MANAGEMENT OF AGRICULTURAL RESOURCES IN CHANGING ENVIRONMENT PROSPECTS

By

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Abstract

Agriculture is the largest user of land, water and labour causing directly or indirectly land degradation and water scarcity. It is a major player in underground water depletion, agro-chemical pollution, soil exhaustion and global climate change, accounting for upto 30% of green house gas emission. Besides this, it is a major provider of environmental services generally unrecognized and unremunerated, managing water sheds and preserving biodiversity. Pakistan with a population of 173 million (2010) is a developing country and its rich resource base rainfall, ground and surface waters and soils are well suited to agriculture which is the mainstay of her economy. These elements have been important to its development. However, there is an increasing and apparently permanent imbalance between population growth and the natural resource base. The habits and needs of the individual users are becoming threat to the environment. Trends show that, for many years, there has been a steady decline in the status of the environment. Pakistan's natural resource base has been developed to the maximum with little considerations for sustainability. This has led to deterioration of natural resources threatening the survival not only of the flora and fauna but also the livelihoods they support. The environmental damage caused by these changes has raised a number of issues in the form of ecological, economic and social impacts. These issues are apprehended to be aggravated under changing environment prospects such as climate change, population dynamics and globalization. The main areas of resource degradation are land and water (water scarcity, over mining of ground water and water quality deterioration impacting irrigated agriculture), riverine forests and riverine agriculture etc. Agriculture intensification is a key and desirable way to increase land and water productivity through sustainable resource utilization such as enhancing water storage capacity, ground water management, adoption of resource conservation technologies, better water pricing, suitable agro farm practices and appropriate agriculture policy, environmental awareness etc.

1. Introduction

Agriculture is in fact a dynamic combination of various components (resources) of the system which requires to be tuned every now and then for increased efficiency and higher production. Climate, land and water, is one (basic) set of components. Biological organisms such as plants, animals, fish, insect, fungi etc are another set of components (resources). Most important component of agri-ecosystem is man himself and his institutions. Man influences the ecosystem through policy decisions, providing regular inputs, timely organizing various cultural operations, discovering and utilizing new knowledge, efficient disposal of farm products at attractive profits and conserving natural

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components (resources). He can thus alone make or ruin the system. Although modern agriculture has been successful in increasing food production, it has also caused extensive environmental damage. For example increasing fertilizer use has led to degradation of water quality in many regions. In addition some irrigated lands have become heavily salinized, causing the world wide loss of approximately 1.5 million hectares of arable land per year, along with an estimated $11 billion loss in production. Upto 40% of global crop lands experience some degree of soil erosion, reduced fertility or overgrazing. The loss of native habitats also affects agricultural production by degrading the service of pollinators, especially bees. In short, modern agricultural land use practices may be trading short term increases in food production for long term losses in ecosystem services.

Pakistan is still a natural resource based economy. The agriculture sector is primary employer and the most important contributor to economic surplus and the principal source of its foreign exchange. Optimal utilization of natural resources for more productive purposes is imperative for many reasons like very high stake for rural livelihood, health and productivity consequences of uncontrolled population and high costs of migration to urban areas etc. Unfortunately these natural resources (land, water, forests, rangelands and fisheries) were exploited for high growth targets without giving any due consideration about their regeneration, conservation and rehabilitation. This lavish behavior has given birth to bad environment outcomes like underground water depletion, agro-chemical pollution, soil exhaustion and climate change due to green house gas emission. The country is now suffering from problems like water scarcity for crop production, salinity & sodicity of fertile soils, more erratic and low rainfalls and low carrying capacity of rangelands. A major challenge is to reverse the degradation of natural resources and minimize damaging effects on the environment. The paper discusses the potential threat to natural resource base and its management for supporting agriculture on sustainable basis.

2. Resource Base

Pakistan possesses a great variety of natural resource base ranging from majestic high mountains of Himalayas, KaraKarm and Hindu Kush with snow covered peaks as a source of water for irrigation and electricity generation, to the inter mountain valleys down in the north. Further down are the vast rich irrigated plains in the Indus Basin sustaining agriculture, stark deserts and impressively rugged rocky expanse of plateaus in Balochistan providing range lands and custodian of a significant proportion of livestock population of the country. The resource base supporting agriculture is discussed as under:

2.1 Climate – Rainfall

The climate of Pakistan varies widely from temperate climate in the north to hot and dry tropical climate in the south. The country is characterized by wide variations in both temperatures and precipitation. Temperature reach as low as $-25c^0$ over the Northern mountains, and as high as $52c^0$ over the central arid plains. The mountainous and sub

mountainous area of the northeast receive over 1700 mm of precipitation annually, in contrast to the arid plains of southwest Balochistan with 30 mm of average rainfall.

2.2 Land Resources

Pakistan's total land area is about 79.61 mha. About 56% (44.30 mha) of the total land area is often classified as un-useable for agriculture or forestry and consist mostly of deserts, mountain slopes and urban settlements. About 38% (29.38 mha) of the total land area is cultivable. About 5% (4.20 mha) of total land area is under forest and 1% (0.79 mha) of the total surface area is covered by wet lands. The classification of land utilization of the cultivable area for the year 2009-2010 is given as under:

(million hectares)

Year	Total Cultivable Area				Area sown more than once	Total cropped area
	Cultivable waste	Current fallow	Net area sown	Total cultivable area		
2009-10	8.10	5.02	16.25	29.38	7.42	23.67

Source: *Agricultural statistics of Pakistan 2009-10*

2.3 Water Resources

Pakistan's water resources comprise of surface and ground water as briefly described below:

a) Surface Water – The Indus River System is the major source of surface water which derives mostly from snow and glacial melting. Pakistan receives snowfall only in the Gilgit-Baltistan during winter. Rainfall is markedly erratic in magnitude, time of occurrence and aerial distribution. Pakistan is dependent on the three western rivers including Kabul, Indus, Jhelum and Chenab. Post-Tarbela (1976-2010) average annual flows (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala and with eastern rivers contribution) were 145.63 MAF. The three eastern tributaries of the Indus – Ravi, Sutlej and Beas – were allocated to India for its exclusive use. The Kabul River contributes 21 MAF to the surface supplies of the country:

b) Ground Water – Pakistan is extracting about 50 MAF from the aquifers and has already crossed the sustainable limit of safe yield. This over-mining and pollution of aquifers has resulted in secondary salinity and the presence of fluorides and arsenic in water, which in turn is degrading the quality of agricultural lands and health issues. The northern part of the Indus Basin is fresh where as, southern part is saline.

3. Agriculture Sector

Agriculture is the mainstay of the national economy of Pakistan. It contributes about 21% to Gross Domestic Product (GDP), accounts for 60% of the country's exports, provides livelihood to about 62% of the country population in rural areas and supply 45% of the national labour force. The foremost challenge before the sector is to adequately provide

food and fiber to meet the needs of growing population without irreversibly damaging the fragile ecosystem. Being open to vagaries of nature, this sector is highly vulnerable to climate change phenomena. The small scale farms accounting for 86% of the total farms with 43% of the farm area are most vulnerable to the impact of climate change because they lack financial resources and access to information needed for adaptation (Table-1).

Table-1: Number and area of farms by size of farms

Size of Farm (Hectares)	Farms (000)		Farm Area (000 hectare)	
	Number	% of total	Total	% of total
Small Farms (upto 5)	5672	85.6	8864.35	43.4
Medium Farms (>5 to 10)	580	8.8	3891.23	19.1
Large Farms (above 10)	368	5.6	7651.20	37.5
Total:	**6620**	**100.0**	**20406.78**	**100.0**

Source: *Census of Agriculture 2000.*

The *Agriculture* sector has strong linkages with the rest of the economy as on the one hand, the sector is a primary supplier of raw materials to downstream industry, contributing substantially to Pakistan's exports, on the other, it is a large market for industrial products such as fertilizer, pesticides, tractors and agricultural implements. Despite its critical importance to growth, exports, incomes, and food security, the Agriculture sector has been suffering from secular decline (Table-2).

Table-2: Historical Agricultural Growth Performance

Years	Percent
1960	5.1
1970	2.4
1980	5.4
1990	4.4
2000	3.2

Source: Pakistan Economic Survey 2010-11

Growth in the sector, particularly in the crop sub-sector, has been falling in the past three decades. Productivity remains low, with yield gaps rising i.e. 36 percent in case of rice (paddy) and 52 percent in case of wheat and cotton seed. (Table-3) Critical investments in new seeds, farming technology and the water infrastructure are not being made. The stagnation or decline in agricultural economy is mainly due to inefficient management of the overall agricultural production system viz-a-viz poor technology transfer at the farm level, especially to the small farmers, non availability of inputs and credit on time, inefficient marketing system, lack of sound agricultural policies, water logging, salinity, soil erosion and inefficient water management.

Table -3: Comparison of National Crop Yields with Major Growing Countries

(kg/ha)

Country	Wheat	Percent of Best*	Sugarcane	Percent of Best*	Rice (Paddy)	Percent of Best*	Cotton Seed	Percent of Best*

World	3086	65	71510	59	4309	44	2099	54
China	4762	100	73114	60	6556	67	8906	100
India	2802	59	68877	57	3370	35	1206	31
Pakistan	2451	52	51494	43	3520	36	2046	52
USA	3018	63	73765	61	7672	79	2250	58
Brazil	-	-	79709	66	4229	44	3757	96
Egypt	-	-	121136	100	9731	100	2333	60

Source: *Ministry of Food and Agriculture, 2008* Note: **Best = 100*

4. Environment Status – An outcome of resource over exploitation

In using natural resources, agriculture can create good and bad environmental outcomes. It is by far the largest user of land, water and labour, causing directly or indirectly land degradation and water scarcity resultantly some environmental issues. It is a major player in underground water depletion, agro-chemical pollution, soil exhaustion and global climate change, accounting for upto 30% of green house gas emission. Besides this, it is a major provider of environmental services generally unrecognized and unremunerated, managing water sheds and preserving biodiversity. Managing the connections among agriculture, natural resources conservation and the environment must be an integral part of using agriculture for development.

There are, however, concerns raised with respect to the costs and practices of the past development in terms of environmental degradation, resource misuse and depletion. Population growth and poor management have reduced per capita water availability from 5260 m^3 (1951) to 1038 m^3 (2010). Wood logging has contributed to deforestation and extensive soil erosion. Each day the Indus River adds an estimated 500 thousand tons of sediment to the Tarbela Dam, which has reduced its life span by 22% and its water holding capacity by 32%. The irrigation system contributes millions of tons of salt to the commanded/flood plain farm land. Approximately one third of cropped area in Pakistan is impacted by salinity. The irrigation system also has wrecked havoc on the delta region's ecological balance. The annual estimated cost of environmental and natural resource degradation and damage is about Rs 365 billion or six percent of GDP. The highest cost is from inadequate water supply, sanitation and hygene (Rs 112 billion) followed by agricultural soil degradation (Rs 70 billion), and indoor air pollution (Rs 67 billion), urban air pollution adds another Rs 45 billion. Rangeland degradation and deforestation costs are the lowest at about Rs. 7 billion in total. It is imperative to emphasize that serious environmental damages and stress on natural resources have been experienced. Pakistan's natural resource sector is under intense stress. The forest sector is severely damaged, fisheries need major remediation, and agricultural land is increasingly becoming waterlogged, saline and fragmented while groundwater supplies in places like Balochistan are running out. The glaciers in the northern mountains of Pakistan are beginning to melt due to global warming and agriculture will either greatly diminish or require major adjustments.

5. Main Areas of Resource Degradation

There have been a number of areas of critical importance. The most important environment changes have occurred in land and water resources, forest and waste water management as described below:

5.1 Land Resources

Pressure on land includes high population growth rates, erratic rain fall patterns and droughts, soil erosion from both wind and water, declining soil fertility, saline ground water, lack of credit and financial capital, lack of information about new technologies and farming practices, unclear land property rights, policy disincentives to invest in dry areas and lack of markets and market information. As a result of high population growth rate land holdings are shrinking in size and land productivity is decreasing – with resulting increased poverty and out-migration to cities etc.

The present use of land is not in accordance with its potential. Rather it is based on opportunity, economic status and socio economic needs of the user. Currently the conversion of forest land to agricultural land and agricultural land to commercial land, rapid and unorganized expansion of urban centers, has affected the environment. Extensive areas in Thal, Tharparker and Cholistan have been over utilized for grazing and now seriously threatened by desertification. Sometimes infra-structure and policy mistakes are also responsible for creating adverse impacts on cropping patterns. For instance, setting up of sugar mill in Thal led to extensive sugarcane cultivation, which aggravated water logging problem in the area. Soil erosion by water is one of the severe problems of Pakistan. Its major causes are destruction of natural vegetation cover by uprooting and cutting plants for cultivation, fuel, timber and forage needs; arable farming in shallow lands in steep areas; and rapid decline in organic matter in cultivated soils due to continuous cropping without fertilizer or organic matter recycling. Lands degradation encompasses deforestation and desertification, salinity and sodicity, soil erosion, water logging, depletion of soil fertility and negative nutrient balance etc. About 38% of the cultivated land in Pakistan is already suffering from environmental damage. The status of lands degradation in Pakistan is given in Table-4. Climate change is likely to aggravate soil degradation processes in intensity as well as extent affecting adversely the production potential

Table-4: Status of land Degradation in Pakistan

(Area in 000 hectares)

Province	Salinity & sodicity *	Severely water logged **	Soil Erosion	
			Water	Wind
Punjab	1242.82	453.66	1904.0	380.45
Sindh and Balochistan	3141.24	1479.15	4641.9	2332.5
KPK	102.80	34.00	4292.2	36.50
Total:	**4486.86**	**1966.81**	**13050.2**	**6173.5**

* Survey period 2001-2003.

** Average of 1993-2002.

Source: *SCARP Monitoring Organization WAPDA.*

5.2 Surface Water Scarcity

On the average 145.63 MAF of water enters the Indus Basin annually; out of which 104 MAF is diverted for irrigation purposes at canal heads. It is estimated that about 35% of that water is lost in transit from canals to fields and 20% because of inefficient irrigation techniques. Figures of population growth and available water indicate that the current

annual per capita water availability has dropped to almost 1000 m^3 – from 5260 m^3 during 1951 in period of about 60 years. Shortage of water during the Rabi season has become a permanent phenomenon that not only affects the Rabi season crops (area & productivity) but also affects the planting of cotton crop.

5.3 Ground Water Abstraction

A tremendous ground water development has taken place during the last four decades to supplement the inadequate surface water supplies and cater the requirements of increased cropping intensities. The unsystematic/ unevenly distributed large scale pumpage through more than one million tubewells have given birth to a number of problems like ; (a) Abnormal lowering of water table in some areas making the pumpage more expensive depriving poor farmers from using ground water ; (b) Saline water intrusion in fresh groundwater areas ; (c) Deterioration of ground water quality in areas with shallow fresh ground water overlying SGW ; and (d) Soil degradation through secondary salinity as a consequence of poor quality ground water application.

The continued abstraction of groundwater particularly through over pumping has led to the depletion of water table in many areas. This problem has become more acute in recent years due to the continued and extended drought suffered by Pakistan. Lahore, parts of Balochistan and some densely populated urban areas of Punjab and Sindh have severely been affected by this phenomenon. In the irrigated areas too, in more than 50% canal commands the water table has fallen. The degree of depletion is significant in areas where water allowances are lower and crops are heavily dependent on tube well irrigation. The average depth to water table in the Province of Punjab measured during pre and post monsoon 2006 corresponded to 647 to 623 cm respectively. In some areas of Faisalabad, Multan and Bahawalpur ground water is rapidly declining due to overdraft of the aquifer.

5.4 Water Quality

The ground water aquifer ranges from very good to very poor in quality and according to 2006 survey by Directorate of Land Reclamation Punjab, 54% of the areas are underlain with brackish water in Punjab and groundwater is unfit for irrigation as evident from Table-5.

Table-5: Ground Water quality status during 2006 in Punjab

Quality Parameter	Unfit %
Electrical conductivity > 1.5 dS/m	46
SAR > 10.0	22
RSC > 2.5	22
Overall status:	**54**

Surface and groundwater quality is deteriorating day by day in all streams and water bodies. The indiscriminate discharge of industrial and domestic waste water into open water bodies and groundwater is the most serious threat to country's reserves. The absence and non implementation of legislative measures and standards has been the

root cause of the deterioration of water quality observed over the years. The injudicious management of fertilizer-tillage-irrigation matrix is resulting in leaching of nutrients to pollute ground water reservoirs. According to a study by SMO, Wapda during 2001 to 2004, nitrate values were found higher than permissible limits in Dallas Drain and Kalpani Nullah, (Khyber Pakhtunkhwa), Samundri, Jaranwala and Hudiara drains (Punjab). The contamination of fertilizer residue in Indus River at Chachran Sharif was observed in the form of nitrate beyond permissible limits. These interactions are likely to turn into a serious situation if proper attention is not paid to arrest these trends.

5.5 Riverine Forests

Riverine forests occur in the tropical thorn forest zone in the Indus inundation plain. These forests play an important role in providing timber, fuel wood, wood for the mining industry and fodder as well as a refuge for wildlife. Riverine forests have been strongly influenced by climatic events such as droughts, the status of natural resources and seasonal un-predictabilities.

The development of Indus water resulted in a reduction in inundation in the riverine areas and this has had a severe impact on the riverine forest ecosystem. The riverine forests along many riverine belts in Sindh and Punjab have dried up. In the past, areas inundated annually by Indus River and its tributaries were covered by riverine forest. In recent years, declining discharges – as a result of more irrigation water being used in the canal command areas – have had an adverse effect on the entire riverine tract, particularly in Sindh where approximately half of the riverine forests have been seriously affected.

5.6 Agriculture in Riverine Areas

It depends primarily on residual soil moisture and the high water table created by floods. Sailaba cultivation in Rabi season was the mainstay of incomes in the riverine areas. The signing of Indus Water Treaty combined with rapid demographic growth initiated a process of far reaching changes like decrease in the frequency and depth of floods particularly after construction dams/reservoirs, decline in water table due to exploitation of groundwater through tube well irrigation and decrease in rate of its recharge.

5.7 Indus Water Treaty (1960)

Perpetual loss of 24 MAF water of three eastern rivers as a result of Indus Water Treaty (1960) affected not only the riverine areas, but also the ecological, economical and social conditions in the Indus Basin. Consequently alternative sources of irrigation were deployed to sustain agriculture, resulting some other environmental problems. i.e. (a) Traditional flood irrigation (Sailaba), has largely disappeared on all rivers and local communities have been shifted to well irrigation, further deteriorating the natural cycle of regeneration and return flows, (b) The Sutlej, Ravi and Chenab rivers have reduced to low and limited flows in summer during normal conditions. The river Beas has extinguished from Pakistan. (c) The maintenance cost of system has increased with new link canals and storages.

5.8 Deforestation

The country has low forest cover, below the required 20-25 percent of the covered area. Excessive use of forests and forest products has resulted in deforestation causing floods and desertification. Population growth, excessive use of wood and rise in poverty are expected to increase the rate of deforestation. The forests are very important for conservation of agricultural resources but the country's lost of forest cover every year at the rate of 1.5 percent is affecting the efforts to conserve the forest area.

5.9 Waste Water Management

The disposal of sewage streams into fresh water channels and agricultural drains has been increased as a consequence of the growth of human settlement and associated activities. According to an estimate, volume of sewage of some major cities of Pakistan is about 4156 cusecs and volume of industrial effluent is about 540 cusecs. The growing population and fresh water scarcity increases the scope of reuse of urban waste water in agriculture. Evidences show that it has both positive and negative impacts on crop productivity and yields. Given the agronomic and water management practices, it can be used as supplementary water for irrigation, reduce fertilizer cost and can increase/ decrease yield depending on the plant nutrient content of the waste water, which has implication for profitability of crop production, pollution of soil resources or lack of demand for the crops produced in the fear of the health impacts. There seems lack of awareness and information concerning the impacts of using untreated municipal waste water for irrigation in rural areas adjoining to big cities for crop production.

6. Changing Environment Prospects

Development in agricultural policies, crop prices, mechanization in agriculture, crop diversification, the developments in relation to the Word Trade Organization (WTO) and the Millennium Development Goals (MDG) will all have to a certain extent their influence on agricultural production patterns. Climate change might modify agricultural production opportunities and constraints in ways that present new challenges regarding the world's food supply. Sustained changes in temperature and atmospheric concentrations of key elements might have unforeseen impacts on forests, fisheries, wetlands, grass lands and other ecosystems. The pressures imposed by climate change and population dynamics on food production and ecosystems might generate responses that cause further degradation of natural resources and environmental amenities.

The impacts of climate change will vary with geography and levels of economic development. In regions of water scarcity with low agricultural productivity, global warming might cause substantial harm and large financial investments and policy reforms would be needed to boost economic development. Climate change can place new pressures on current conflicts in some regions. The potential impact of climate change on per capita water availability and resultantly on economic development needs to be viewed seriously.

6.1 Climate Change

Pakistan is an emerging economy and is most vulnerable to climate change especially because of its agrarian economy. Water is life line for agriculture and modification in the hydrologic cycle through climate changes and human activities has shown tremendous change in agriculture performance. According to some studies, growing season length for wheat and Rice Basmati will decrease with increase in average temperature due to climate change. Simulation modeling studies show that national wheat and Basmati rice production in year 2080 under the influence of climate factors will be 6-8% and 15-18% lower than the potential production, respectively. These findings have very serious implications for the future food security of Pakistan such as reduced productivity of crops and livestock, increased crop water requirements, uncertainty in timely availability of irrigation water, erratic and uncertain rainfall, floods, drought and cyclones, degradation of range land and cultivated lands, intrusion of sea water etc. On the whole climate change is irreversibly harming Pakistan with its tremendous social, environmental and economic impacts by creating challenges in the sectors of agricultural productivity, human life and use of natural resources.

6.2 Population Dynamics

The first critical area of concern which has implications for all dimensions of resource use and environmental degradation is population dynamics. The rapid rise in population is increasing the burden on resources. The issue of population growth and poverty are critically linked with environmental degradation. Rapidly increasing population in mega cities has caused environmental problems. Industrial waste, poor sanitary conditions, pollution created by smoke emitting vehicles and traffic noise have an adverse impact on climatic condition, particularly enhancing frequency of drought cycle and health hazards.

Pakistan is the world's sixth most populous country. With an estimated population of 173.51 million as at the end-June 2010, and an annual growth rate of 2.05%, it is expected that Pakistan will become the fourth largest nation in population terms by 2050. Since 1950, it is estimated that Pakistan urban population has expanded over sevenfold. Future population growth at various index years up to 2030 is given in Table-6:

Table-6: Population and Growth Trends

Year	1951	2002	2010	2015	2020	2025	2030
Population (million)	34.0	139.5	173.5	191.7	201.1	227.3	242.0

6.3 WTO Effects on Agriculture

World Trade Organization (WTO) is the principal international institution responsible for laying down rules for the smooth conduct of trade in goods and services among nations in this globalize world. The agriculture was included in the multilateral trading system after the 8th (Uruguay) round of talks under GATT (General Agreement on Tariffs and Trade, predecessor of WTO). This trade round stretched from 1986-1994 and concluded in establishment of WTO and including agriculture. WTO policies impact agriculture principally through the agreements viz-a-viz. (i) Agreement on Agriculture (AOA), (ii)

Agreement on application of Sanitary and Phytosanitary Standards (SPS) - dealing with health and disease related issues, (iii) Agreement on Technical Barriers to Trade (TBT)-dealing with regulations, standards, testing and certification procedures, packaging, marking and labeling requirements etc and (iv) Agreement on Trade related aspects of Intellectual Proprietary Rights-dealing with patents and copy rights, plant breeders rights etc.

The three pillars of Agreement on Agriculture are domestic support, market access and export competition. At best, agreement on agriculture (AOA) has turned to be a modest attempt to lay down some institutional framework and general principles that can be further developed to move towards a fair and market oriented trading system in agriculture. At worst, it has been perceived as legalization of trade distorting practices, being carried out by developed countries by virtue of which market access to foreign agricultural products is denied and domestic support to local agricultural products is continued to be provided. Market access provisions under WTO are based on the principles of "Tariffs only" whereas, bound levels of tariffs for agriculture products originating in developing countries are excessively high in developed countries. It has made very difficult for agricultural products from developing countries to enter and compete in developed countries markets. Import barriers (market access restrictions) and domestic subsidies have increased the prices of agricultural products in internal markets of developed countries leading to over production of agricultural products. By providing export subsidies and export credits, developed countries have been able to effectively dump their excess-production in international markets causing a fall in prices of agricultural products. Resultantly developing countries exports suffer from low profits and in worst scenarios their domestic markets have been lost due to inflow of artificially cheap imports from developed countries. Needless to emphasize that their practices accentuate poverty through loss of jobs and diminution of GDP. Pakistan's agriculture is vulnerable to WTO effects and requires government's attention to minimize these impacts.

7. Future Strategies

Agriculture intensification is a key and desirable way to increase productivity of existing land and water resources in the production of food and cash crops, live stock, forestry and aqua culture. The cumulative demand for irrigation water is likely to increase in warmer seasons, raising the competitions for water between agricultural, industrial and urban uses. In such situation, water management practices in all sectors are needed to be implemented for sustainable resources utilization. These include to; (a) Increase water storage capacity through construction of dams; (b) Improve the crop productivity per unit of land and water; (c) Improve farm practices by adopting resource conservation techniques such as laser land leveling, zero tillage, crop diversification, proper cropping patterns, optimized planting dates etc; (d) Provision of incentives for adoption of water saving technologies such as bed and furrow irrigation, high efficiency irrigation systems, water course improvement; (e) Better pricing of irrigation water; (f) Develop new breeds of crops which are high yielding, resistant to heat stress, drought tolerant, less prone to insects/ pests etc; (g) Enhance the research capacity of various relevant Organization; (h) Enhance the capacity of farming community for adaptation measures;

and (i) Formulate agriculture policy to counter the adverse impacts of climate change and other related aspects causing low productivity.

The bio-saline approach offers better use of saline land and water on sustained basis through the profitable and integrated use of genetic resources and improved agricultural practices. The quality of natural water resources have generally been degraded by untreated/ partially treated municipal and industrial waste water. For sustainability of irrigated agriculture, it is imperative to operate the irrigation system based on conjunctive use of treated and partially treated waste water and saline water.

Application of chemical fertilizers and pesticides subsequently degrades the soil structure and pollute groundwater. Organic farming being accepted all over the world, has great potential to tackle problems related to export risk under WTO. Organic farming can reduce the use of chemical fertilizers and pesticides and hence can reduce the import bill. It increases soil fertility and ultimately generates environment friendly and healthy foods. Pakistan needs to formulate policies to mitigate the adverse impacts of WTO. Pakistan needs to provide patent protection to its valuable export brands like Basmati rice, varieties of mangoes, oranges etc. We need to improve our production, storage, packaging, labeling, testing, processing and make up marketing facilities on scientific lines to pursue an export led growth strategy with adequate safe guards.

8. Conclusions and Recommendations

Based on preceding description it is concluded and recommended.

8.1 Conclusions

- Agricultural is the largest user of land, water and labour causing environmental issues but at the same time provider of environmental services.

- Over the time, there is over exploitation of natural resources and misbalance in allocation between competing sectors as well as in recharge and discharge of ground water. The consequences are in the form of environmental degradation, social inequity and heavy burden on sustainability for present and foreseeable future generations.

- The issue of environment degradation is not properly managed. The urgency of addressing Pakistan’s environmental problems has never been cared fully. It is not just because of the intrinsic virtues of promoting responsible environmental stewardship, but also due to unawareness of economic consequences of environmental degradation usually happening in future course of time.

8.2 Recommendations

- The implementations of water management strategies/ practices in all water use sectors are earnestly required for sustainable and environment friendly utilization.

- Highest priority must be accorded to enhance surface water storage capacity and groundwater management and its replenishment by recharge.

- Policy decisions regarding agriculture production targets, management of groundwater pumping, groundwater recharge, drip & sprinkler irrigation to improve irrigation efficiencies, desalination of saline effluent and treatment of polluted industrial and municipal waters are urgently required.

- To achieve the vision of an efficient, competitive and sustainable agriculture sector, major investments in human resource and infrastructure, reforms in agricultural practices and management of challenges from globalization and climate change are required.

- Environmental awareness among the public must be raised and environmental laws must be implemented on both public & private sectors.

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