

Food Security Indicators, Distribution and Techniques for Agriculture Sustainability in Pakistan

Sana Arshad

Department of Geography
Baghdad ul jadeed campus
Faculty of Science
The Islmia University Bahawalpur 63100
Pakistan.

Adila Shafqat

Department of Geography
Baghdad ul jadeed campus
Faculty of Science
The Islmia University Bahawalpur 63100
Pakistan.

Abstract

Safe production and secure food supply is one of the major need of low income countries. Initially the concept of food security focused on availability and price regulation on food commodities. Environmental conditions are continuously changing and sustainable development risk factors are mounting with the increasing of urban population in developing countries like Pakistan, India, and Bangladesh, etc. The issues of food crisis like famine and hunger are subjectively investigated after 1970s due to global environmental change. Thus the concept of food security encompasses availability, accessibility and utilization of food stuff in populated part of the world. Food insecurity exists if the people don't have equal physical, social, or economic access of food. Food insecurity is the result of several factors like poverty, health conditions, gender equity, availability of water, sustainable environmental conditions, farming and livestock changes, natural disasters, population growth and rapid urbanization. The role of agriculture is most significant in addressing the issue of food security in low income countries like Pakistan. Agriculture should be able to support population growth for eradicating poverty and hunger which is the ultimate causes of food insecurity. Sustainable agriculture gives the concept of using natural resources in the place of high input fertilizers to maintain the ecosystem services as well as safe and secure food. The objectives of paper include, analyzing the food security indicators at districts levels in Pakistan. Moreover the paper discusses the issues of agriculture including demand and supply of agricultural production. The concept of Agro-ecosystem has not yet attained great importance for sustainable food production and supply. Agro ecosystem focuses on increases production along with sustainable management of ecosystem services. The paper will conclude an approach of agro ecosystem for managing agricultural landscape to ensure sustainability and food security in 21st Century. The paper will also provide agriculturalist stakeholders, advisors and policy makers with state of art knowledge of agro ecosystem to maintain profitable and sustainable agri-practices in farm lands of Pakistan.

Key words: Agro Ecosystem, Agri-practices, Food Security, Availability, Accessibility, Utilization

1. Introduction

Food security is a very complex issue covering many determinants including social, economic and environmental parts. To better understand the concept of food security the comprehensive term of Food system is described by Erikson 2008. It covers food system activities, outcomes contributing to social and environmental benefits in the context of food security. (Ericksen, 2008)The concept of food security therefore surrounds the components of agriculture, environment, employment and income, marketing, health and nutrition and public policy(Johan, 1999).

Food security is described by three major components a) availability, b) accessibility, c) utilization. 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (FAO, 1996)

A food can be judged as good if it covers following aspects

Table 1: Criteria for a good food system

Physical	Social	Environmental
Good for nutrition	Efficient in social prices	Reduce vulnerability
Offers security	Supports high standards of education	Good for environmental sustainability
Accessible for poor	Enables people to have status, dignity and influence	Provides ecosystem services
Complete nutrition	Promotes equality in general	Not causing land degradation
Consumed by poor	Promotes social inclusion	Ensuring sustainable development

Source:(Kugelman & Hathaway, 2010)

Food security encompasses food availability, accessibility and utilization.

Food availability covers three elements as production, distribution and exchange

Production: The determinant of production includes land holding size, resource tenancy arrangements, human capital, and economic turn to labor.

Distribution: The determinants of distribution includes transportation and infrastructure, storage facilities, governance, security etc

Exchange: Determinants includes income levels and purchasing powers, informal social arrangements barter, local customs for giving and receiving gifts, migration, gender and age structure, markets, terms of trade, currency value, and subsidies.

Food Accessibility covers three elements as Affordability, Allocation and preference

Affordability: determinants of affordability are pricing policies mechanisms, seasonal and geographical variations in prices, local prices relative to external prices, income level and wealth of households.

Allocation: Determinants includes government policies often are designed to correct market failures by allocating food to remote areas or at lower prices.

Preferences of people: religion, season, advertising, preparation requirements, human capital, tastes, customs, and female labor force participation are its determinants.

Food utilization: Three elements of food utilization are nutritional value, social value and food safety

Nutritional value: Determinants of nutritional value include diversity of food consumed, type of primary protein, disease incidence (which affects food absorption), education, facilities for cooking and preparing food, access to clean water and hygiene practices.

Social value: community and household relations, as well as cultural customs.

Food safety: The main determinants of this are the procedures and standards and regulations (or lack of) for food production, processing, and packaging. (Ericksen, 2008)

Although, agricultural technologies are one of the major factors in ensuring food security of the poor and the nation as a whole, it is not the only factor. The other parameters of food security are access of the people to agriculture resources and markets and policy environment. Therefore, the role of policy and trade has surfaced prominently to ensure especially national food security. The paper will discuss review of literature for the different agri practices (organic and intensive), and their impacts on ecosystem services, to achieve food security that will give a conceptual knowledge of agro ecosystem. Agro ecosystem gives a concept of sustainable agriculture.

Agricultural sustainability suggests a focus on both genotype improvements through the full range of modern biological approaches, as well as improved understanding of the benefits of ecological and agronomic management, manipulation and redesign.(Pretty, 2008)

2. Study Area

The study area focused in article is Pakistan having rich natural resources and covers various ecological zones. Pakistan being strong agri based economy having great potential to meet the food demands of its population. The total Geographical area of Pakistan is 79.6 million hectares, out of which 27% is under cultivation. (Suleri & Haq, 2009) The major sources of watering in agriculture land of Pakistan are irrigation and rain fed. However, 86% of the total land area is included in irrigated cropped land.

3. Agriculture production in Pakistan

According to economic survey 1999-2000 (Kugelman, 2010), Agriculture is the major sector fulfilling the food demands of increasing population. As the growth rate of Pakistan is increasing 2.1% annum, therefore the production of food is increasing and the percentage share of agriculture sector in total GDP increased up to 25% since 2000. However, according to economic survey of 2009-2010 agriculture sectors is contributing 21% of GDP and absorbing 45% labor force of the country.

But the performance of agriculture is marked by different trend in production and consumption. There have been some years of slow to moderate growth in this sector.

Due to unbalance between food demand and supply, the percentage share of agriculture sector is varying as it decreased by 22% after 2000.

http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1269620455636/6907265-1287693474030/PAK_Regional_Food_Prices.pdf

(FAO) Statistics of Food and Agriculture organization shows distribution of land use and economic distribution of agriculture sector in Pakistan.

Table 2: Agriculture Land use distribution and share in economic sector of Pakistan

Total Agriculture Land area	77 088 ha
Arable land	21302
Permanent crops	658
Pastures	5000
Irrigated land	18230
Agriculture as % of Gross Domestic Product	21%
Share of agricultural exports (% of total exports):	9.37%
Value of agricultural exports (US\$ millions):	1 254

Source: Food and agriculture organization (Vaughn, 2010)

Feeding the increasing world's population in a sustainable manner is becoming one of the major challenges of world. Management of food production in a sustainable manner is very crucial and important. Pakistan covers various climatic and ecological zones and thus supports the production of various categories of food.

Pakistan's agriculture production is dominated by five basic sectors including major crops, minor crops, livestock, and fisheries. Major crops includes, wheat, rice, cotton, sugarcane, and maize, while minor crops includes oil seeds like cottonseed, rapeseed, mustard, sun flower, and canola and cereal crops including masoor, mung, mash, potato, onion and chilies.

According to economic survey of Pakistan 2009-10 (Kugelman, 2010), the four major crops (wheat, rice, cotton, and sugarcane), on average, contribute 7.1 percent to GDP. Livestock contributes 53.2 crops account for 11.1 percent to agricultural value added – much more than the combined contribution of major and minor crops (43.9%).

As wheat is the major staple food of Pakistan and contributes in fulfilling the major feed needs of country

According to Agriculture census organization, area under important crops is presented in the figure 1

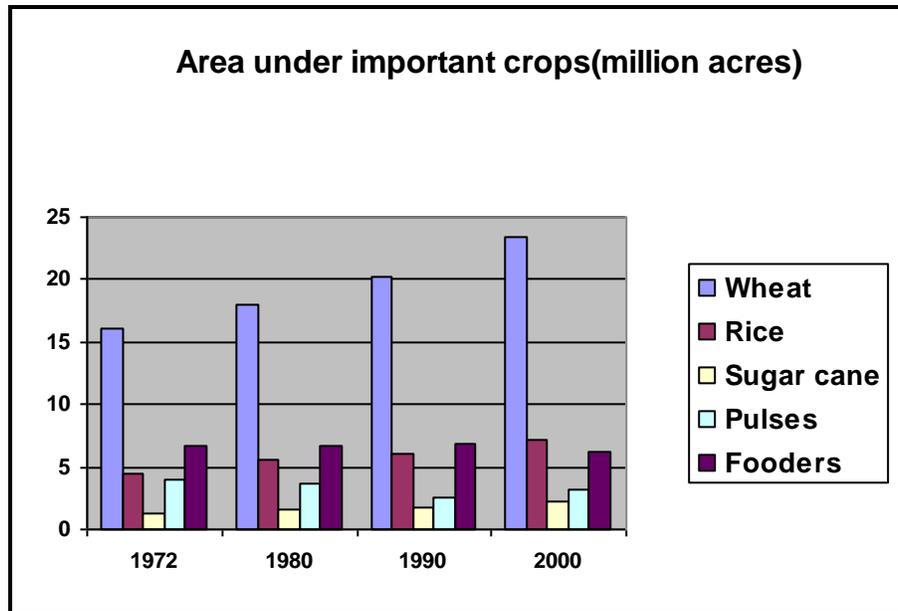


Figure 1: Cultivation area of major crops in Pakistan

Source: Agriculture census organization(statistics division) (Bengali & Jury, 2010)

4. Situation of Food security in Pakistan

Food insecurity exists when people don't have an adequate physical, social and economic access to food. (Suleri & Haq, 2009) Countries with poor resources and marginalized economies have large number of poor and food insecure people. Pakistan is one of them and ranked 11th at 'extreme risk' on the Food Security Risk Index (FSRI) ahead of Bangladesh and India which, though 38 at 'high risk'. (Munir & Ejaz, 2010)

Out of total 155 million populations in Pakistan, 35 million people are undernourished. (Vaughn, 2010) Research carried out by "sustainable development policy institute of Pakistan" (2003) collaborate with WFP (world food program), stated that 52% of the total rural population in 80 out of Pakistan's 120 districts is food secure. (Johan, 1999)

Vulnerability to food insecurity is more in rural areas of Pakistan as compared to urban areas. The food insecurity increased after the 2007-08 food crises, with increasing food inflation up to 30%.

4.1 Food security Indicators in Pakistan

The key pillars of food security are availability, accessibility, and utilization.

4.1.1 Food availability in Pakistan

National food availability in Pakistan includes

- Local production of all foods
- All food imports
- Stocks of all foods
- Food aid of all foods

The significant contribution of major and minor crops shows that Pakistan keeps good potential yield but there are certain constraints that are making the agriculture production low and also posing threat to the services generated by agriculture ecosystem.

Figure 1 shows increase in crops cultivation from 1970s to 2000. As wheat is the staple food of Pakistan, therefore with increasing population growth the demand for wheat increased and its area under cultivation increased from 15 million acres to 23 million acres from 1972 to the year 2000.

Since agriculture is the dominant form of land management and agro ecosystem is the both provider and consumer of ecosystem services. (FAO, 2010)

According to Pakistan economic survey 2009-1(Kugelman, 2010), area, production and yield of wheat from the year 2005 to -10, as shown in table 2 below.

Table 3: Area, production and yield of Wheat in Pakistan during various years

Year	Area (thousand hectares)	Production (thousand tons)	Yield (Kgs/Hec)
2005-06	8448	21277	2519
2006-07	8578	23295	2716
2007-08	8550	20959	2451
2008-09	9046	24033	2657
2009-10	9042	23864	2639

Report of Pakistan economic survey(Kugelman, 2010) clears that the size of wheat crop is provisionally estimated at 23,864 million tons, 0.7 percent less than last year crop as shown in table 2. The prospects for wheat harvest improved somewhat with healthy fertilizer off take and reasonable rainfall in pre harvesting period. However, the impact of lower acreage and water shortages is likely take its toll and wheat harvest is estimated to be lower than the 2009-2010 targets of 25.0 million tons.

The production of various crops also varies in different regions of Pakistan due to tough topography. The western and south eastern regions of the country are largely arid and deficient in agriculture production. Other than that, the transportation of food is also very important for discussing its availability.

4.1.2 Accessibility of food in Pakistan

National food accessibility in Pakistan is determined by

- High food prices
- purchasing power and poverty
- Food consumption score
- Exposure to natural disasters and coping strategies
- Household living conditions

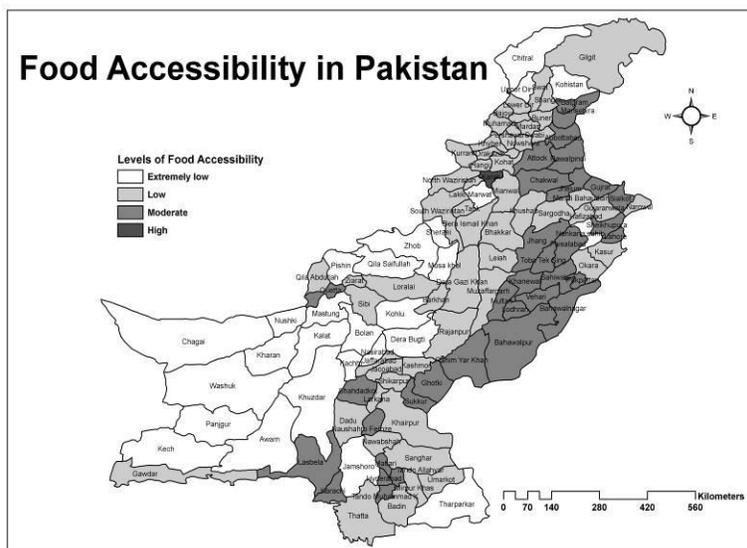


Figure 2: Accessibility levels of food; Pakistan

Data Source: World food program, 2009

Other than the above discussed reasons of food insecurity in Pakistan is accessibility of food. As accessibility is the 2nd major determinant of food insecurity as discussed above. Therefore it is very important to discuss its determinants with the perspectives of Pakistan.

Purchasing power

Access to food is a function of purchasing power and low purchasing power means poverty. Poverty is a function of livelihood and livelihood is a function of employment.(Bengali & Jury, 2010) During the past two decades, 1987-2007, food poverty incidence in the country shows that about one-third of the households were living below the food poverty line and they were not meeting their nutritional requirements. The incidence of food poverty is higher in rural areas (35 per cent), than in urban areas (26 per cent). Urban and rural areas, however, did not differ much in terms of calorie intake per capita, the differences across the four provinces were also not substantial. The problem lies in the non-equity of food distribution within each of these categories and even within the members of the household. (Suleri & Haq, 2009) As Pakistan is agri based country, therefore the highest percentage of employment is within this sector. (Bengali & Jury, 2010).

Affordability of food

is very important factor in food security components. Developing countries are facing economic crises and in turn people are affected in the context of high food prices. inherent structural problems that factors such as inflation (partly due to the economic and energy crises), panic buying and hoarding of food, ineffective and dysfunctional social safety nets, and increased cost of production has made food inaccessible for many in Pakistan. (Munir & Ejaz, 2010)

Household income

is another major indicator to access the food accessibility and affordability of population. According to the report of World food program 2009, the average household monthly income of Pakistan is 14127 Rs. However it varies from rural to urban areas.

Another important indicator is the *food consumption score (FCS)* measured in kilo calorie intake. According to the report of World food program 2009, 15.7 percent of the population has poor food consumption while 58 percent are at the borderline in the country.

Food and agriculture organization measured the food deprivation in kilo calories from the year 1992 to 2007.

Table 4: Food deficit of undernourished population

1990-92	280 kcal/person/day
1995-97	260 kcal/person/day
2000-02	280 kcal/person/day
2005-07	290 kcal/person/day

Source: FAO 2010

http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/country_profiles/eng/Pakistan_E.pdf

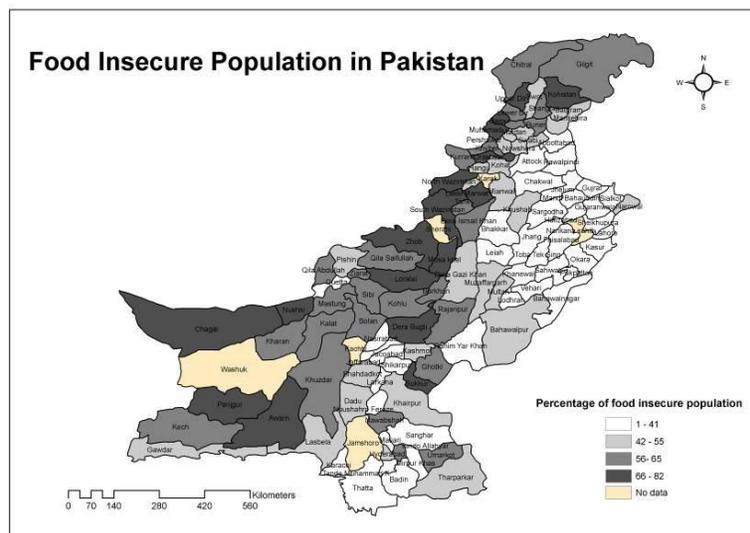


Figure 3: Percentage of food insecure population by districts; Pakistan
Data Source: World food program, 2009

Accessibility issues are considered as very serious for food insecurity. Figure 3 shows the percentage of insecure population by districts in Pakistan. The highest percentage of insecure population belongs from Balochistan other than district Quetta and NWFP. These specific deficit regions have many other problems like difficulty in mobility and lack of governance. If figure 3 is compared with figure 2, it becomes clear that all those districts having low accessibility of food covers food insecure population

4.1.3 Food Absorption and utilization

National food utilization is determined by following indicators

- Availability of drinking water
- Sanitation facilities
- literacy rate and education
- Gender equity

Food utilization means biological absorption of food which is a function of human development. Availability and accessibility alone cannot ensure complete package of food security, instead balanced utilization and absorption also plays key role. The distribution of food absorption by districts shown in figure 4 clarifies that it is at high and moderate levels in various districts of Punjab

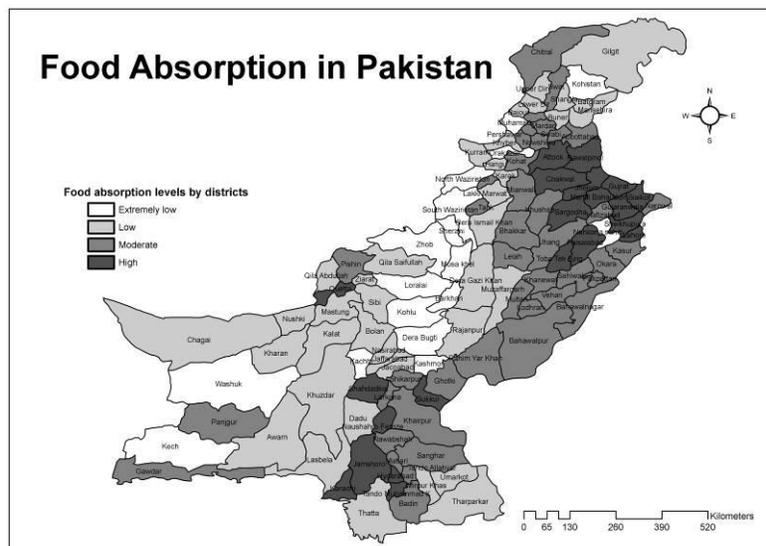


Figure 4: Absorption of food by districts; Pakistan
Data source: world food program, 2009

Different reasons sorted out for low levels of food absorption in NWFP and in some districts of Balochistan are low water quality and poor sanitation facilities.

5 Overall situation of food insecurity in Pakistan

There are several reasons of food insecurity in Pakistan. The most important of them includes poverty, poor health and sanitation, less water availability; gender and equity, disasters and conflicts etc. However the incidence of food poverty is higher in rural areas (35 per cent), than in urban areas (26 per cent)(Suleri & Haq, 2009)The figure 5 shows the distribution of food insecure districts in Pakistan. Majority of FATA and NWFP is included in food insecure region due to poor political conditions. (Munir & Ejaz, 2010)

The major reason stated by the report of “sustainable Development Policy Institute (SDPI) produced in collaboration with the World Food Programme (WFP)” (2009) for food insecurity in rural areas of Pakistan is instability in Govt. Policies and international view of Pakistan. Western parts of the country especially FATA and KPK are facing fighting wars and as a result social life and livelihood resources are depleting and agricultural land is converting into nonproductive land. The second reason is energy crises of Pakistan that is reducing mobility and accessibility of food.



Figure 5: Food insecurity by districts; Pakistan
Data source: world food program, 2009

6. Sustainable agriculture (Agro ecosystem)

The concept of sustainable agriculture means using technology or such ways that can increase the production without providing any harm to the environment. The key principles for agriculture sustainability are to integrate biological and ecological processes such as nutrient cycling, nitrogen fixation, soil regeneration, predation and parasitism into food production processes. (Pretty, 2008)

Therefore the management of agriculture as an ecosystem is very necessary for sustainable development as well as to meet the food demands of a growing human population. However, some land management practices can severely reduce the ecological and financial contribution of some of agriculture services, which in the longer term can offset the ability of farming to produce large amounts of food and fiber. Therefore, to improve the understanding and enhancement of these services, it is crucial to know the opinions of farmers who manage ecosystem services on their land. (Harpinder S. Sandhu, 2007) Agriculture ecosystems can provide a range of supporting services that are further sub divided in to regulating and cultural services to human communities, in addition to provisioning services and services in support of provisioning.

Regulating services from agriculture may include flood control, water quality control, carbon storage and climate regulation through greenhouse gas emissions, disease regulation, and waste treatment (e.g. nutrients, pesticides) (Power, 2010)

Modern agricultural practices are becoming increasingly intensive and the expansion of farmland resulting in the destruction of natural ecosystems. Undisturbed natural areas contain significant amounts of biodiversity; this provides valuable ecosystem functions that are often overlooked in terms of the economic contributions they make to agriculture and our everyday lives. (Barnes, Wratten, & Sandhu, 2008)

7. Problems of Intensive VS Organic agriculture

Agricultural practices can reduce the ability of ecosystems to provide goods and services. For example, high applications of fertilizers and pesticides can increase nutrients and toxins in groundwater and surface waters, incurring health and water purification costs, and decreasing fishery and recreational values. (Keenan, Olson, C. Hersey, & M. Parmer, 2001)

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. (Suleri & Haq, 2009) Therefore agricultural intensification in the landscape can diminish the ecosystem services. Protecting the ground water and surface water quality is threatened most because of agriculture intensification.

Intensive agriculture in the past has made significant changes to agro ecosystem, resulting the decline of ecosystem services,(Cassman & Harwood, 1995) because farmers became dependent upon use of more input in the form of capital, labor, fertilizers and for making more production to ensure food security ignored the role of ES in agro ecosystem.

However, organic agriculture relies more on nature's services to produce more food as well as to make a balance between ES and food production. Organic farmers utilize the techniques of crop rotation, use of biological control pests, and appropriate land management practices. Organic agriculture is therefore more sustainable than conventional agriculture which degrades most of the ecosystem services.(Harpinder S. Sandhu, 2007). Conventional agriculture is a diverse set of technologies using the best available knowledge, whose ultimate goal is the safe, efficient provision of foods in abundance and at lowest price. As with all technologies, problems often arise in the practices of conventional agriculture — but rejection of a technology because of problems also means losing potential benefits.(Simon, 1996) Soil carbon sequestration is very important ecosystem service that can be generated by adopting organic agriculture techniques like conservation tillage, and no till cultivation can conserve soil carbon, crop rotation and cover crops can reduce the degradation of sub surface carbon. (Lal, 2008) Table 5 gives the description based on various literature reviews about both types of agriculture systems

The significant contribution of major and minor crops shows that Pakistan keeps good potential yield but there are certain constraints that are making the agriculture production low and also posing threat to the services generated by agriculture ecosystem. With perspective to the Pakistan there are several reasons of unsustainable agriculture in Pakistan. In spite of economy based sector, it is neglected by the Government policies and mismanagement of natural resources, land degradation, mismanagement in ground water resources and irrigation patterns.

Disease, poor weed control, and water management, timely planting are the major factors of low yields(Cassman & Harwood, 1995)

Food and Agriculture organization in 2006 reported that number and prevalence of hungry people in Pakistan is increasing day by day. Sustainable production in agro ecosystem is therefore an important component and depends upon the balance between demand and supply of agriculture production.

<i>Type of agriculture</i>	<i>Impact on ecosystem services</i>	<i>Food production</i>	<i>Public goods and benefits</i>
Intensive agriculture	Decline in pollination, soil fertility, ground water pollution	High	High
Organic agriculture	Enhance pollination, biological pest control, maintain surface and ground water quality	Moderate	Low

Table 5: Agro ecosystem approach for food security
Created by: Author

8. Strategies for sustainable production and food security

Some of the proposed strategies for sustainable production are

- **On farm management practices**

Farm management practices are defined as the decisions and practical operations that shape the practical management of farms, such as cropping methods (soil cover and tillage methods) and the type and capacity of storage for farm manure and slurry

- **Nutrient management practices**

Nitrogen and phosphorous applied in intensive agriculture limits the biological production in agriculture ecosystem. Nitrogen and phosphorous fertilizers have increased the amount of new nitrogen and phosphorous in the ground and surface water resulting increase in human diseases.

Nutrient management practices includes cover cropping and inter cropping that could enhance the microbial assimilation of nitrogen and reduce standing pools of nitrogen. Legume intensification for biological nitrogen fixation, diversifying nutrient sources and rotations are good management practices. (Drinkwater & Snapp, 2007)

Other than that Government of Pakistan should take the following action for overall food security and focusing on following steps

1. Good and efficient system of food production, storage and transportation and ensuring the food accessibility at all purchasing powers throughout the country
2. Creating the employment opportunities to reduce the poverty and access of poor households to food
3. Developing policies to make market efficient for food transportation and trade
4. introducing corporate farming
5. Low cost energy inputs, using mixed farming techniques like organic mixed intensive to ensure sustainable production as well as managing agriculture based services for environment
6. Use of more efficient irrigation technologies
7. Utilizing such districts like Chaghi in Balochistan for agriculture production.

9. Conclusion

The concept of sustainable agriculture covers the concept of using natural goods and service while maintaining those also for the future needs. Supporting ecosystem services from agriculture ecosystem are categorized in to provisioning, regulating, and cultural services. Millennium development goals focuses on eradicating poverty and good nutritional status in developing countries since 2015, along with a balance of maintain the agro ecosystem services. As increasing human population in developing countries specifically Pakistan is increasing the demands of food production and consumption. Therefore, stress on agriculture ecosystem is increased as compared to past to fulfill the needs of population. Different agri practices have different impacts on agriculture production as well as ecosystem services. As the concern of food security is increasing in developed and developing countries and requiring a wide range of sustainable agriculture practices. Therefore the need of agro ecological approaches for landscape management of ecosystem services and enhancing agriculture productivity is necessary. The best strategy for stakeholders proposed by policy advisors is to combine organic and conventional measures for the sake of food security without providing any harm to agriculture landscape.

Organic agriculture is more suitable in this context as it utilizes crop tillage rotation techniques, uses mineral fertilizers, and it also costs low in using input technologies for producing food and fiber.

Therefore to meet the current and future challenges of food insecurity, there is a need to develop low cost input eco technologies to ensure sustainable food production. There is also a need to implement new mechanisms to enhance sustainable agriculture. For this purpose encouraging rapid technological change should be incorporated with natural systems in the context of natural resource management. Community based approaches can also play an important role for this purpose.

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