects subsequently. Biological safeguards, as Pakistan has formulated, are therefore necessary to reap the benefits of new gene revolution.

Green vs 'Gene' Revolution

Tasks	Green Revolution	'Gene' Revolution
Technology	Hybridization (Dwarf Gene/Biodiversity)	Recombinant DNA Technology
Technology Transfer	Free	Barriers
Inventor	Public (CGIAR/NARS)	Private (MNCs), Few PS
Regulations	None	PBR, WTO, TRIPS, CPB, SPS
Thrust	Public Good	Profit/Efficiency

Beyond applications to crop sector to increase production of food, feed and fiber, biotechnology will be used in the livestock sector for genetic improvement of animals in terms of milk or meat production, disease resistance, detection and prevention, vaccine and drug production etc.

Germplasm enhancement, human resource development

Major investments have been made over the years in agricultural biotechnology, and a few research centers attained international recognition. There is a need to establish more such centers especially on agro-genomics to act as the supplier of all basic information for developing desirable transgenic crops and animals. Investments in this area will have high rates of return.

6.3 The Water Challenge

Pakistan has not managed its water resources with care and is now becoming increasingly water stressed (current availability of 1100 cubic metres per capita which is fast approaching the water scarcity regime of under 1000 cubic metres per capita), compounded by overuse of water resulting in water-logging and salinity. The country's current storage capacity at 9 per cent of average annual flows is very low compared with the world average of 40 per cent. On average 35 MAF of water flows to the sea annually during flood season. In addition, extensive damages result due to flooding.

The cropping intensity for major crops in Pakistan is already nearly twice the 75 per cent assumed in the Indus Basin Treaty.

Without additional storage, the shortfall will increase by 12 per cent over the next decade. Increasing storage capacity is thus an important part of the strategy. It is planned to increase storage capacity by 18 MAF (6 MAF for replacement of storage lost to silting / sedimentation and 12 MAF of new storage) in order to meet the projected requirements of 134 MAF. The large storages will be complemented by a comprehensive programme of small dams, delay action dams, and other measures for recharging underground reservoirs.

Integrated water resource management, which aims at ensuring the most optimal use of water, is a major strategy for overcoming the looming water scarcity. While agriculture sector will remain the predominant user of water, the requirements for

industry, municipal and human use will continue to increase. The strategy is to enhance efficiency for all uses of water, including re-cycling and re-use.

The massive expansion of private-sector tube-well irrigation in Pakistan has had its serious environmental consequences; 11 per cent of the 22 million hectares of arable land has been declared as 'disaster area' because of severe water-logging and salinity (water table only 0 – 5 feet), while another 20 per cent is under stress (water tables 5 – 10 feet below the surface). The reforms would involve changing the institutional and legal environment in which water is owned, supplied and used, with the objective to improve water use efficiency.

There is a dire need for aggressively pursuing all the resource conservation technologies for sustainable agriculture. Our existing water use methodologies, based on gravitational irrigation are extravagant. All possible incentives are being provided for the adoption of water saving technologies such as laser land levelling, furrow irrigation and high efficiency irrigation systems (drip & sprinkle) . In addition efforts are being made for rain harvesting. Drought tolerant and water-use-efficient crop varieties through biotechnology will also augment conservation of water resources.

There are nearly 14 million acres of salt affected waste land with brackish underground water as well as large areas of sandy desert. Pakistani scientists have pioneered bio-saline agriculture technology whereby such lands can be economically utilized through an integrated approach. A National Biosaline Agriculture Programs is being launched to bring into use all such lands. Salt tolerant, fast growing grasses, shrubs & trees could be grown with brackish water, and used as a feedstock for economic conversion to methane or ethanol. This allows excellent use of wastelands, which will not only alleviate the poverty of local communities, but also improve the environment.

By use of all these technologies and construction of proposed water reservoirs, we are confident to meet the needs of agriculture during the coming quarter century and beyond.

6.4 Dairy and livestock

Agriculture sector is more than just crops. Livestock and fisheries sub-sectors contribute nearly 50 per cent of the agriculture value added and 11 per cent to the GDP. They are net source of foreign exchange earnings, contributing 8.5 per cent of the total exports. The livestock sub-sector has been able to sustain an annual growth of rate of 4 - 5 per cent during the last decade without major investments. Historically, it has been a subsistence sector dominated by small and landless farmers to meet their needs for food, draft animals, and some cash income. The development is constrained by inadequate and poor quality of feed, poor health coverage, indiscriminate breeding of genetically inferior livestock, outdated and limited marketing facilities, lack of investment in R&D and market infrastructure. The recent emphasis on this sector provides optimism for continued sustained growth of the sector at a projected growth rate of 5 per cent or higher (MTDF 2005-10).

Dairy and livestock have an important role to play in poverty reduction, as well as in gender empowerment, since women outnumber men by nearly 50 per cent in these two activities. Major new initiatives have been launched recently to improve the skills technology and training among the people who actually do the work. These are focussed on men and women in areas such as milk collection, animal health and feed.

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The agriculture sector has intimate linkages with other sectors such as rural development, water resources, industries, poverty alleviation and environment. High growth rates in the agriculture sector will help achieve MDGs by providing opportunities for employment and income generation through diversification of the rural economy toward agro-based industries and non-farm activities such as livestock, fisheries and poultry. The development of rural infrastructure will help the farmers in marketing their products. The key elements in future agricultural

development will be the management of land and water resources in a sustainable manner and structural transformation of agriculture from small scale subsistence farming to diversified and commercialized agriculture.

6.5 Food Security for All

The challenge of achieving food security for Pakistan remains a real one notwithstanding the progress in agriculture output since it depends on both *availability* of food as well

as its *access* and *affordability*. By best estimates, nearly half the population still suffers

Increasing food availability alone will not overcome the problem of malnutrition unless other basic needs such as provision of safe drinking water, improved health care and basic education are made available to all as a part of the overall strategy to achieve food security for all.

from varying degrees of outright malnutrition, as well as mild and moderate under-nutrition, with the most vulnerable being children, women and the elderly, especially among the lower 30 per cent income group. Prevalence of micronutrient deficiencies such as Vitamin-A, iron and iodine deficiency are also common.

In spite of a worryingly high population growth, we are confident that Pakistan's rich and productive resource base - augmented by the enterprising spirit of its farmers, and scientists – will not only achieve food, feed and fiber security, but also produce exportable surpluses. *However the achievement of the following levels of output will not be possible under the business as usual scenario.*

Milk Crops and Livestock	2004-05	Expected levels of Output (millions of tons)		
	Production (Benchmark)	2009-10 **	2015 ***	2030 ****
Wheat	21.6	25.4	30.0	33.0
Rice	5.0	6.3	7.5	8.5
Cotton(lint) *	14.6	17.0	20.7	21.5
Sugarcane	45.3	56.7	63.4	NA
Fruits	6.0	7.0	10.8	NA
Oil Seeds	5.8	7.5	8.12	NA
Meat	2.8	3.1	4.2	NA

Notes: The figures for future dates reflect our best estimates of expected levels of output based on the assumption that market conditions remain similar to what persist now. As the market conditions are dynamic and since agriculture will be demand oriented, actual production growth of some crops will be more pronounced than others and growth of some may even decline in response to declining demand or declining competitive advantage.

* Million Bales ** MTFD 2005-2010 *** MINFAL 2015

**** Production based on Regression Analysis of 16 years data (1990-2005) and using compound growth method

While the share of agriculture in GDP may decline to 10 per cent by 2030, as has happened in the newly industrialized countries, continued growth of the agriculture sector would be important because it plays such a vital role in sustaining food security and natural resources base.

6.6 Facing Poverty

The food balance sheets for the last decade indicates that the overall per capita availability of food items has only marginally been maintained, during which period the population grew by 20.1 per cent, from 124.5 million in 1995 to 154 million in 2005.

The availability of per capita calories declined during this period from 2522 kcal/day to and per capita availability of protein declined from 66.6 grams/day to 64.3 grams/day. Per capita per day caloric level in Pakistan (2466 kcal/day) is less than the Recommended Dietary Allowance (RDA) of 2550 kcal/day. However, the protein level is 7.2 per cent more than the recommended dietary allowance of 60 grams/day.

There have been slight reductions in total cereals (wheat, rice, maize, millet sorghum, barley), and meat. However, increases have been recorded in milk, eggs and edible oil. Over the longer period of the last 25 years, availability of calories per day during this period (1979-80 to 2004-05) has decreased on average by 1.3 per cent from 2301 to 2271 while that of protein has increased from 61.5 gm per day to 65.5 per day.

Based on the pattern of existing food production and availability, and desirable change to the National Food Basket, on the pattern recommended by FAO, the consumption requirements per capita of major food commodities has been

worked out up to 2030. This shows we would require lesser cereals, but increases in pulses, meat, oils, vegetables and fruits and dairy products.

Internationally, most of the current agro-biotechnology research is being undertaken by a few multilateral companies and caters to the interests of rich farmers and developed countries. We are optimistic that Pakistan will also generate international players in its private sector, but for the time being, the public sector will play the major role in ensuring that small and disadvantaged farmers and resource poor areas are not left further behind by the upcoming gene revolution.

6.7 Globalisation and Agriculture

Globalisation offers both challenges and opportunities for further economic growth in Pakistan, and can facilitate rural and general economic development. Globalization has also made mandatory for Pakistan to introduce new regulatory rules and bring fundamental changes in its agricultural production regimes. The competitiveness will be strengthened by adopting Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) in agricultural production and processing. In this way, by meeting WTO requirements and standards, agricultural commodities from Pakistan can get more opportunities of export due to dynamic market evolution, continued social change and shift in consumer preferences for high value crops. Investments in the transport and preservation technologies is already underway in Pakistan through appropriate government interventions and triggers, which will improve the entire value chain in agro-industries.

6.8 Managing Natural Resources

There is unprecedented consumption and degradation of water, land, and air because of continuous growth in the scale of human enterprise worldwide. Development, and economic growth have also perhaps destroyed irreversibly the scale of natural biodiversity, with result that the eco-system now has lesser capacity to sustain waste or human life.

Land degradation is a serious problem both in irrigated and less favourable areas. In irrigated areas, monoculture and excessive or unbalanced use of chemical inputs resulting from pricing and subsidy policies has been the main cause of environmental degradation. In less favourable areas, mining of soil nutrients, erosion and deforestation are the major causes.

The rapidly increasing demand for meat and livestock products, and the resulting pressure on livestock production could cause similar or more environmental degradation in this sector, if science-based high yielding technologies are not adopted/ developed. In fisheries, production has also increased significantly over the last two decades in response to increasing demand and this has led to severe strain on coastal resources. There is therefore need for sustainable management of natural base to meet the needs of present and future generations.

6.9 Climate Change

Global change, especially in biophysical environment, is impacting the lives of all inhabitants. Ramifications of global warming are having disastrous consequences in the form of drought, floods, low and high temperatures extremes and hurricanes. Recent data reveals that 1990s was the warmest decade, and 1998 was the warmest year. Unprecedented heat wave in 2004 resulted in large number of deaths.

Similarly, high intensity typhoons in the USA and the Tsunami in Indonesia, the prolonged and severe drought in Southern Pakistan confirm a trend in global climatic change. In our region, the monsoon season has been shifting both in intensity and time resulting in heavy losses to national economies. Therefore, comprehensive and careful research studies are needed to understand the nature and the extent of this climatic change and develop plants and animals types and farming systems, which are less vulnerable to such climatic changes.

Models show that Pakistan will grow warmer by 1.0 degree C by 2030 ¹; this may require extra water for wheat. We will also need wheat varieties which are more drought as well as more flood resistant. On the whole, wheat yield is likely

¹ CICERO; Report 2002-2

to go up, even though its geographical distribution will change, while rice will not be affected.

We also expect more waters in our rivers because of greater melting of glaciers, suggesting benefit of greater water storage schemes for this bonus period of next 25 – 30 years.

We believe that it is possible to achieve the vision of an efficient and competitive agriculture sector which will be able to meet on sustainable basis, the food security and agricultural product needs of a developed, industrialized and prosperous Pakistan envisioned in the Vision 2030. This can be attained through the application of science and technology and sustainable management of natural resource base, which in turn requires major investment in human resource, reforms in agricultural practices and rural institutions, infrastructure, and management of challenges from globalisation, biotechnology and climate change. *However it will be managed only* if the economics of ecology and biodiversity is firmly embedded in our young people's minds as a part of inter-generational equity, and as a part of their inheritance.

We are aware that even if all this is achieved, trade and non-tariff barriers in the developed countries will also need to be reasonably amended to allow a level playing field for Pakistan's agriculture sector to become an efficient exporter.

Biotechnology research, and patents, are raising major concerns about intellectual property right issues, because of undue claims of multinationals on the indigenous genetic material of Asian countries. These common issues necessitate a common negotiating stance of the developing countries in Asia to counter outside threats. The recent such examples are 'basmati' rice, turmeric and 'neem'.