DETERMINANTS OF FOOD SECURITY IN TURKMENISTAN

THESIS

SUBMITTED TO UNIVERSITY OF KASHMIR FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY (Ph.D.)

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BY

MUSHTAQ AHMAD DAR

UNDER THE SUPERVISION OF

Professor (Dr.) G.M.MIR
Director, Area Study Centre

CENTRE OF CENTRAL ASIAN STUDIES
UNIVERSITY OF KASHMIR
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Centre of Central Asian Studies
University of Kashmir
NAAC Accredited Grade 'A'

Declaration

I solemnly declare that the theses entitled, ***"Determinants of Food Security in Turkmenistan",*** submitted by me in the discipline of Geography under the supervision of Prof. G. M. Mir, embodies my own contribution. This work which does not contain any piracy, has not been submitted, so far, anywhere for the award of any degree.

Mushtaq Ahmad Dar
CCAS,
University of Kashmir.

Dated: _____

Centre of Central Asian Studies
University of Kashmir
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CERTIFICATE

Certified that the thesis entitled, **"Determinants of Food Security in Turkmenistan"**, submitted by Mr. Mushtaq Ahmad Dar is suitable for submission and worthy to award the degree of Doctor of Philosophy subject to the approval of examiners. The scholar worked under my supervision on whole-time basis for the period required under statutes. The receptivity and conduct of the scholar has remained satisfactory.

Prof. G. M. Mir
Supervisor

Countersigned

Prof. G. R. Jan

DEDICATED

TO MY

BELOVED FATHER

(LATE HAJI GH. HUSSIAN DAR)

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Place_____ **Mushtaq Ahmad Dar**

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Introduction

Significance of the Study

Food security is emerging as one of the important issues in agricultural geography as food is necessary for the basic sustenance of mankind. Within food items, focus is concentrated on cereals which are the food components of majority of masses who can bear poverty, sustain without other supplements but cannot live without foodgrains. The crisis of food shortage owing to a number of factors, particularly in the past few years, has revived the debate over food security and underscored the need of shift to the concept of greater self-sufficiency instead of relying on imports. It is realized that food security is a major factor for sustainable, stable and social development of humankind. So every country tries to be self-sufficient at least in foodgrains.[1]

Food and Agricultural Organisation (FAO) has defined food security as "ensuring that all the people at all times have both physical and economic access to the basic food that they need." Later the concept was broadened further to take into account such factors as the nutritional value of food and people's social and cultural preferences.[2] The more comprehensive concept of food security was presented at the World Food Summit in 1996, "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". Throughout history, human populations have experienced deficiencies in food production.[3] In spite of several World Food

Summits during the past decade, the number of people going to bed hungry, is increasing and now exceeds one billion.[4] Therefore, one of the urgent issues of the modern world is food security.

Food and nutritional security are key issues for human sustenance and well being. Researchers, governments and organisations working with food and nutrition are concerned with the nutritional status of the general population especially children and pregnant women in the developing countries. In these countries natural disasters, underdeveloped economies, political instability, population explosion, soaring prices of food commodities, poor implementation of agricultural policies, inadequate food intake among people are common.[5]

Central Asia belongs to a region of high fertility rate with fast population growth. According to World Bank data, the total population of the countries within the Aral Sea Basin will be 173 million by 2050. At present, there is food crisis in all the Central Asian countries except Kazakhstan. So shortage of food is experienced all the times in the region.[6] Over the past decade, since the independence from former Soviet Union in 1991, Central Asian countries have experienced rising poverty, food insecurity and malnutrition. Increasing food insecurity and malnutrition present a major development challenge to the governments of Central Asian Countries. Prior to their independence, the Central Asian States were economically interdependent on each other and on the Soviet republic in general. In terms of grain, certain countries were net exporters (for example Kazakhstan) and certain countries were net importers (for example, Uzbekistan, Tajikistan and Turkmenistan). Following independence and the dissolution of their existing trading arrangements, the Central Asian Countries faced a choice between self-sufficiency in food production and food security through the

combination of own production and regional trade. Unable to benefit from comparative advantage through regional trade arrangements, each country has chosen to produce only the amount of grain needed by its population. The countries which were previously importers, have increased domestic grain production accompanied by increased market prices and farming of marginal lands.[7]

Total demand for cereals in Central Asian republics fell sharply during the 1990s, from 27.5 million tons in 1992 to 18.9 million tons in 1997. Deteriorating economic conditions and escalating poverty contributed to the significant reduction in cereal and meat demand that occurred during the 1990s. At the time of the break-up of Soviet Union in 1991, the Central Asian republics inherited economic structure that were heavily dependent on the Soviet supply and trade networks, with Russia being the main source for inputs and the main market for outputs. Moreover, the Central Asian republics faced various shocks resulting from the withdrawal of subsidies from Moscow, interruption of inter-republic trading patterns and adaptations of tight stabilization policies. These shocks resulted in a dramatic reduction of output across the region. Between 1990-2005 gross domestic product (GDP) fell on average annually by 16.4 percent in Tajikistan, 9.6 percent in Turkmenistan, 7.3 percent in Kyrgyzstan, 6.9 percent in Kazakhstan, and 1.9 percent in Uzbekistan.[8]

These indicators show that poverty has increased significantly in the region. Highest percentage of poverty is found in the republic of Kyrgyzstan (85%) in 2010 and it is followed by the republic of Tajikistan (80%) while Uzbekistan and Kazakhstan have same percentage of poverty head (60%). Escalating poverty has affected a substantial proportion of the population in Central Asia. **(table 0.1)**

Table 0.1
Poverty Level in Central Asian Countries
(1990-2010)

Countries	Poverty head count (%)			Total number of poor (millions)		
	1990	2000	2010	1990	2000	2010
Kazakhstan	5	65	60	0.8	11	10
Kyrgyzstan	12	88	85	0.5	4.0	3.8
Tajikistan	14	85	80	0.6	3.8	3.5
Turkmenistan	**15**	**55**	**50**	**0.5**	**2.6**	**2.8**
Uzbekistan	24	63	60	4.8	13.3	13.0

Source: Milanovic (2005)

It is evident from the above table that there is increase in terms poverty head count in all the republics of Central Asia since 1990. However, there is little improvement in poverty rates across all republics from 2005 onwards. Poverty rate increased from 15 percent in 1990 to 50 percent in the republic of Turkmenistan. The primary reason for the increase of poverty in Central Asian States following their independence is the deterioration of macro-economic environment, as characterised by decrease in national output and high inflation, because of the lack of subsidized inputs and assured markets for their products, many firms have reduced their output or stopped production altogether. These increased the levels of poverty in Central Asian Countries reduced living standards, which have further resulted in high levels of food insecurity and malnutrition.

Agriculture is almost entirely dependent on irrigation. Expansion of the irrigation network, particularly since the late 1950s, has significantly increased the country's agricultural output especially cotton.[9] While problems of waterlogging and salinization of Turkmenistan's irrigation systems have been reported in the past. Data from the mid-1980s onwards indicate that there has been a

significant increase in the area of land where the water table is less than 2m below the surface and more and more land are becoming saline. Declining soils and water quality has significant implication for future agricultural development and could thwart Turkmenistan's plans to diversify its agricultural base from one almost entirely dependent on the cotton to one that will enable the country's food requirements to be met.[10] Agriculture is a vital component of Turkmenistan's economy, currently employing more than 48 percent of the country's workforce and contributes about 20 percent towards Gross Domestic Product.[11] The soviet policy of cotton at any price which turned the region into a series of huge cotton plantations meant that at independence the country was unable to meet its food requirements. In 1994 the Halk Maslahey, Turkmenistan's People's Council, approved the ambitious *'Ten Years of Prosperity' plan* which aims to set targets for increased agricultural output in foodgrains to achieve food self-sufficiency by 2002. However, the region could not improve the productivity of crops due to waterlogging and heavy salinization of soils. The country is far from being self-sufficient in respect to food and is already falling behind on the targets set by the *'Ten Years of Prosperity'* plan.

The republic of Turkmenistan is currently facing serious development challenges associated with increasing food security, alleviating poverty and minimizing natural resource degradation. Anecdotal evidence suggests that food insecurity caused by declining incomes in the recent years is a major development concern in Turkmenistan. Information on the incidence of malnutrition is scanty. However, available data indicate that 24 percent of children under three years of age are stunted in the rural district of Turkmenistan. Available information suggests that poor design and slow implementation of institutional and policy reforms

have resulted in degradation of natural resources, threatening the sustainability of agricultural and livestock production.[12]

Monetization of new republics with low level of foreign exchange reserves, coupled with poor trading arrangements which don't speed up transaction and payments for the produce exported from the region, have created economic uncertainty, for example Turkmenistan continues to export natural gas to other members of the Commonwealth of Independent States (CIS) but it has not received full payments for the past several years, including some years during the former Soviet era. Low level of foreign exchange for importing foodgrains and other food commodities has forced the republic to focus on food self-sufficiency as a food security.[13]

In addition, uncertainty in regional trade for food commodities and the resulting focus on self-sufficiency as a strategy for food security have also forced farmers to concentrate on domestic production of cereals. The collapse of the Soviet Union and the economic reforms were disastrous for the republic of Turkmenistan. Many negative factors accompanied the economic reforms. Such as the disintegration of inter-regional economic relations among the republic of former Soviet Union.[14] Since its independence, the republic of Turkmenistan developed its own model for the transition to market economy. Turkmenistan's economy is highly open to the external world. The share of GDP is relatively high and represents US $367.1 million. The main exported products are natural gas 63.7 percent and cotton products 28 percent. At the same time, Turkmenistan has large import demand for food products.[15]

Relating to the available land and pressure of population, the demand of food grains is very high because the population growth outstripped the rate of increase in agricultural product. The effects of social policies and economic changes on the well being of the

people of Turkmenistan are evident from the household budget data collected by the Ministry of Agriculture.

So for as the production of foodgrains in Turkmenistan are concerned, these are not enough to meet the growing demands of people. Wheat and rice production in Turkmenistan has been hampered for years by a crumbling infrastructure and limited inputs. Therefore, the country has been deficient in food grains and it has to import about large quantity of food grains every year from other states. **(table 0.2)**

Table 0.2
Imports of Foodgrains
(1990-2010)

Year	Deficit/Surplus (000 tons)	Temporal change in (%)	Deficit/surplus (%)
1990	-514	N.A	-55.74
1995	-398	-22.56	-27.52
2000	-297	-25.37	-19.39
2005	+170	+42.76	10.41
2010	-326	-91.76	-18.82

Source: Compiled and Computed on the Basis of Data from CIS Statistical Data base (1980-1990), Statistical Year Books of Turkmenistan 1991-2010, FAO, 2010.

Table 0.2 clearly reveals that the republic imported about 56 percent of foodgrains and the country has been able to decrease the share of foodgrains imported to 19 percent in 2010. However, during the period 2005, the country was able to produce surplus foodgrains due to improvement in the yield level following favourable climatic conditions. The main reason for the highest imports during the period of 1990s in the republic of Turkmenistan was because during this period more and more land was devoted to cotton (80%). Since independence of Turkmenistan, the quantity of imports has reduced to some extent as the country launched a

number of programmes aimed at achieving food self-sufficiency in terms of foodgrains. Although there has been substantial increase in the production of wheat and rice, but Turkmenistan is yet to be self-sufficient.[16]

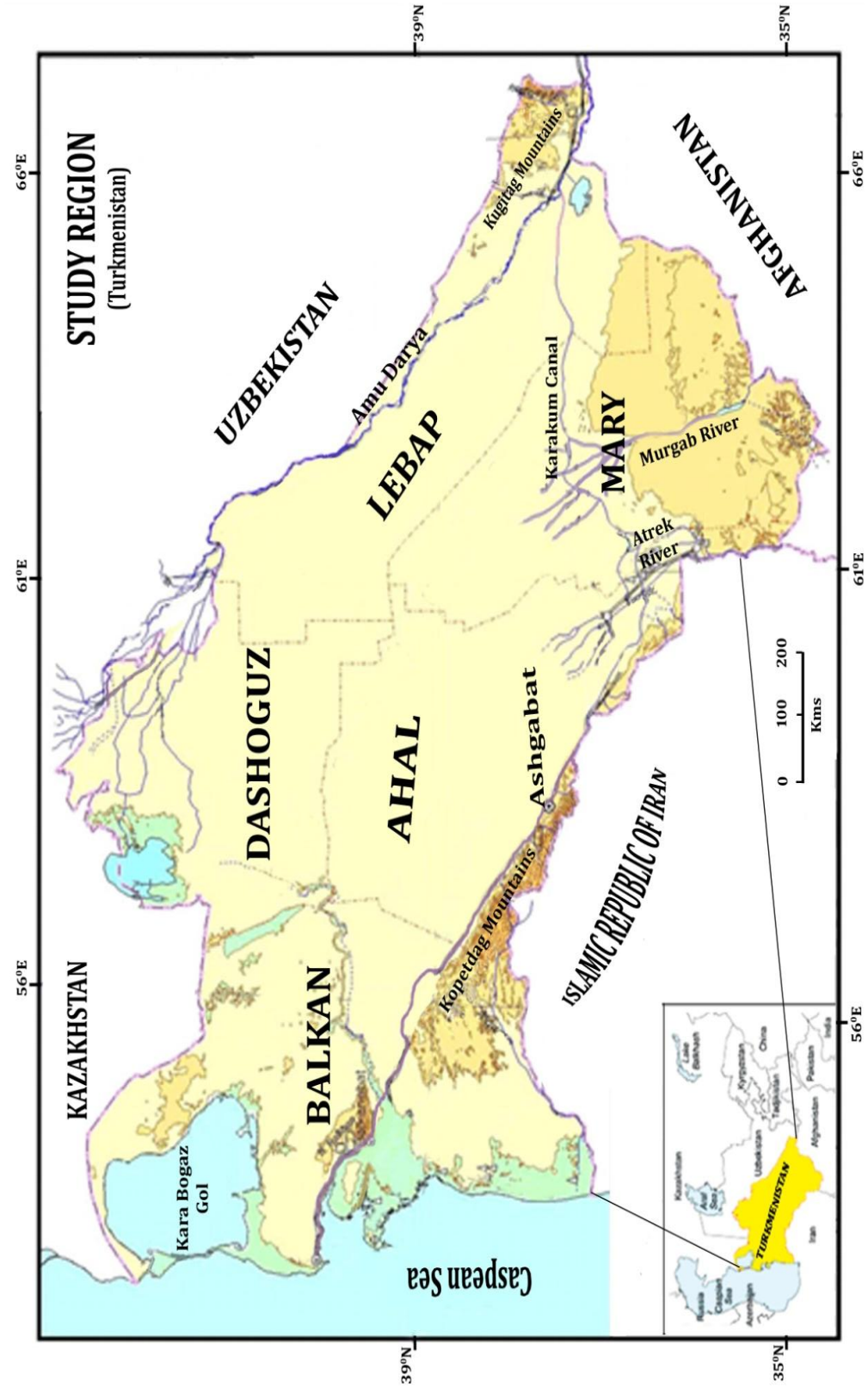
The current food security policy of Turkmenistan aims to achieve domestic food self-sufficiency. To achieve this goal, a new subsidized fund for agricultural development was established in 1994 to provide rural producers with credit of basic production activities.[17] Theoretically, no state is capable to ensure full and sustainable food security for their population in the long term since food demand depends on supply. However, food security is achievable in Turkmenistan if the country's resources are put to good use within overall developmental plan including the improvement in yield level for example within the republic of Turkmenistan, the yield levels per unit area is not sufficient and uniform and yield of crops vary from one region to another. The republic of Turkmenistan is witnessing lower yield than its neighbouring countries with respect to foodgrains within almost similar agro-climatic zone. [18]

Besides, the republic of Turkmenistan has potential to increase its cultivable area if the available water is utilized efficiently. In the republic of Turkmenistan, the most crucial challenges to food security is not only to bring more and more land under cultivation but at the same time it needs sustainable management of land and water resources particularly in arid and semi-arid regions[19] such as to improve the conditions of soil, irrigation area, drainage system, controlling rangeland desertification, soil salinization and water logging, increasing the natural fertility of rangelands, introducing intensive cropping pattern and increasing the productivity of livestock production and increasing other productivity rates by

providing incentives for private producers. As per the latest figures reported by various International Institutions 50 percent of the population of Turkmenistan falls below poverty line. This segment of population is the soft target of all anti-social elements like narco-economy, drug trafficking, illegal trade, prostitution etc. This figure is alarming and here lies the urgency of addressing the issue of food security on priority basis.

Study Region

In view of the increasing desertification, lower irrigation efficiency, and simultaneously the potentials for improvement, Turkmenistan has been selected for the detailed analysis. Turkmenistan forms a sub region of Amu Darya Basin. It is situated between the Turkmen-Khorasan Mountains in the south and Ustyurt Plateau and the Aral Sea in the north, the Caspian Sea in the west and the Amu darya River in the east. It is located between 35°08' and 42°48' of northern latitude and 52°27' and 66°41' of eastern longitude. The mean elevation of the region 100 to 220 meters above sea level, with its highest point being Mount Ayrybaba (3137 meters) in the Kugitang Range of the Pamir Alay chain in the far east. Its territory extends from west to east by about 1100 km and from north to south 650 km. It occupies an area of about 491,200 km^2, consisting of five provinces namely Ahal, Mary, Lebap, Dashoguz and Balkan. The major drainage channels include Karakum Canal. Being most important, the Karakum Canal extends from Kerki guage in the east to Gazanjik in the west and it measures 1200 km and is the largest canal of Central Asia.[20] **(fig. 0.1)**



Source: Department of Peacekeeping Operations, Cartographic Section, United Nations.

Fig. 0.1

Objectives of the Study

In view of the significance given above and the need as well as potentials for converting Turkmenistan into a prosperous independent state at least with respect to food items, the major objectives of the study were as under:

(i) Assessment of the domestic availability and food need of Turkmenistan.

(ii) Identification of economic linkages with food deficit/surplus.

(iii) Possibility of improving irrigation efficiency in order to improve production and productivity

(iv) Analysing the problems and prospects for increasing food production through improving yield level and increasing acreage under food crops.

(v) Regionalization of food-surplus and food-deficit sub-regions for encouraging intra-regional cooperation.

Hypotheses

In consonance to the aforementioned objectives, following hypotheses have been tested and proved.

(a) Population and food consumption ratio determines food security.

(b) More the water available through efficient irrigation technology, more the cereal cropland available and higher the food production.

(c) Purchasing power and food security are directly correlated.

Review of Literature

Although a lot of work has been done on various aspects of Turkmen agriculture and population but the problem under study which needs an urgent attention being peculiar in many ways, has not been undertaken so far by any individual or agency. However, some scanty works have been carried out which have some indirect bearings on the topic. Such studies have helped me in building a proper perspective of the problem. Suresh Babu, William Reidhead in the paper entitled, "Poverty, Food Security and Nutrition in Central Asia: A Case Study of The Kyrgyz Republic" *Food Policy,* attempted to provide insights into poverty, food security, and malnutrition in Central Asia in the period following independence, and present the available evidence from household-level data in Central Asia. Similarly, Saidi Yokubzod in his paper, "Food Security and the Improvement of Water-Use Efficiency" *Minister of Land Reclamation and Water Resources of Tajikistan,* 2005, points out the extensive use of water resources in Central Asian countries are gradually leading humankind to the water scarcity and food crisis. G. M. Mir in his paper, "Irrigation Management in Central Asian Republics", *journal of Central Asian Studies,* Vol. xix, 2010, highlights the importance of irrigation for the agriculture of Central Asian Countries which are more or less dependent entirely depend on irrigation. He also suggests several traditional as well as modern techniques for improving irrigation efficiency, a panacea for regional development.

The paper "Agriculture Policy Reforms and Food Security in Kazakhstan and Turkmenistan" by Adilya Baydildina et.al, *Food Policy,* Vol. 25, December, 2000, provides an overview of agricultural policy reforms and their impact on food security in Kazakhstan and Turkmenistan. Suresh Chander Babu, Alisher

Tashmatov, in the paper published in 1999, entitled "Attaining Food Security in Central Asia- Emerging Issues and Challenges for Policy Research", *International Food Policy Research Institution, Washington D.C,* the authors in this paper suggest developing long term strategies for improving food security, alleviating poverty and encouraging sound use of natural resources for sustained economic growth in Central Asia. Redjepov O, Gurdov and Mamedova L, in the paper, "Efficient Water and Resource Saving Technique of Soil Pre-Sowing Treatment under Winter Wheat Cultivation Conditions" highlight the main characteristics of agricultural efficiency of the crop yield.

Douglas L. Tookey (2007), USA, in his paper, "The Environment, Security and Regional Cooperation in Central Asia" *International Food Policy Research Institution, Washington D.C,* highlights the environmental changes, resulting either from a scarcity of natural resources or environmental degradation, which may contribute to security risks in Central Asia. The paper written by E. Lioubimtseva and G. M Henebry published in 2009 entitled, "Climate and Environmental Change in Arid Central Asia: Impacts, Vulnerability and Adaptations" deals with the vulnerability to climate change and other hazards which have explored three major aspects of human vulnerability such as food insecurity, water stress and human health. Micheal Trueblood in his paper, "New Independent States" has cautioned that the people in Central Asia don't get the balanced nutritional food requirements. He also estimated that the access to food will continue to be a problem for the lower income groups. Zvi Lerman, 2004, in his paper, "Evolving farm structures and Land Use Patterns in Former Socialist Countries" *World Bank,* discussed the role of land policies in the evolving farm structure of transition countries of Central Asia. He also suggests that fast transition towards individualization is not feasible for social and political

reasons, the strategy should focus on creating the conditions that provide inducement to the break up the large corporate farms into farms of more efficient size given local circumstances- farms that typically will be much smaller and certainly more manageable.

Sarah L. O'Hara in the paper, 1996, UK, "Irrigation and Land Degradation: Implication for Agriculture in Turkmenistan, Central Asia" *Arid Environments,* describes that the agriculture in Turkmenistan is almost entirely dependent on irrigation. Expansion of the irrigation network, particularly since the late 1950s, has significantly increased the country's agricultural output, especially of cotton. While the problem of waterlogging and salinization in the agricultural resulted in the decline of crop yields. In the paper, "principal of economic geography" Ellsworth Huntington has given a detailed account about the impact of natural environment like water. Amarnath Tripathi, 2009, Banaras Hindu University, in his paper, ''Agricultural Development in India since Independence: A Study on Progress, Performance and Determinants" points out the agriculture plays an essential role in the process of economic development of less developed countries. He also suggested that productivity and production of food grains is achievable if science and technology is applied properly. J. Timsian and D.J. Connor, 2000, Australia, in his article, "Productivity and Management of Rice-Wheat Cropping Systems: Issues and Challenges" describes the importance of rice and wheat which are the world's most important cereal crops, contributing 45 percent of the digestible energy and 30 percent of the protein in the human diet, as well as substantial contribution to feeding livestock. They also highlighted that the increasing demand for food must be met by more intensive production system because no new land is available for expansion of agricultural purposes in future.

The paper authored by Uwe A. Schneider et.al, 2009, "Impacts of Population Growth, Economic Development and Technical Change on Global Food Production and Consumption" *Agricultural System,* highlights the importance of land and water for mankind. They pointed out that these resources are under pressure by population growth and economic development and environmental change. Diversification" directs the process of agricultural transformation. "Challenges Land Use Patterns and Farming Strategies in the Degraded Environment of the Irangi Hills, Central Tanzania" By Richard Y. M Kangalawe, Carl Chirstiansson, Wilhelm Ostberg, 2007, Sweden. Authors in this paper focus on the diversification of crops and at the same time suggests how can farmers put the degraded lands into productive farmlands. Mushtaq A. Dar and Ab. Majid 2011, "Irrigation Management Initiatives and its Impact on Crop Production in Central Asian States", *Eurasian Studies,* April-june., 2011, highlighted that agricultural growth has remained one of the foremost components of development strategy in the Central Asian Studies, particularly in view of long soviet agrarian policy owing to comparatively weak industrial base of the region.

Karnieli et.al 2007, Germany, in the paper entitled "Assessing Land Cover Change and Degradation in Central Asian Deserts Using Satellite Image Processing and Geo-statistical Methods" described the soil and vegetation degradation around watering points in Central Asia with the help of Remote Sensing. Shyam S. Bhatia, 2005, India, "Patterns of Crop Concentration and Diversification in India" analyse the cropping pattern on a regional basis with a view to bringing out the areal concentration and diversification of crops. Tantyana A. Saiko, 2000, Moscow, "Irrigation Expansion and Dynamics of Desertification in the Circum-Aral Region of Central Asia" aims to examine the causes and dynamics of desertification in Central Asia. The paper entitled, "Impact of Inefficient Irrigation

System on Crop Productivity in the Republic of Turkmenistan", *Eurasian Studies,* Vol. 3, (3) Sept.-Oct., 2011, authored by Mushtaq Ahmad Dar describes the importance of irrigation for agricultural development. He further highlights that irrigation has been assigned such a crucial role because this is the single most important factor, which can facilitate the future utilization of the scarce farm land resources and can facilitate acceptance of improved technology. However, sustainable management of land and water resources in arid and semi-arid region is of concern as a result of merciless and inefficient use of waters. The paper also shows that here agricultural productivity, the strongest indicator of agricultural development, is positively correlated with irrigation intensity and water-use efficiency. The paper entitled *"Natural Resource and Development*" a bi-annual collection of exploration and exploitation of natural resources focus on water-the lifeline and sustainable development in agriculture.

Zvi Lerman (2001), in his book entitled, "*Turkmenistan: An Assessment of Leasehold Based Farm Restructuring".* The author in his book highlights the priorities of Government policy with regard to achieve full self sufficiency in the republic of Turkmenistan. He also suggested the importance of agriculture in Turkmenistan. It deals with the sectoral context of land reform in Turkmenistan. Sarah L. O'Hara, in the book published in 2002 entitled, "Agriculture *and Land Reform in Turkmenistan Since Independence",* reviews the major components of Presidential program designed to achieve food self sufficiency in the republic of Turkmenistan. Lavischer 1969 in his book *"Economic Geography of the USSR"* has described natural resources, agriculture, industry of Central Asian States in detailed manner. Moonis Razza in his book "*Renewable Resources for Regional Development"* 1980, the author describes how to make judicious use of renewable resources for

regional development. A.S.Mathur in the book, *"Land use"* 1986 described land use and water resources.

Cris Borrow in his book 1987 *"Water Resources and Agricultural Development in Tropics"* has described role of water with the agricultural. Fisher in the book, *"Geography and development"* has given full detail about the regional development with respect to environment. G. M. Mir (1993) in his books entitled *"Regional Geography of Central Asia"* and *"Resource management Regional Co-operation and Sustainable Development in Central Asia States"* has described the various aspects of regional geography and irrigation productivity with respect to water in Central Asian republics. A. M. Michal in "*Irrigation Theory and Practice*" describes the various irrigation techniques. E. Wenithal (1993) *"Water Management Institutions in Central Asia"* given detailed account about the water management institutions. Vassilie in his book published in 2003 entitled "Central Asia *Political and Economic Challenges in the Post-Soviet Era"* focuses on economic aspects of the region. Boris Rumer in his papers entitled *"Central Asia in Transition-Delimmas of Political and Economic Development",* "*Central Asia-The Challenges of Independence"* and *"Central Asia and New Global Economy*" Touches almost all aspects of Central Asia particularly natural resources, and economic aspects. The World Bank reports, F.A.O reports, touch almost every sector of Central Asia States. The book edited by R.Lal, B. A. Stewart et, al, entitled, *"Climate Change and Terrestrial Carbon Sequestration in Central Asia",* highlighted the impact of climatic change on the production of crops in Central Asia. They also discussed that judicious use of water resources can bring more area under cultivation but no one has highlighted the *"Determinants of Food Security in Turkmenistan*" directly. So the present study will be first

attempt in the direction highlighting the ground realities at gross root level.

Database

The study is mainly based upon the blending of secondary sources consisting of books, journals, proceedings as well as other publications of World Bank, IMF, Embassies. For the collection of data and information, different sources were consulted which include the publications from World Bank, International Monetary Fund (IMF), United Nations, World Factbook, FAO, The Institute of Statistics and Information of Turkmenistan, Agricultural Production of Turkmenistan, the relevant information was acquired from the concerned Embassy as well as other national as well as International agencies working on different aspects of Turkmenistan. I also visited different Universities of the country including JNU, AMU, University of Delhi etc. for the collection of data regarding my research work. Some Russian manuscripts were translated with the help of some Russian language experts, which helped me to supplement the study. Interviews and face to face discussion with some academicians, scholars, experts and officials of Turkmenistan during some International Conferences and other occasional interactive programmes eluded the absence of field study to a larger extent. Every effort has been made to check and cross-check the information and data of different sources through the application of relevant standardization techniques. Besides, relevant data and information has been downloaded from internet in order to supplement the study.

Methodology

The study is descriptive and analytic in nature. In order to achieve the set objectives, the empirical approach based on quantitative and

qualitative techniques have been adopted. For the examination of food security in the republic of Turkmenistan, the secondary data was processed and analysed. A number of statistical techniques have been adopted to analyse the potentials of food security of Turkmenistan. Keeping in view the varied dimensions of the problem, the methodology applied is also of different nature. Suitable statistical techniques have been used in order to get the results based on cause and effect relationship, Simple Linear regression to find out relationship between area and cereal production, Weavers method (Minimum Deviation), Doi's method, and Maximum Positive Deviation method for crop combination. Location Quotient technique has been applied to find out crop concentration. In order to find out the crop diversification Gibbs Martin method has been applied. Relative Yield Index and the Relative Spread Index for the determination of suitability of crop have been applied. Irrigation Intensity index has been utilized to find out the ratio of Gross irrigated area and net irrigated area. For productivity measurements Yang's Method and Kendal's method have been applied for finding out productivity variation from one region to another region within the territory of Turkmenistan. Yield level for each region and the whole country has been calculated. This has been done at each crop level also. Growth level and Yield level of crops have been computed and also shown through different cartographic presentations. Similarly, showing the impact of irrigation means, rainfall, fertilizers, tractors etc. on levels of agricultural development, Spearman's rank correlation and Karl Pearson's technique have been used in order to assess the impact of environmental, institutional and technological factors on the overall socio-economic development of the region, an index has been worked out by superimposing all the relevant indicators.

Organization of the Study

In order to analyse properly the sub-themes, the study has been divided into following chapters.

Introduction

Chapter

1. Regional Structure of Turkmenistan
2. Land use and Cropping Pattern
3. Production and Productivity of Food Crops
4. Regional Population and Food Consumption
5. Food Security; Issues and Challenges

Conclusion and Suggestions

Bibliography

Introduction briefly introduces the subject matter of the study. This chapter also deals with the introductory concept of food security. Importance of the study, its aims and objectives, literature review, hypotheses framed, methodology and data base has also been the focus of this part of study.

The first chapter deals with the study of physiography of the region, its climate, vegetation, types of soils, and drainage system. It also highlights the role of these natural features in overall agricultural development of the country.

In the second chapter land use and cropping pattern of the republic has been discussed. This chapter also highlights the changing cropping pattern after the independence of the country which was more in favour of cereals than non-cereals.

The third chapter attempts to find out the relationship between agricultural investment and productivity in the republic. Investment is viewed as an important aspect to enhance agricultural productivity, and the key to promoting long-term growth, although technology and policy are other important long-term factors. Low levels of investment in agriculture bode poorly for long-term prospects of achieving food security in Turkmenistan. Hence, improving the production capacity of agriculture in the region through productivity increases is a critical component of improved food security.

In the fourth chapter attempts have been made to find out area under cereals and fruits and vegetables, its per head production and also its per head consumption. This chapter also focuses on the food-deficit and surplus regions of the republic. The chapter further attempts to show the production and consumption of vegetable and fruits.

The last chapter attempts to work out the relation between the poverty and nutrition. The purchasing power of the people in the study region determines the access to food, shows that there exists positive correlation between purchasing power and food security. This chapter also focuses on the mitigation measures. How the region must develop an understanding and consensus on the problems it faces and the actions needed to alleviate poverty, reduce malnutrition, food insecurity, and sustainably manage the natural resource base.

Finally, the study was concluded on the basis of some main findings and suggestions were given for future planning with the hope that the study will be useful for the policy makers, administrators and academicians.

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Chapter-1

Regional Structure of Turkmenistan

- Relief and Geology
- Climate
- Drainage
- Ground Water Resources
- Lakes
- Soils
- vegetation

Chapter-1

Regional Structure of Turkmenistan

Turkmenistan is an arid country with a territory of 491,200 km^2 ranking world's 52^{nd} largest country in terms of area. According to the World Bank the population of Turkmenistan amounted to 5.6 million people in 2010, making it the fifth most sparsely populated country in Central Asia. In the north, Turkmenistan borders with Kazakhstan, in the east with Uzbekistan, in the south with Iran and Afghanistan, in the west across Caspian Sea with Azerbaijan. Most of its territory (80%) is covered by the Karakum Desert.[1] Turkmenistan declared independence on 27 October 1991 and gained official recognition on December 25, 1991, a day before the final dissolution of the Soviet Union.[2]

Relief and Geology

The desert relief dominates, that makes the land of Turkmenistan distinctive and picturesque. Turkmenistan is the plainest Republic of Central Asia. The major part of the territory, about 80 percent is occupied by the Karakum desert, and the other 20 percent are taken up by mountains, plains and hills. Kopetdag (2942 meters above sea level) is situated in the southern part of the Republic. The river Murgab entering Turkmenistan in the southeast separates the northern foothills of the Paropamiz heights, the Badkhyz (upto 1267 m.) and Karabil (upto 984 m.). The highest peak of the Republic is a spur of the Gissar ridge (upto 3139 m.). Krasnovodskoe plateau (upto 308 m.) is situated in the western part of the country and on

the southern outskirts of the plateau Ustyurt, in the northwest. In between Amu-darya and Syr-darya there are southeastern Karakumy. Small right side coastline of the Amu-darya entering into Turkmenistan.[4]

Based on geographic location, the territory of Turkmenistan can be divided into following physiographic divisions:

- Lowland deserts and desert plateaus
- Kopetdag Mountains
- Kugitang Mountains
- Caspian Sea

Lowland Deserts and Desert Plateaus

Landscape geographers distinguish upto ten types of deserts in Turkmenistan based largely on soil types. Most prominently represented here are sand deserts, including the great sand desert of Karakum, which occupies a vast territory of 350,000 km^2. While sand dune of various types dominate Karakum, sand-gravel deserts are also found. Salt (*solonchak*) deserts occur throughout but are especially predominant in the Central Karakum and along the Caspian shores. The plant communities in the desert are dominated by the perennial *Chenopodiaceae*, large shrubs such as white and black saxaul *(Haloxylon persicum H. alba*), sand acacia (*Ammodendron*), kandym (*Calligonum*), ephedra (*Ephedra strobilacea*), and a large diversity of ephemeral plants. Desert plateaus occupy only isolated areas in the west and south of Turkmenistan. Stony deserts occupy the major part of these plateaus. Relict plant species here include *Dendrostellera turkmenorum, Calligonum spp.*, and *Asparagus turkestanicus*. In the south, between the Tedjen and Murghab River valleys, the Badghyz rises upto 1,225 m and is covered with remnants of the

savanna-like groves of wild pistachio (*Pistacia vera*) with herbaceous communities of *Carex pachystylis*, *Poa bulbosa,* and ephemeroids. Closed depressions with salt pans (*solonchaks*) are characteristic and support a number of endemic species of plants and animals. A very important element of the deserts is the *tugai* (desert riparian forest), a complex ecosystem found along the valleys and terraces of the large rivers such as Amudarya — the largest river of Central Asia.

Kopetdag Mountains

The mountains lie in the south and south-east of Turkmenistan. The largest of them are the Kopetdag Mountains stretching for 650 kms, from the north -west to the south-east. The highest peak of the Kopetdag Mountains in Turkmenistan is the mountain Shah-Shah of 2,912 m. The main mountain ranges go in parallel to each other, they are divided among themselves by valleys.

The bio-geographical origins and development of the flora of Kopetdag have resulted in an extremely diverse set of plant communities. The major communities are described below. Wormwood *(Artemisia*) communities (300 to 800 m). Wormwoods (*A*. *badhysi*, *A*. *turcomanica*, *A*. *kulbadica*) occupy most of the foothills, combined with *Poa bulbosa* and desert sedge (*Carex pachystylis*). These communities include numerous ephemeral plant species. Under heavy grazing, wormwood cover declines, resulting in an increase in annual grass communities including such species as *Eremopyrum orientalis*, *Anisantha tectorum*, *Avena barbata*, and *Bromus japonicus*.

Kugitang Mountains

In the south-eastern part of Turkmenistan on a right bank of the Amudarya River there are the Kugitang Mountains which are the

spurs of the Gissar Mountains. Just in these places one can see unique sights of nature and rare endemic animals. The structure of plant communities is similar to that of Kopetdag. A number of species belonging to Gissar flora are found here but not present in Kopetdag. There are such unique territories as Dinozavr plateau, numerous caves (Kopkatan and etc.), karst lakes and craters, Ayrybaba peak of 3,139 m. It is the highest peak of Turkmenistan. [5]

Yerbent Region (desert)

It is also called as Desert region which is located in the Central Karakum Desert, 80-260 km northward of capital city of Ashgabat and occupies area of almost 9,000 km^2 with 8,000 inhabitants. The relief of project's region is a combination of dunes of various forms and takyr depressions. The climate is arid and sharply continental. The greatest part of the region (around 90%) is represented by the desert pastures. Pastures could be used throughout the year. There are numerous settlements scattered all over the region inhabited by the different numbers of families ranging from 3-4 to 100. Those are mainly pastoral families who live from the sheep-, goats-, and camels–breeding both private and state. Extensive livestock-breeding is the main source of income for local people. Traditionally distant pasture animal husbandry (cattle, sheep, goats and camels) is the main activity of the local population. Natural desert pastures are used as the main forage base. The desert pastures have been experiencing a heavy degradation due to excessive animal pressure and absence of rational pasture management. Lack of watering points has led to the concentration of greater amount of animals around the existent wells. A structural change in the pastoral system (more goats and cattle instead of camels; more unguarded pasture around settlements instead of long distance pasture) has resulted in degradation of the vegetation, particularly around

settlements and watering points. Moving sand dunes cover houses, schools and roads, and heavy sand-storms occur more and more frequently.

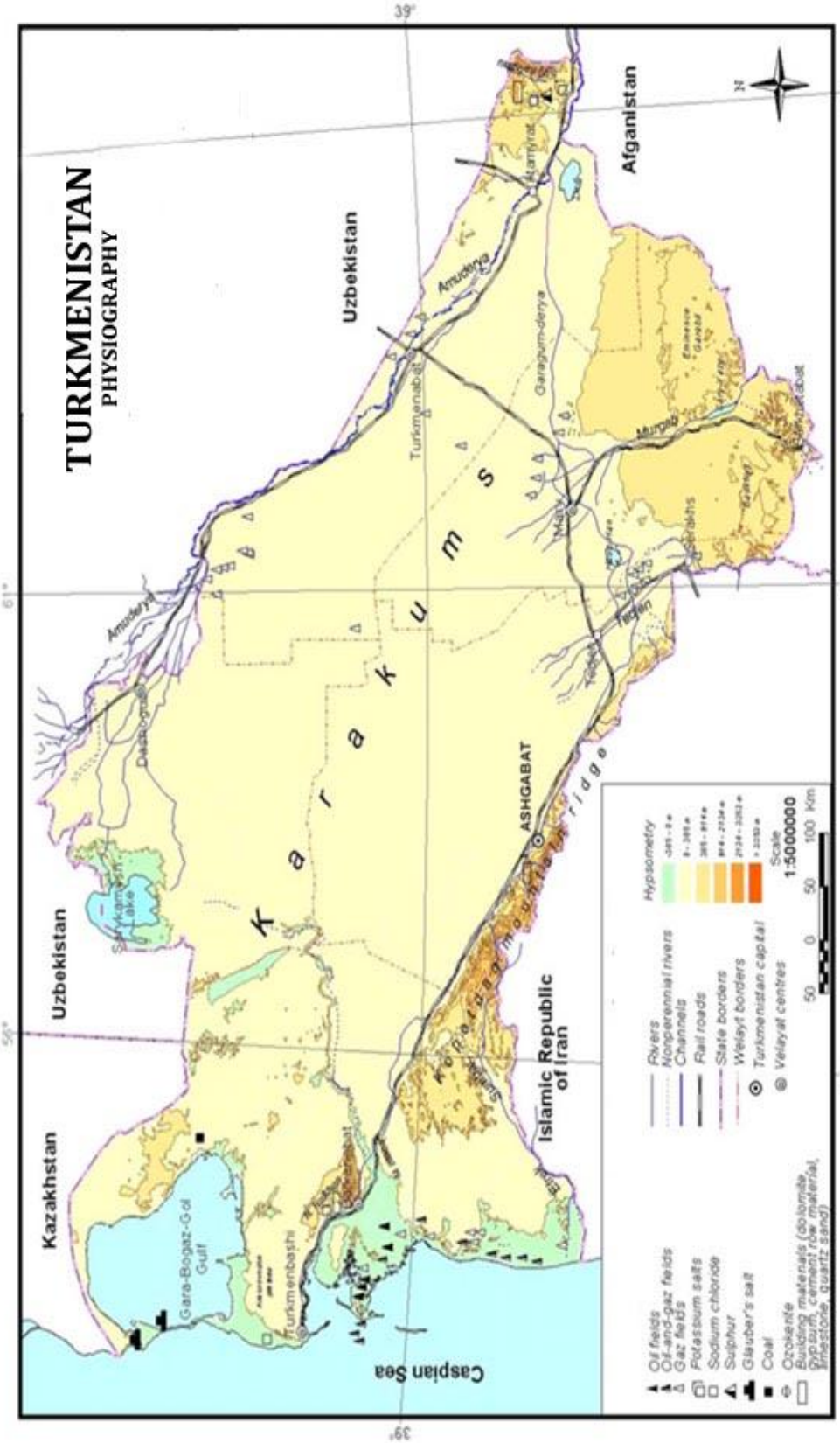
Sakar-chaga Etrap (Oases)

Sakar-chaga Etrap is also known as Oasis and it is located in the north-western part of Mary Velayat in the delta of Murgab River. The region stretches for 190km from south to north and 26-70km from east to west and occupies the total area of 1214,7 thousand hectares. 34 settlements and 17 peasant associations are located in these Oases (Sakar-chaga Etrap). Population of the region is 112,000, largest part of which lives in oasis where 80 percent of settlements are located. The climate of the region is continental with cold winter and hot summer, and low air humidity. The main human occupations in the region are agriculture and animal-breeding. The interregional drainage canal runs through the territory of Sakar-Chaga Etrap which causes tense meliorative regime of the territory. Due to disposal of drainage water the temporary and permanent lakes are emerging on rangeland deteriorating vegetation cover. Near 80 percent of population do not have access to drinking water. Soil salinization is the main problem of this site due to inadequate irrigation techniques and lack of drainage. The actual irrigation management system leads to irrational use of both water and land resources. Due to improper land levelling of irrigated land and high level of ground water, about 60 percent of irrigated land is prone to waterlogging. The productivity of irrigated land decreases from year to year because of irrational use of mineral fertilizers, salinization of soils and absence of appropriate systems of crop rotation. No monitoring of the ground water level, mineralization and salinization of soils is carried out.

Caspian Sea

The largest inland body of water in the world, the Caspian Sea has total surface area of 400,000 km^2. The southeastern sector of the sea, with 1,768 km of shoreline, is in the territory of Turkmenistan. In the west of Turkmenistan there are isolated mountain chains: the Large and Small Balkhans. The highest peak of the Large Balkan chain is the Arlan Mountain -1,881 m. The height of the Small Balkan is 774 m.[6]

The preceding physical regions and sub-regions give rise to major eco-regions of the study area. Desert territory, which occupies approximately 80 percent of Turkmenistan, can be subdivided into three subzones: tertiary plateaus (southern parts of Mangyshlak and Ustyurt); sand deserts; and submontane plains (northern foothills of Kopetdagh). Mountains cover less than 20 percent of the Turkmenistan territory, with the Kopetdagh range stretching along the southern border. The Greater and Lesser Balkans rise in isolation to the northwest of the Kopetdagh. Foothill spurs of Paropamiz mountains stretch from Afghanistan in the very south of Turkmenistan, forming the Badghyz and Karabil Plateaus. In the extreme east of Turkmenistan lie the Kugitangtau Mountains, part of the Gissar mountain system, shared with Uzbekistan and Tajikistan.[7] (**(fig. 1.1)**)



Source: Initial National Communication on Climate Change under United Nations Forest Conservation.

Fig. 1.1

Climate

The study area lies in the zone of warm and arid continental climate zone. Since the study area occupies quite a large territory from south to north there are some climatic differences. Thus, for better understanding some ecological processes in the territory can be further divided into following climatic regions Lower Amu Darya, Northern Karakum, Southern Karakum and Southeast Karakum. The meteorological parameters of these areas slightly differ from each other **(table 1.1).**

The Lower Amu Darya climatic zone covers the irrigated downstream region on the north of the study area. This zone is the coldest plain part of the Turkmenistan. The Northern Karakum climatic zone encompasses the northern part of Amu Darya valley from Dargan-Ata till crossing border with Uzbekistan. This zone is comparatively cold due to its openness to the north and consequently a penetration of cold air masses. The Southern Karakum climatic zone is divided into two parts – Lower Karakum zone which is located between the west side of the Amu Darya River and Sundukly zone on the east side of the river. This zone includes many industrial cities such as Turkmenabad, Kerki, Seidy. It is the warmest part of the Amu Darya river basin which is characterized by a high mean temperature and relative warm winter.

The Southeast Karakum climatic zone covers the southeastern part of Lebap province and includes the Karakum Canal region. A specific feature of this region is the presence of "Afghans" - the strong gusty winds bearing a large amount of a dust. "Afghans" happen in a warm and cold season, and in the second case together with dust snowfalls are possible.

Table 1. 1
Climatic Parameters of Turkmenistan

Parameters	Lower Amu Darya	Northern Karakum	Southern Karakum	Southeast Karakum
Mid annual air temperature, ^{0}C	12	12.3	15.8	16.8
Average temperature of the coldest month, ^{0}C	-6	-5.2	-0.2	+20
Average Temperature of the warmest month, ^{0}C	+27	+28	+31	+31
Temperature fluctuations, ^{0}C	-	-	31	29
Frost free days	187-200	200	230	230
Days with temperature above 10^0 C	196	210	-	250
Annual precipitation, mm/year	76-90	100	134	204
Evaporation, mm	-	1700	2248	2155
Maximum temperature, ^{0}C	-36	-32	-25	-31
Snow cover days per year	-	10-15	10-13	15

Source: Sustainable and Water Management in Turkmenistan: Challenges and Solutions by Amangul Ovezberdyyeva, Arndt University of Greifswald p 17.

Precipitation

Average annual precipitation varies from 100 millimeters (on the Kara-Bogaz-Gol Bay and north-east of the republic) to 398 millimeters (at Koine-Kessir in the Kopetdag Mountains). Rainfall occurs mainly during the winter season, mainly in October and April. The amount of precipitation in the cold period is two or three times greater than in the warm one. The territory of Turkmenistan is divided into 4 zones on the basis of annual quantity of atmospheric precipitation:

The Northern Regions

In the northern regions, where severe winters keep low temperatures, snow precipatation can be observed and the snow cover is stable. From June to september there is a lack of precipitation (2.55-5 mm). Precipatation in the summer months is caused by cyclonic activity when the level of convection reaches the level of condensation which is located at an altitude of 1.2-1.4 km.

East and South Region

In the east and south of the territory, precipatation regime is identified by invasion of the southern and western cyclones, the north and north western cyclones. Maximum precipatition (64.3 mm) is observed in March. Much of the precipatition is observed from December to April i.e. 87.88 percent of the annual amount.

The Western Region

This zone belongs to the province of Balkan where maximum precipitation is experienced in March (23.33 mm). Much of it is marked in autumn and spring seasons (October and May) and is 86.5 percent of the annual amount.

The Plain Region

On the plain territory during the year, the maximum number of precipation days is marked in the cold period. Maximum frequency of precipatition is marked in the second half of winter and spring when the cyclone activity grows rapidly. Much of precipatition fall at this period. In summer it becomes dry.

Drainage

Due to deterioration of the water economy situation in the Aral Sea Basin and impossibility to get the additional resources from outside, water becomes the most valuable raw material, acquiring more and more important economic and social significance.

There is practically no surface runoff in the territory of Turkmenistan. The episodic runoff can occur only in some places formed by takyrs and tykyr-like soils after rains of more than 3-5 mm. This local runoff and reserves of groundwater form the own water resources of the desert of Turkmenistan. As the local runoff is related only to the plots with weakly permeable soils and its volume

is small, reserves of groundwater are limited, the own water resources are insufficient for desert development. Water formed on the adjacent to desert territories is widely used for desert irrigation.

By location of the regions of runoff formation water resources of Turkmenistan can be divided into two main groups. The first group includes the rivers with the flow fully or mostly being formed beyond the country's boundaries, such as Amudarya, Murgab, Tedjen, Atrek Rivers, small rivers of East and Central Kopetdag and other highlands, reserves of fresh groundwater and the local runoff being formed on the weakly permeable soils of piedmont plains and plain part of Turkmenistan.

Amudarya River

Amudarya River plays extremely important role in providing the Turkmen economy with water. The largest hydro-technical creation, the man-made river Karakum canal takes from Amudarya 10-12 Km^3 every year and brings it to the central part of Turkmenistan with scarce water resources and western waterless regions. Amudarya River is the main and vitally important water source, covering almost 90 percent of the country's water demand.

Murgab River

The second largest river of the Turkmenistan, Murgab River inmates from northwestern Afghanistan in a basin bounded on the north by the Turkestan Mountains and on the south by the Safīd Mountain Range. The main supply of its water is melting snow on the mountains and partially rains, mostly in winter-spring period. The river's regime is characterized by spring slightly prolonged flood caused by melting mountain snow and rainfalls. The distribution of the Murgab flow during the year is less favorable for irrigation than

Amudarya. The flow during May-August constitutes only 42.2 percent.

Tedjen River

The third largest river of Turkmenistan is Tedjen. The river's regime is characterized by main spring flood, which has several peaks, caused by rainfalls. Quite often rains can lead to the short-term floods during the winter. In July-November the river is drying up.

Atrek River

Another river namely Atrek located in the southwest of the country which flows towards Caspian Sea practically a rainfed rivulet.(**fig 1.2)**

Thus, the total resources of the multi-year average flow of the large and small rivers and sources equal 27.1 km^3/year. **(table 1.2)**

Table 1.2
Water Resources of Turkmenistan

Sources of Water	Water resources (million m^3)
A. Permanent Water resources	
1. Surface water (Amudarya, Murgab, Atrek, and small rivers	27,100
2. Water wells with salinity less 3 g/l	3,300
Total for 1 and 2	30,400
B. Temporary and alternative water resources	
3. Runoff from indigenous water harvesting systems (takyrs and takyr-like soils)	332
4. Fresh water of underground lenses near the rivers and canals	307
Total for A and B	31039

Source: Water Resources of Turkmenistan: Use and Conservation, N. Orlovsky and L. Orlovsky

The Small Rivers

In addition of the mentioned major rivers, there are a number of small rivers and water channels whose catchment change from tens of thousands up to 3 thousand cubic kilometers, but their lengths do not exceed several tens of kilometers. The rivers flow along valleys, some parts of gorges and canyons. The water of the greater part of

the rivers is used for irrigation within mountains and foothills. The level of water of the rivers of Kopetdag is low: the water expense does not exceed 0.5-1.0 cu. m/sec.[9]

Artificial Irrigation and Drainage Network

It is a characteristic element of desert zone and consists of a number of irrigation (the length 39.1 thousand sq.km.) and collector-drain channels having length of 35.14 thousand km. The length of the largest canal having the status of the river-Karakum is 1300 km. It is the artificial river in the desert - the second after Amudarya, according to the water discharge.

Groundwater Resources

Fresh groundwater is an important source of water supply. However, aquifers are dispersed and occupy relatively small area. There have been discovered 134 location of fresh water. Estimated forecast exploitation capacity of 73 locations of groundwater is 3.3km3/year and explored reserves are 1.12 km3, 689 m3/year of them (61.5 % are being used at present)

The lakes

The lakes are mainly situated in the rivers flood lands or in the regions adjacent to the culminating parts of irrigation, collector-drain systems. There are about 30 lakes in the area of Murgab, whose area does not exceed 10-20 ha, and the average depth is 2-3 m. The waters of the lakes which have lost linkages with rivers are salty. Some large lakes are nearby the Kelif Uzboy. During the construction of the Karakum Canal they were connected by channels and serve for collection of sediments coming with the water from the Amudarya river. The numerous lakes of filter origin appeared in the Karakum river zone . Some small lakes with bitter

and salty water and three with a fresh water (Yaskhan, Kara-Tegelek, Topiatan) are located in a dry bed of West Uzboy. Recently, due to the drainage waters many small lakes and floods have appeared in the region of Karakum, adjacent to Murgab and Tedjen oases. The largest one is the Sarakamysh Lake which appeared as a result of draining. Its area is over 2,200 sq. km.[10]

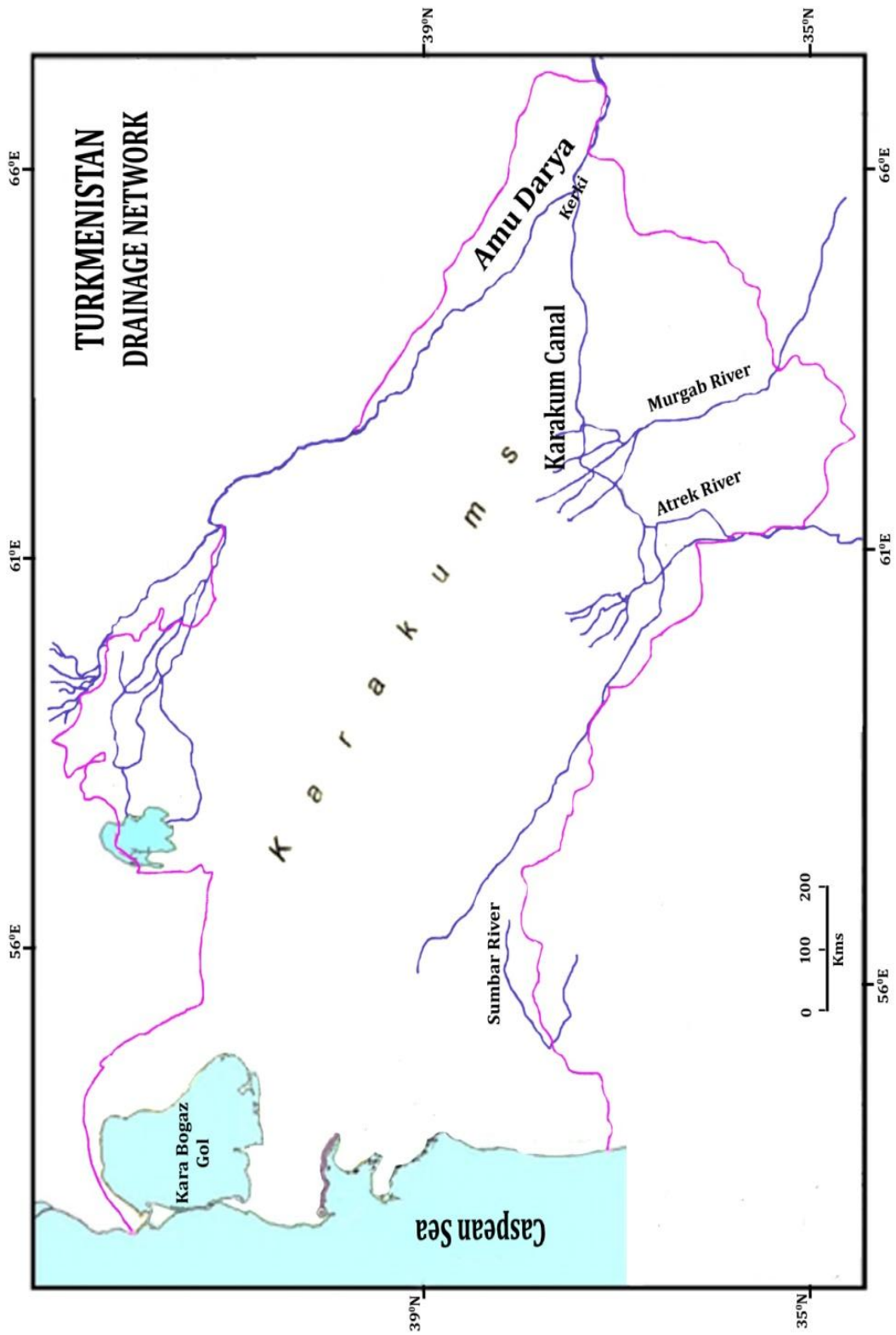
Turkmenistan has practically no surface water but she receives about 22 billion m^3 from Amudarya River through water sharing agreements. **(table 1.3)**

Table 1.3
Use of Surface Water
(1990-2010)

Year	Water Intake (mln, m^3)	All Users (%)	Agricultural Users (%)	Other Users (%)	Irrigated Land (000 ha)	Water used per ha irrigated land (000 m^3)
1990	22,435	19800	87.7	12.3	1439	14.0
1995	27608	20695	91.3	8.7	1737	10.9
2000	24917	17430	89.7	10.3	1793	8.7
2005	27958	19251	88.8	11.2	1852	9.2
2010	24122	20765	90.8	11.6	2000	9.2

Source: Sustainable and Water Management in Turkmenistan: Challenges and Solutions by Amangul Ovezberdyyeva, Arndt University of Greifswald p.56.

Table 1.3 indicates that about 92 percent of the total surface water is consumed for agricultural purposes meaning that agriculture in the country is totally dependent on irrigation owing to arid and semi-arid conditions. During Soviet period Turkmenistan was dominated by cotton cultivation therefore about 14,000 m^3 of water was used per hectare of land. However, the water used per hectare of land has shown improvement after the independence of the country from 14000 m^3 in 1990 to 9200 m^3 in 2010. This change has happened following the change in agricultural policy by the respective governments of the republic which was designated in favour of food crops and food crops need lesser amount of water than that of cotton.



Source: Initial National Communication on Climate Change under United Nations Forest Conservation.

Fig.1.2

Soils

The parent materials of the soils in the study area are fluvial or eolian sediments. According to the FAO soil classification (Driessen and Dudal 1991) the relevant soil types in the study area are: Fluvisols, Gleysols, Solonchak, Arenosols, and Anthrosols. The former three are characterized respectively by fluvic, gleyic, and salic properties as diagnostic indicators. Arenosols are soils which have developed in the eolian sediments. Anthrosols are the soils changed by agriculture. They are characterized by accumulative agro irrigational sediment, deep humus horizon. The anthropogenic contribution such as every possible fertilizer, regular irrigation has resulted in the formation of such soils. These soils are used for irrigation agriculture.[11] Fallowing are the main soil types of the republic which include:

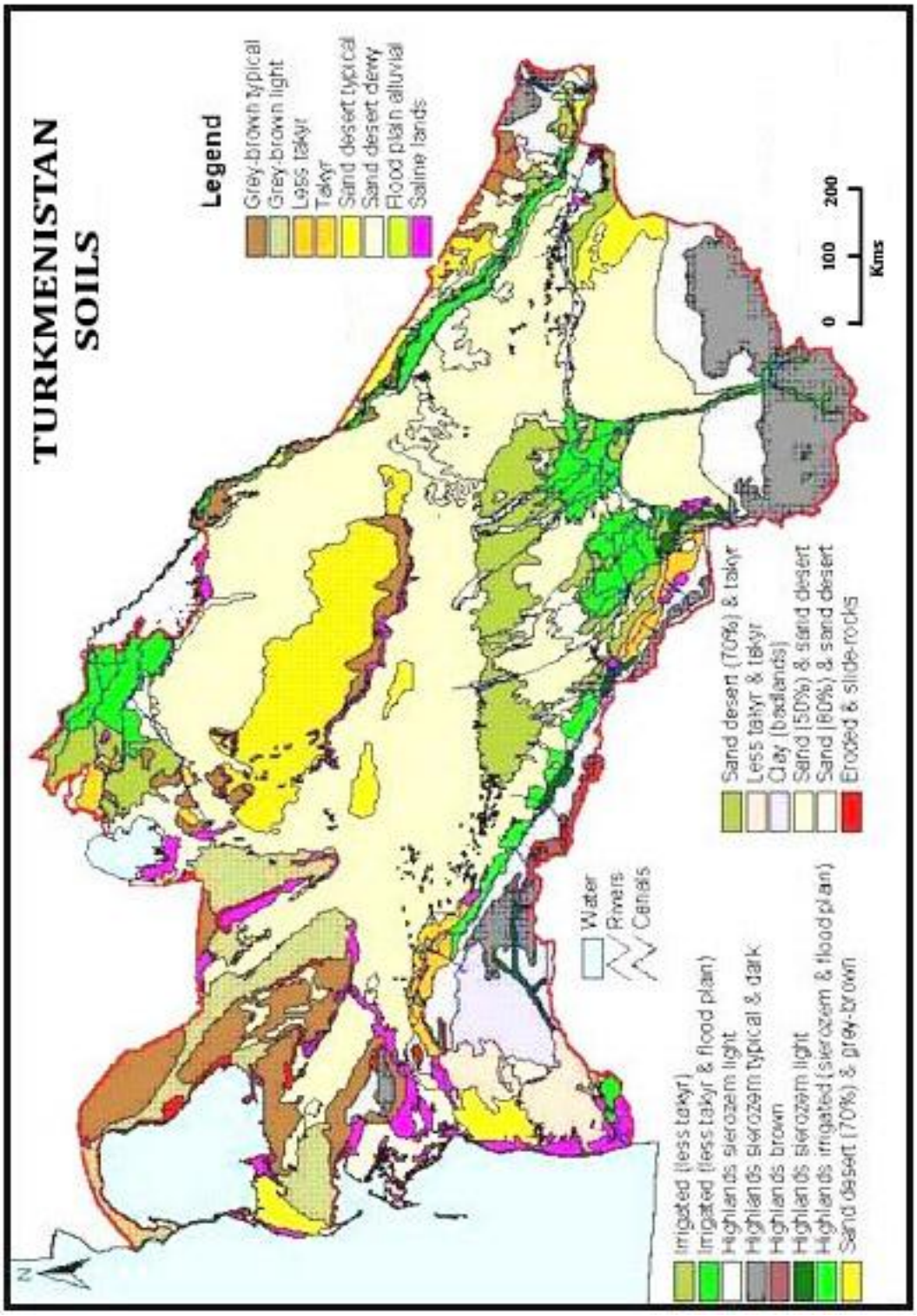
• **Meadow, meadow swampy soil** (Fluvisol, Gleysol) - Accumulation of organic matter from litter of herbaceous and woody plants; gleyic properties in the subsoil. Parent material consists of fluvial sediments. Degree of salinity varies from slight to severe. Tugai vegetation is common here. These soils can be reclaimed only by construction of drainage. Floodplains and alluvial fans along the Amu Darya (Kharin 2002).

• **Takyr like soil and takyr** (Takyric Solonchak, Solonchak) – Takyr like soils formed by fluvial sediments with a surface layer of fine materials from former water body. These soils are medium or strongly saline, the content of humus is low – about 0.5-1.0 percent. These soils locate on ancient delta plains of the Amu Darya and widely used in irrigation agriculture. Takyr is a specific soil formation in Central Asian deserts. They are usually located in shallow depressions. The thickness of soil profiles is 15-25 cm. It is

very difficult to reclaim these soils because of their heavy mechanical composition, high salinity and low humus content. In the considerable area of Karakum Desert consolidated (fixed) sands are widespread, alkali soil, takyrs and takyr type soils are found in the low lands.

• **Gray Brown Soils** (Arenosol) - Formation on fine sandy loam and on sandy deposits underlain by limestone and pebble diluvium. Soil material usually contains much crystal gypsum ground water are usually saline, their depth is more than 20 m the content of carbonate is very high, the humus content is very low, about 0.5 percent.[12] These soils distributed on fluvial sand and sand dune areas. Gray and brown soils occupy the plateau Ustyurt, Krasnovodskoe and Zuanguzskoe. On the foothill plains light grey desert soil is widely spread. In the low mountain zone – typical grey desert soil; and in the high mountain zone–black grey desert soil. Brown soils are found at the highest parts of the mountain plateau and ridges of Kopetdag and Kugitang Mountains.

• **Irrigated Soil** (Anthrosol) - Formation of a horizon with gleyic properties due to irrigation, partly secondary salinization through inappropriate irrigation. These soils are distributed in areas influenced by irrigation.[13] **(fig. 1.3)**



Source: Initial National Communication on Climate Change under United Nations Forest Conservation.

Fig.1.3

Vegetation

Forests proper occupy 4,126 thousand hectares. On the basis of information, three main types of forest are distinguished in Turkmenistan. These are as follows.

a) Hilly Forests

The basic species is Juniper Turkmenian (Juniperus turkomanica), which is the main component of biocenosis and hilly ecosystem of Kopetdag on the whole. The overall area occupied with it is 66,200 ha, including 400 ha of young growths, 6,900 ha of middle-aged stands, 15,100 ha of ripening and 43,800 ha of ripe and overripe stands. Forestry reserves are 1,32 mln m^3, of which 1,01 mln m^3 are middle-aged and ripening. As for Circassian walnut (Juglans regia), in hilly forests it grows mainly in Western Kopetdag and in the valleys of the rivers Sumbar and Arvaz. It occupies an insignificant area of only 100 hectares.

The over-all area of pistachio stands exceeds 100,000 hectares, 36,400 hectares of which are forest stands. The principal fructiferous stands are situated in the Forestry of Serkhetabad, natural Reserve of Badkhyz and on an insignificant area in the Forestry of Makhtimkulin. Pistachio (Pistacia vera) plays an important role in conservation of biodiversity, since it represents feed source for many a herbivorous and predatory animal. It is an extremely valuable nuciferous wood species for dry horticulture of Turkmenistan. Pistacia vera can prove very profitable for the organizations and farmers, that choose to cultivate this species and sell its products. However, thickness of forest stands of pistachio results in poor harvest. It strongly needs reconstructing. A significant part of the harvest is lost due to ineffective guarding. Vermin and illnesses also add to harvest losses. Hilly forests of

Turkmenistan are rich in wood species and represent high potentials as a source of valuable rough timber (Juniperus turkomanica, maple Turkmenian, hawthorn, almond-tree, barberry, dog-rose, Zizyphus, etc.)[14]

b) Desert Forests

Vegetation of desert territories of Turkmenistan is typical xerophilous with large endemic diversity of species. The main wood and shrubby species are the following:

saxaul white (Haloxylon persicum), saxaul black (Haloxylon aphillum), Salsola richteri, several kinds of Calligonum, Ephedra, Halothamnus, Ammodendron, and Astragalus.

Saxaul white (Haloxylon persicum) is typical mainly for high relief forms with fine-grained soil. The density of the stands of saxaul white (Haloxylon persicum) is less than of those of saxaul black (Haloxylon aphillum). It reaches 400-500 trees a ha on average.

Saxaul black (Haloxylon aphillum) prefers dense sandy soils and tends to occupy positive relief forms. Some samples of old saxaul black (Haloxylon aphillum) can reach 6-7 m high and weigh up to 1 ton. The maximum over-all weight of biomass reaches 40 tons a hectare. A significant part of the desert vegetation is represented by perennial herbs. They preserve a large stock of nutrition supply and are highly potential reserves for livestock breeding. The general area of saxaul stands is 688 100 ha, including 15,000 hectares of young growths, 284,100 hectares of middle-aged stands, 320,700 hectares of ripening stands, and 67,900 ha of ripe and overripe ones. The reserves of wood products reach 2,050,000 m^3, 1,720,000 m^3 of which are of middle age or ripe. Turkmenistan has a wealth of experience in afforesting of desert areas, which is used to prevent their desertification and to put these areas into economic

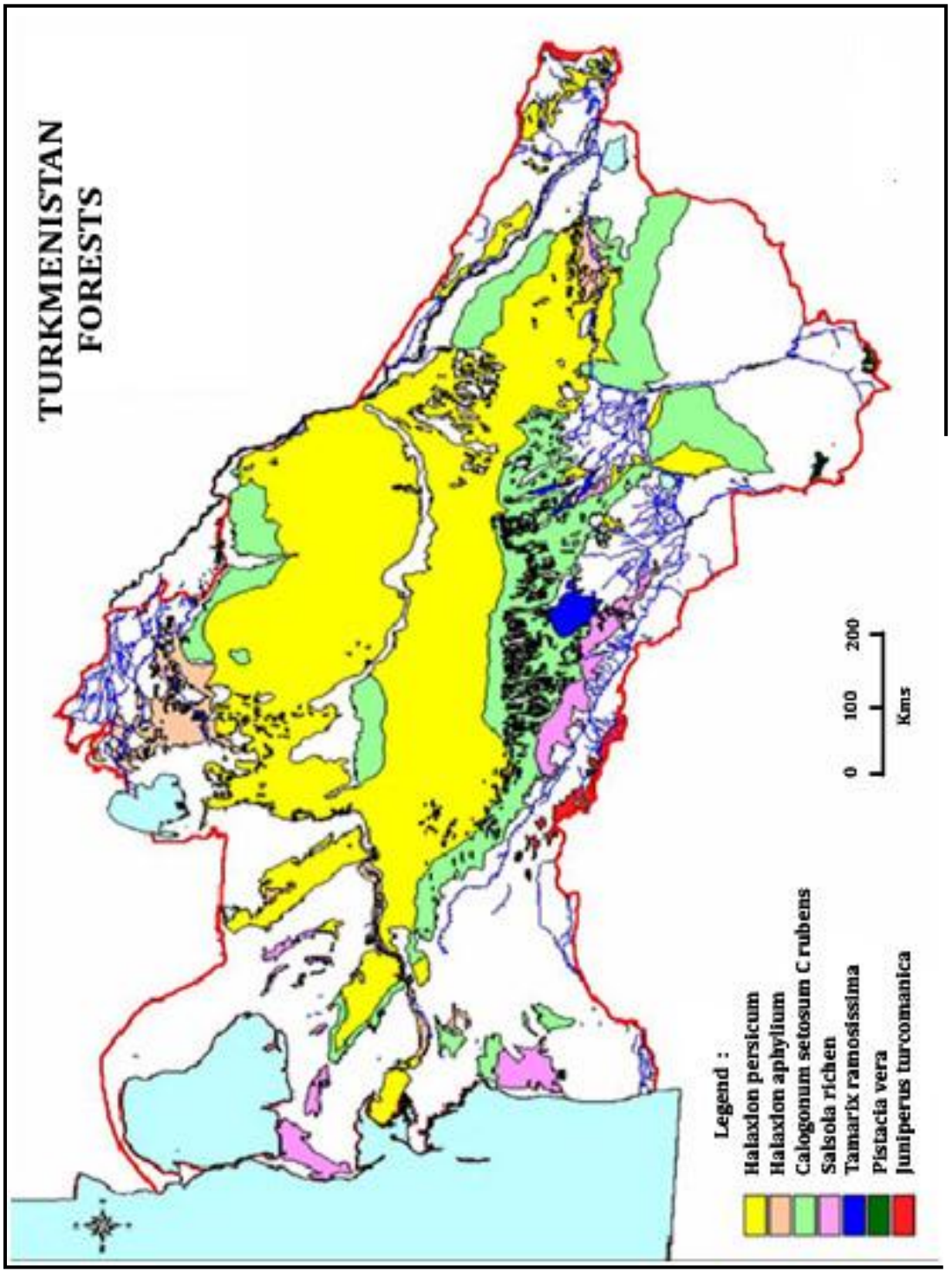
circulation (pastures). Forest amelioration is widely used in the construction of railway and highway Ashgabat-Dashoguz (over 600 km long). Desert forests are of great significance to the inhabitants of sandy regions (koomly) as they supply them with pastures, firewood, and building materials.

c) Tugai Forests

These represent a strip 50-500 metres wide along the rivers Amudarya, Murgab, Tedjen, and Atrek. During the Soviet period they were ploughed up and turned into agricultural cotton fields. At present the over-all area of tugai forests in Turkmenistan is 38,800 hectares, this not including the territory of the Amu-Darja Reserve (5,000 hectares). Biocenosis of tugai forests is constituted by such typical wood species as poplar (Populus pruinosa), sometimes willow (Salix songarica) and oleaster (Eleagnus orientalis). However, the most characteristic of salt soils are Tamarix and Tamarix meyeri. High mesophile grass species, such as Arunda donax, Imperata cylindrical and Erianthus ravennae comprise complexes with hygrophilous biocenosis. Tamarix comprises biocenosis of annual plants with peculiar species and vegetation.

d) Artificial Forests

Artificial forests include wood stands on mountainous, sandy and irrigated areas within the territory of Social Forestry, field-protection forests and pasture-protection forests.[15] **(fig.1.4)**



Source: National Institute of Deserts, Flora and Fauna of Turkmenistan.

Fig.1.4

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Chapter-2

Land Use and Cropping Pattern

- Cropping Pattern
- Food and Non-food Crops
- Crop Combination Regions
- Crop Diversification
- Crop Concentration

Chapter-2

Land Use and Cropping Pattern

Geographically, land has been regarded as a specific area of the earth's surface. It is the most important asset of the nation and from the earliest times man has used it to satisfy his multiple needs. Land use is a primary indicator of the extent and degree to which man has modified the land resources. It is the application of human controls in a systematic manner, indicating an intimate relationship between prevailing ecological conditions and man. It is the result of the combination of both natural genesis and human influences which have been brought to bear on it, in the past and of those which are still active in the present. Land is mainly used for the agriculture, as an important economic activity of man. He uses vast tracts of land for crop cultivation. This agricultural land belongs to rural areas and it is essentially a rural activity. The use of these land resources is of great interest to the geographers. The increasing pressure on the utilization of land resources has threatened the ecosystem, resulting in the environmental deterioration. It, therefore, needs a rational utilization of land ensuring optimum yields with minimum disturbances to ecosystem.[1]

Agricultural land accounts for more than 80 percent of Turkmenistan's total territory. However, Turkmenistan is a desert country, and most of its agricultural land is desert pastures, with very little cultivable land. **(table 2.1)** The share of cultivable land

(excluding pastures) has been steadily rising, from 1.5 percent of agricultural land in the 1960s to 4 percent in the 1990s and 2010. This has been achieved through the expansion of irrigation, which transforms the desert into arable land. Cultivable land averaged about 4 percent of agricultural land since 1993. The remaining 96 percent of agricultural land is pastures which continue to dominate the country's territory despite the impressive growth of cultivable land.[2]

Table 2.1
Land Utilization in Turkmenistan (000'ha)
(1995-2010)

Year	Total land	Agricultural land	Arable land	Fallow	Land under perennials	Cultivable land	Pasture	Area under forests	Other land	Share of cultivable land in agricultural land (%)	
										Including fallow	Excluding fallow
1995	49403	40534	1622.2	11.2	52.3	1685.7	38848.4	4127	4741.9	4.2	4.1
2000	49121	40202	1642.7	50.7	44.4	1737.8	38464.3	4127	4791.8	4.3	4.2
2005	49121	39937	1733.9	12.6	32.7	1779.2	38157.3	4127	5057.4	4.5	4.4
2010	49121	39920	1525.7	155.5	30.1	1711.3	38208.6	4127	5074	4.3	3.9

Source: Compiled and Computed on the basis of data from CIS Statistical database and from Statistical Year Book of Turkmenistan 2010.

It is evident from table 2.1 that Turkmenistan has a total land area of about 49121 thousand hectares, excluding area under inland water bodies, national claims to continental shelf and exclusive economic zones. Out of the total land area, agricultural land has occupied an area of 39920 thousand hectares. The republic of Turkmenistan being desert country, therefore, about 75 percent of the total agricultural land is dominated by desert pastures. It clearly indicates that there is low percentage of area available for agricultural purposes. **(fig2.1**) The table also reveals that the area under arable land has increased from 1177 thousand hectares in 1990 to 1525 thousand hectares in 2010. Similarly, the area under cultivable land has also shown an increase from 1990 to 2010. There is 0.5 hectares of arable land per rural resident compared with 2-3 hectares in Ukraine and Russia. Land and water are the two most precious resources in the country, because about 80 percent of the land area is without surface runoff and is covered by one of the largest sand deserts in the world—the Karakum Desert. It may also be noted that there have been quite appreciable changes in the area under various land use categories since the independence of Turkmenistan. Area under non-agricultural uses is likely to increase because of the ever increasing demand on land for the construction of roads, new sectors of the expanding towns, industrial development and urbanization etc. A deep insight into the table reveals that the desertification and population increase counter balance expanding irrigated cropland, leading to a situation which forces to encompass and follow a trend which will be more in favour of increasing the production and productivity.

Understanding land use change in relation to its driving factors provides essential information for land use planning and sustainable management of resources. A spatial-explicit modeling framework is

proposed to study the pattern of land use and land use changes. Research findings have shown that human-induced conversions (e.g. deforestation) and modifications (e.g. changing land use management such as fertilizer use and irrigation practices) of land use have significance for the functioning of the earth system through their impact on bio-geochemical cycles. Changes in these bio-geochemical cycles, as a result of ecosystem conversion, can change the dynamics of greenhouse gas emissions.[3]

Land use changes can also have an important impact on the water and energy balance, directly affecting climatic conditions. The impacts of these land use changes become globally significant through their accumulative effects. Apart from its implications for environmental sustainability, land use change can also have important consequences for food security. Conversion of cultivated land to non-farm uses such as housing, factories and infrastructure in combination with a growing population are for some countries regarded as a serious threat to future food security. The importance of land use change for the functioning of the earth makes studies that explore land use changes very relevant. In studies on land use change it is essential to link land use changes to their driving factors. These driving factors (e.g. population or development), mediated by the socio-economic setting (e.g. market economy, resource institutions) and influenced by the existing environmental conditions or context, lead to changes in land use through the manipulation of the biophysical conditions of the land. Understanding trends in land use change in relation to the driving factors will provide essential information for land use planning and sustainable management of resources.[4]

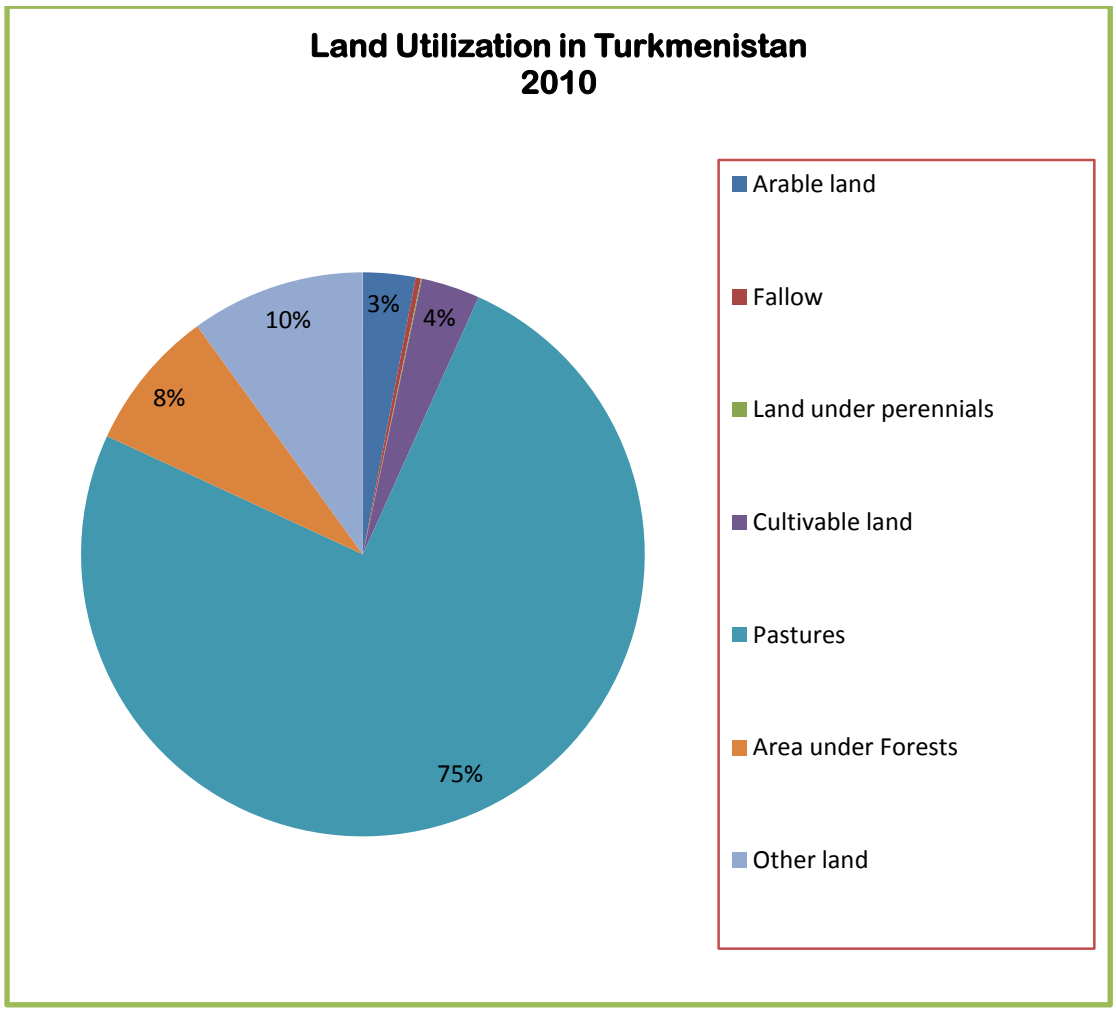


Fig. 2.1

Cropping Pattern

Cropping pattern has been defined as a time and space sequence of crops which simply means the proportion of area in a region under various crops at a point of time. Spatial and temporal cropping pattern are influenced not only by physical factors but socio-economic consideration are also equally important. Physical environment imposes certain broad limits within which particular crop may be successfully cultivated but at the same time the scale, intensity and extent of production within these physical limits is determined by economic consideration such as cost of production, market demand, competition between different land uses and government support policies and subsidies. The farming communities have developed their own traits and traditions, which results in crops not always being grown where they are best suited nor where they can be grown most economically. Thus, the cropping pattern in a region, besides having an economic importance has an element of the socio-cultural determinants in it. But the cropping pattern is never static, it is generally a dynamic phenomena. Under the influence of dynamic socio-economic factors, the cropping pattern also goes on getting modified so much that sometimes it gets absolutely replaced after a sufficiently long span of time. Even micro social changes e.g. the change in dietary habits of the populace or the acceptance or rejection of a particular crop due to social-economic changes may render any crop out of date and out of place.[5]

The role of man in the cultivation of certain crops in a region is also quite important. The physical environment reduces the choice of crops, either by prohibiting the growth of certain plants or by reducing their yield per unit area. The cropping patterns vary from region to region, depending on the terrain, topography, slope, temperature, amount and reliability of rainfall, soils and availability

of water for irrigation. The perception and assessment of environment also guide to grow certain crops in a region. Those areas of the world where physical diversities are less, the cropping patterns are less diversified.[6]

The study of cropping pattern constitutes a significant aspect within the spatial dimensions of Agricultural geography as it provides a good base for regional planning. Owing to its importance the problem has engaged the attention of geographers and agricultural land use planners. The studies made so far within field range in approach from tropical to regional and vary in extent from small areas of minor political units to the entire country.

Thus, to draw a comprehensive picture of the broad mosaic cropping pattern in Turkmenistan, study of character and extent of its crop association patterns seems imperative. The delineation of crop regions, thus, determined would emphasize the activities and specialization of crops to the area. Cropping pattern may be referred to a particular location such as the country as a whole or to smaller units like the State, districts, villages and ultimately to farms. It may likewise be related to a particular point of time. A change or shift in the pattern implies a change in the proportion of area under different crops which depends to large extent facilities on the available to raise crops in the given agro-climatic setting. Further, the development of marketing infrastructure and the demand pattern of the people are also factor which affect cropping pattern. As such cropping pattern play a very important role in determining the levels of agricultural production. On the availability of alternative and more efficient crop than existing ones, new cropping pattern in a region may emerge. For intensifying the cropping pattern and multiple cropping, the short duration fertilizers

responsive, high yielding varieties are required. Any cropping sequence to be adopted by the cultivator should be flexible.[7]

Turkmenistan is an agrarian country, as agriculture is the main stay of the people of Turkmenistan. Despite climatic limitation, agriculture is an important sector in the Turkmen economy.[8] The importance of the agriculture lies in the fact that it provides the basic ingredients for the existence of mankind as well as most of the raw materials for other sectors of economic activity such as cotton textile industry. Turkmenistan is an agrarian country where agriculture dates back to historical antiquity and where this sector has always remained one of the cornerstones of the regional economy, which is evident from its high share of rural population (58%), high share of agricultural labor in total labor force (48%), and relatively high share of agriculture in GDP (19%). This sector of primary activity being the back-bone of the national economic scene, improvements in the agricultural standards can greatly contribute to the prosperity of the entire region.[9]

Different varieties of crops are grown in the republic which include both commercial as well as food crops. In addition to this, vegetables and fruits are cultivated in the region. **(table 2.2)**

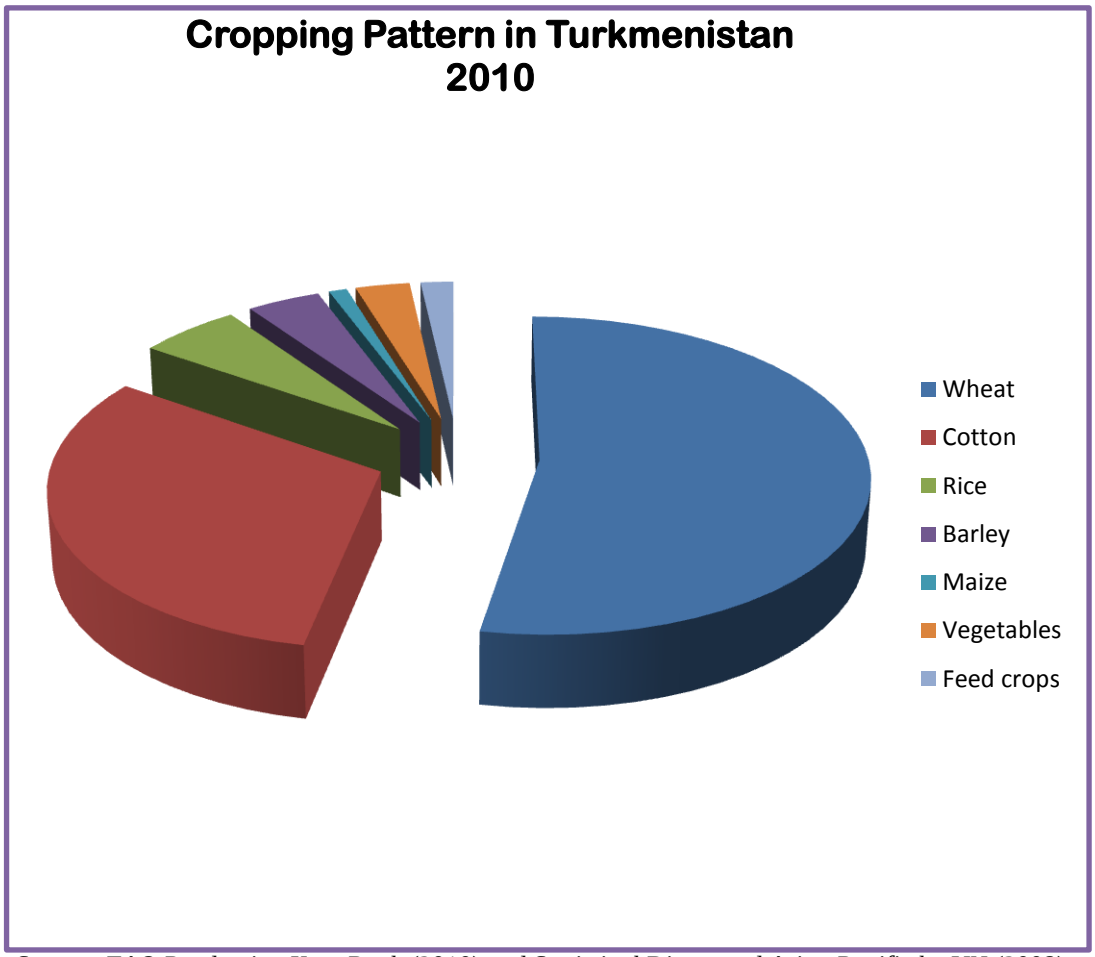
Table 2.2
Cropping Pattern in Turkmenistan
(2010)

Crops	Area (000'ha)	Percentage
Wheat	781	51.24
Cotton	476	31.23
Rice	85	5.58
Barley	61	4.00
Maize	15	0.98
Vegetables	45	2.95
Fruits	34	2.23
Feed crops	27	1.77
Total	**1524**	**100**

Source: Compiled and Computed on the basis of Data from FOA, Statistical Year Book of Turkmenistan, CIA World Factbook.

It is evident from the table that wide variety of crops are grown in the republic which includes Wheat, Cotton, Rice, Maize, Barley and vegetables etc. but the cropping pattern is dominated by wheat and cotton which accounts for 52 and 32 percent of the total cropped area respectively. Rice is the third dominant crop cultivated in the region it accounts about 6 percent of the total cultivable land while barley occupies an area of just 4 percent. Vegetables and fruits constitute the area of 45 thousand hectares and 34 thousand hectares respectively. **(fig.2.2)**

So far as the changes in cropping pattern in the republic are concerned, there has been lot of change in terms of cropping pattern since independence. Before independence, the republic was dominated by cotton cultivation, but post-independence was more in favour of cereals particularly wheat in order to achieve self-sufficiency. **(table 2.3)**



Source: FAO Production Year Book (2010) and Statistical Digest and Asian Pacific by UN (2008)

Fig. 2.2

Table 2.3
Changing Cropping pattern of Turkmenistan
(1990-2010)

Year	Cotton (000'ha)	Temporal change	Grain (000'ha)	Temporal change	Vegetables (000'ha)	Temporal change	Fruits (000'ha)	Feed crops (000'ha)	Temporal change	Total cropped Area(000'ha)	Temporal change
1990	623	N.A	176	N.A	78	N.A	21	338	N.A	1,239	N.A
1995	563	-9.63	561	218	53	-32.05	22	220	-34.91	1,408	-7.5
2000	619	9.94	797	42	34	-35.85	24	63	-71.36	1,500	-1.26
2005	645	4.20	981	23.08	39	14.70	28	321	409.52	2,002	22.68
2010	476	-26.20	942	-3.98	45	15.38	34	27	91.59	1597	-26.04

Source: FAO Production Year Book (2010) and Statistical Digest and Asian Pacific by UN (2008) and State institute of Govt. Statistics and information of Turkmenistan 2006.

Table 2.3 depicts that during the Soviet era, and Turkmenistan was a cotton monoculture, ranking second (after Uzbekistan) in cotton production among the six cotton republics of the former USSR. Cotton accounted for more than 50 percent of the sown area all through the 1980s. Another 30 percent was under feed crops, which not only fed the animals, but also played a very important role in crop rotation keeping the soil healthy for cotton. Grain (mainly wheat) was grown on a mere 15 percent of the cropped area. This cropping pattern remained largely static during the last centrally planned decade of the 1980s. The situation began to change rapidly after 1990, when the concerned government decided to emphasize wheat production in the interest of food self-sufficiency. The area under cereals (mainly wheat) was increased from 15 percent in 1990 to 50 percent in 1998 and it continued to grow to 55 percent in 2002 and then with some fluctuations to 60 percent of total sown area in 2010. The increase in the share of grain areas between 1990 and 2002 came at the expense of some reduction in cotton cropping (which dropped further from 51 percent in 1990 to less than 40 percent after 2002), but mainly due to a sharp contraction of areas under feed crops, which dropped dramatically from 27 percent in 1990 to a mere 3 percent in 2002 and presently stands at less than 1 percent after what looks like a series of statistical correction attempts.

Presently, Crop production is diversified between two main crops—grain is the new leader with 58 percent of cropped area and cotton trails second with slightly less than 30 percent. This change in product mix was primarily achieved by virtually total elimination of feed crops from Turkmenistan's cropping pattern, but it was also supported in part by the steady expansion of irrigated area over time. Due to the expansion of irrigation, the actual area under

cotton declined only temporarily in 1990-1997, these days it is back to the level of 1990 (600,000 hectares, compared to 500,000 hectares in 1980). The declining share of cotton in cropped area is not the result of a physical decrease in cotton cropping, it is a reflection of the much faster growth of areas cropped to grain, which increased from 130,000 hectares in 1980 to 190,000 hectares in 1990 and then skyrocketed to 1 million hectares in 2005-2006—a five-fold increase in 15 years, followed by a small contraction in 2007-2010.**(fig. 2.3)** Climatic change and droughts had taken place in 2008 which led to the decline in the irrigated lands of Turkmenistan during the period 2007- 2010. The table further depicts that since independence of the republic, the government has shown some seriousness regarding food self-sufficiency by way of sprawling food crops at the cost of non-food crops. Also, the increasing cereal production through intensive as well as extensive methods. Here it is pertinent to note that self-sufficiency in food is the basic indicator of food security in the country. (**fig 2.4**)

It has been observed that one peculiar feature of cropping pattern of Turkmenistan is predominance of food crops over non-food crops except cotton. This indicates that food crops in the republic of Turkmenistan have occupied the largest proportion of total cropped area in all the provinces of Turkmenistan. There has been recorded lot of change in the cropping pattern and the republic of Turkmenistan has devoted more and more area under food crops particularly wheat at the expense of cotton and feed crops in order to achieve self-sufficiency in terms of cereals. **(table 2.4)**

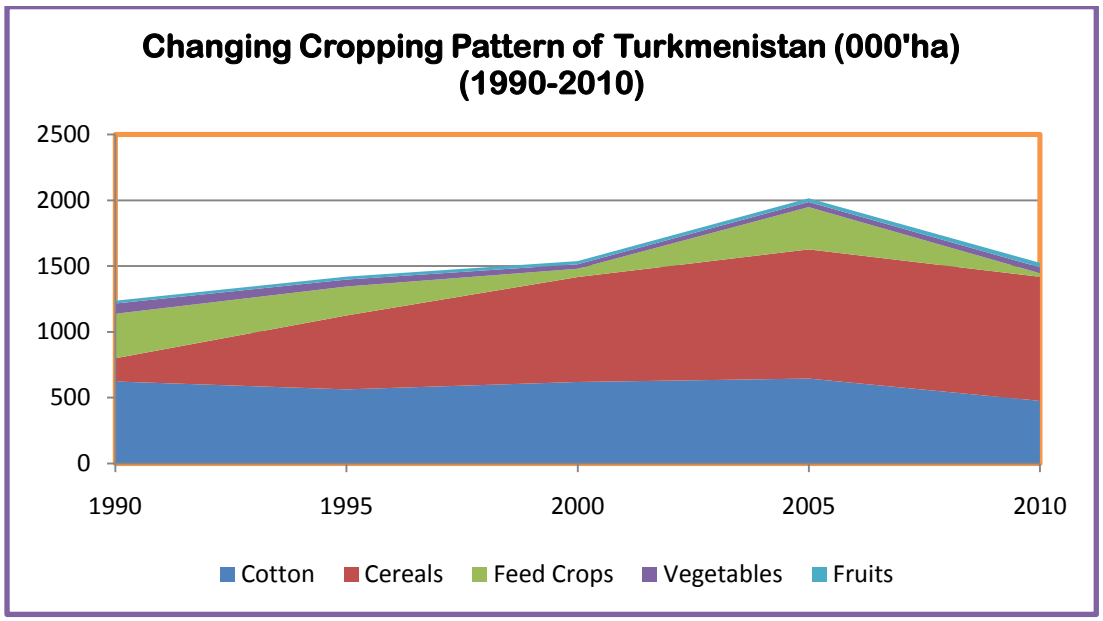

Changing Cropping Pattern of Turkmenistan (000'ha)
(1990-2010)
2500
2000
1500
1000
500
0
1990
1995
2000
2005
2010
Cotton
Cereals
Feed Crops
Vegetables
Fruits

Fig. 2.3

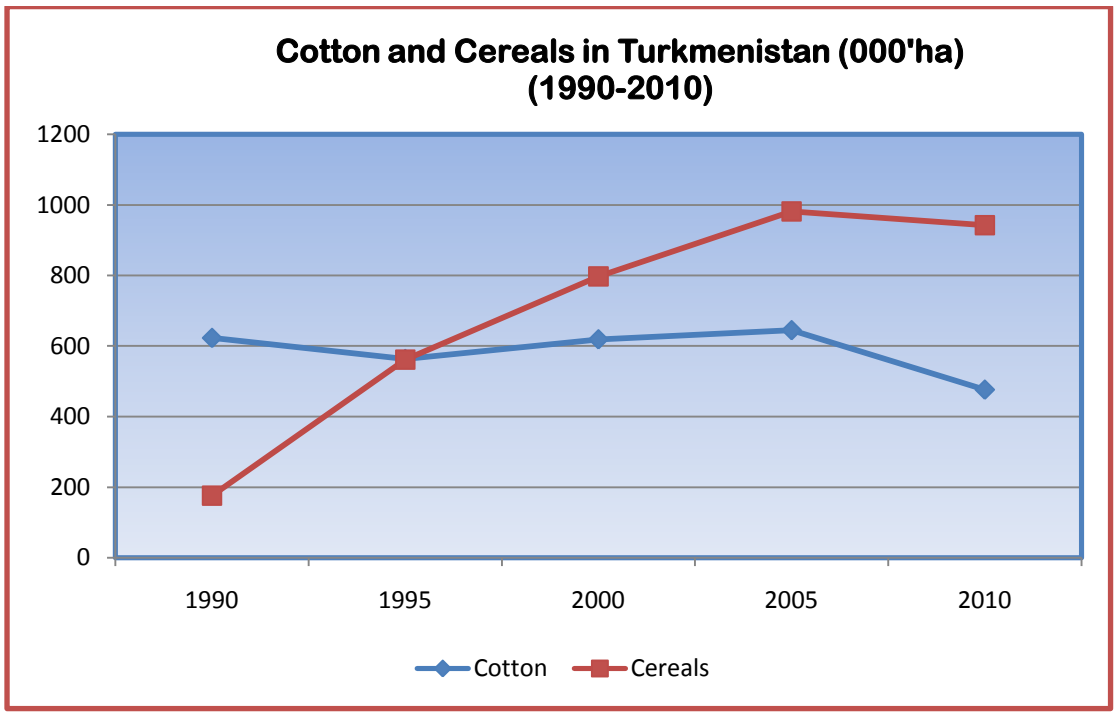

Cotton and Cereals in Turkmenistan (000'ha)
(1990-2010)
1200
1000
800
600
400
200
0
1990
1995
2000
2005
2010
Cotton
Cereals

Fig. 2.4

Table 2.4
Spatial (Province-wise) Pattern in Turkmenistan (000'ha)
(2010)

Provinces	Wheat	(%)	Cotton	(%)	Rice	(%)	Barley	(%)	Maize	(%)	Vegetables	(%)	Fruits	(%)	Total
AHAL	219	56.1	120	30.7	20	5.1	18	4.6	3	0.7	10	2.5	10	2.5	400
BALKAN	45	60.0	10	13.3	10	13.3	2	2.6	3	4.0	5	6.6	2.5	3.2	77.5
DASHOGUZ	139	48.7	115	40.3	11	3.8	8	2.8	4	1.4	8	2.8	5	1.7	290
LEBAP	158	55.2	81	28.3	20	6.9	15	5.2	2	0.6	10	3.5	8.5	2.9	294.5
MARY	220	52.7	140	33.5	24	5.7	18	4.3	3	0.7	12	2.9	8	1.9	425
Total	**781**		**476**		**85**		**61**		**15**		**45**		**34**		**1453**

Source: FAO Production Year Book (2010) and Statistical Digest and Asian Pacific by UN (2008) and State institute of Govt. Statistics and information of Turkmenistan 2006.

The above table reveals that the province of Mary has occupied the highest proportion of cultivated land (27%) of the total cropped land owing to good irrigational facilities from karakum canal and number of oases are located in the province of Mary. The province of Ahal which accounts about (26%) of the total cropped area is the second dominant province of Turkmenistan in terms of acreage of land. The reason for the high proportion in this province is that this province is located on the banks of Karakum Canal and also gets water from the other small rivers such as Tedjen River, Atrek and River Murgab. The other two provinces such as Dasghuz and Lebap also have good acreage of land under cultivation as they receive water from Amu Darya for irrigational Purposes. Balkan has the smallest proportion of land under cultivation due to the non irrigational facilities. However, the work is going on for the extension of Karakum canal to the province of Balkan. However, the new agricultural technology needs to be introduced for bringing about the changes in the traditional cropping pattern in order to increase the cultivable land. Owing to pressure of population, land use planning has to be done and implemented on a scientific basis. Also, the system of farming suitable for the land has to be given due weightage.

Food and Non-food Crops

Both food as well as non-food crops are grown in the region but the cropping pattern is dominated by food crops especially wheat (52%). While, the area under non-food crops, Turkmenistan is dominated by cotton (95%). **(table 2.5, 2.6)**

Table 2.5
Area under Food Crops 000'ha
(2010)

Crop	Area (000'ha)	Percentage share
Wheat	781	76.49
Rice	85	8.32
Barley	61	5.97
Maize	15	1.50
Vegetables	45	4.40
Fruits	34	3.34
Total	1021	100.00

Source: Natsional'nyi institut statistiki i infomatsii Turkmenistana.

It is evident from the table 2.5 that the republic is dominated by the cultivation of wheat which occupies the largest acreage of food crops (76%). Following independence, the area under cereals have increased at the cost of cotton and feed crops, but wheat is given particular importance as it is staple for the people of Turkmenistan. Cultivation of wheat is followed by the rice cultivation which accounts about 8 percent of the total food crops acreage. Other crops have shown nominal change.**(fig. 2.5)**

Table 2.6
Area under non-food Crops 000'ha
(2010)

Crop	Area (000'ha)	Percentage share
Cotton	476	94.63
Fodder	27	5.37
Total	503	100

Source: Natsional'nyi institut statistiki i infomatsii Turkmenistana.

It is evident from the table that non-food crops are dominated by cotton cultivation in the republic which occupies an area of 476

thousand hectares (95%), fodder is next non-food crop cultivated in the region. **(fig. 2.6)**

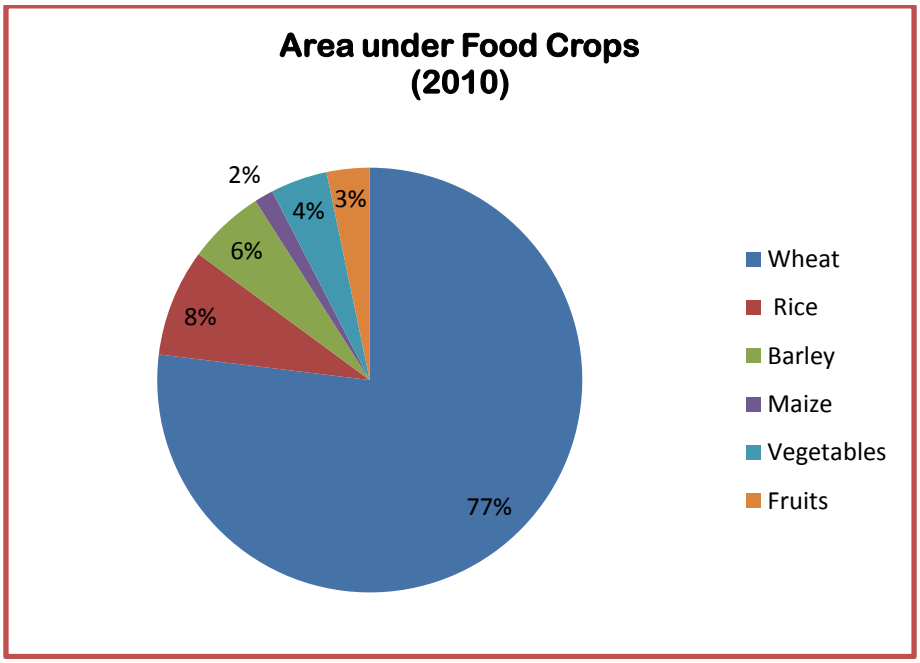


Fig. 2.5

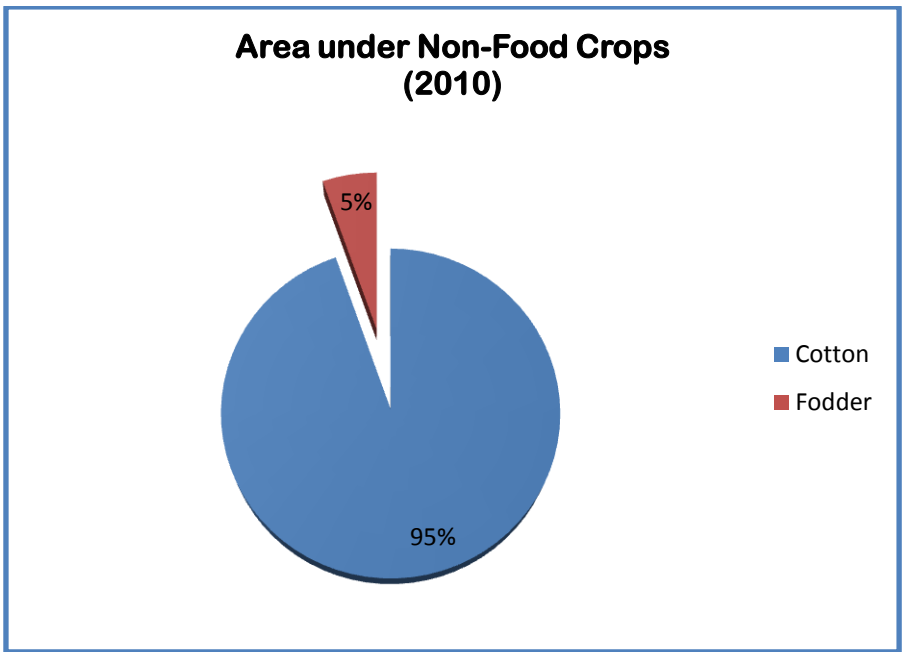


Fig. 2.6

In view of the institutional factors that majority of farmers in Turkmenistan are leaseholders called *arendator* who are assigned land on an annual contract basis in order to grow prescribed crops. There are a small number of private land owners known as *mukldar. Mulkdars* are farmers who have shown consistent high farm performance and have been awarded lifetime ownership of a small plot of land and in some cases have been given a tractor or other farm machinery. Prior to the adoption of the new Constitution in 1992, all land in Turkmenistan was owned by the state. **(table 2.7)**

Table 2.7
Structure of Total Land Use in Turkmenistan (%)
(1995-2010)

	1995	2000	2005	2010
Total land in use, '000 ha	49,403	49,121	49,121	49,121
Percent	100.0	100.0	100.0	100.0
Agricultural producers	69.8	70.2	68.9	68.1
Associations	68.6	69.0	67.2	66.8
Other producers	1.0	0.9	1.6	1.2
Daikhan farms	0.2	0.2	0.1	0.1
State reserve	19.7	20.0	20.5	21.0
Non-agricultural users	10.5	9.8	10.6	10.9

Source: Natsional'nyi institut statistiki i infomatsii Turkmenistana.

It is evident from the table that 70 percent of agricultural land is occupied by the Peasant associations while as *daikhan* or private farms occupy a nominal of irrigated land (0.1%). Land allocated to daikhan farms "for commercial farming" rose meteorically from zero in 1992 to 100,000 hectares in 1995 and peaked at 116,100 hectares in 1998, the year when the private sector (*daikhan* farms and household plots combined) reached nearly 10 percent of all

cultivable land in Turkmenistan. Since 1998, however, the *daikhan* farms have lost 80 percent of their holdings as the authorities began to enforce the legal provisions that made land grants conditional on satisfactory farming performance. As a result, the share of the private sector including household farms has declined to (7%) of its cultivable land in 2010.

Crop Combination Regions

The study of crop combination regions constitutes an important aspect of agricultural geography as it provides a good basis for agricultural regionalization. The crops are generally grown in combinations and it is rarely that a particular crop occupies a position of total isolation other crops in a given areal unit at a given point of time. The distribution maps of individual crops are interesting and useful for planners, but it is more important to view the integrated assemblage of various crops grown in an areal unit. For a comprehensive and clear understanding of the agricultural mosaic of an agro-climatic region and for the planning and development of its agriculture, a systematic study of crop combinations is of great significance. In recent years the concept of crop combination has engaged the attention of geographers and agricultural land use planners

Intensity of crops in different component areal units may be understood by the simple method of ranking of crops but variable position of the individual crops within the different cropping situation is best revealed by crop combination analysis. In order to understand the cropping pattern, crop concentration and agricultural operations in a given region, a study of crop combination is imperative. The objective approach in crop combinational studies stemmed with Weaver, who applied the

minimum deviation in his study of crop combination regions in the Middle West, USA. His study acted as a stimulus to the fellow geographers all over the world. Subsequent researchers have introduced a number to similar quantitative techniques for the delineation of crop combination regions. Though modified and improved by a number of scholars like Thoms in 1963, Rafiullah in 1965 and Doi in 1959.[10]

Weaver's method has got a prominence over the rest of the techniques, because it had been extensively applied and seems to be popular among agricultural geographers. An attempt in the present study has been made to delineate crop combination region in the republic of Turkmenistan based on the technique put forward by Weaver.

Correspond most closely with the actual percentage recorded; the technique of standard deviation (δ) is applied to the actual data, thus

$$\delta = \frac{\int \sum (d^2)}{n}$$

Where δ= Standard Deviation

d= difference between the recorded crop percentage and appropriate percentage in the theoretical standard.

n= number of crops in the combination

In fact, since the relative rather than actual values are significant, the sq. root is not extracted in the practice, the actual formula employed as;

$$\delta^2 = \frac{\int \sum d^2}{n}$$

The minimum value of δ^2 defines the critical combination

From the table 2.4 crop combination of different provinces of the republic of Turkmenistan has calculated as under:

Ahal Province

If it is one crop region, then

$$\frac{(100-56.15)^2}{1} = 1992$$

If it is two crop region, then

$$\frac{(50-56.15)^2+ (50-30.76)^2}{2} = 204.5$$

If it is three crop region, then

$$\frac{(33.3-56.15)^2+ (33.3-30.76)^2 +(33.3-5.12)^2}{3} = 440$$

From the above computation, it is clear that the minimum deviation from the normal curve is in the two-crop region and therefore the area is a two crop region (Wheat and Cotton).

Balkan Province

If it is one crop region, then

$$\frac{(100-60)^2}{1} = 1600$$

If it is two crop region, then

$$\frac{(50-60)^2+ (50-13.33)^2}{2} = 722$$

If it is three crop region, then

$$\frac{(33.3-60)^2+ (33.3-13.33)^2 + (33.3-13.33)^2}{} = 504$$

3

If it is four crop region, then

$$\frac{(25-60)^2+ (25-13.33)^2 +(25-13.33)^2+ (25-6.66)^2}{4} = 458$$

If it is five crop region, then

$$\frac{(20-60)^2+(20-13.33)^2+(20-13.33)^2+(20-6.66)^2 +(20-4)^2}{5} = 424$$

If it is six crop region, then

$$\frac{(16.6-60)^2+ (16.6-13.33)^2 + (16.6-13.33)^2+ (16.6-6.66)^2 + (16.6-4)^2 + (16.6-2.66)^2}{6} = 336$$

From the above computation, it is clear that the minimum deviation from the normal curve is in the two-crop region and therefore the area is dominated by all the crops grown in this region (Wheat, Rice, Cotton, Maize, Vegetables and Barley).

Dashoguz Province

If it is one crop region, then

$$\frac{(100-48.77)^2}{1} = 2624$$

If it is two crop region, then

$$\frac{(50-48.77)^2+ (50-40.35)^2}{2} = 47.3$$

If it is three crop region, then

$$\frac{(33.3-48.77)^2+ (33.3-40.35)^2 + (33.3-3.86)^2}{3} = 385$$

From the above computation, it is clear that the minimum deviation from the normal curve is in the two-crop region and therefore the area is a two crop region (Wheat and Cotton).

Lebap Province

If it is one crop region, then

$$\frac{(100-55.24)^2}{1} = 2003$$

If it is two crop region, then

$$\frac{(50-55.24)^2+ (50-28.32)^2}{2} = 248$$

If it is three crop region, then

$$\frac{(33.3-55.24)^2+ (33.3-28.32)^2 + (33.3-6.99)^2}{3} = 399$$

From the above computation, it is clear that the minimum deviation from the normal curve is in the two-crop region and therefore the area is a two crop region (Wheat and Cotton).

Mary Province

If it is one crop region, then

$$\frac{(100-52.75)^2}{1} = 2232$$

If it is two crop region, then

$$\frac{(50-52.75)^2+ (50-33.57)^2}{2} = 138.75$$

If it is three crop region, then

$$\frac{(33.3-52.75)^2+ (33.3-33.57)^2 + (33.3-5.75)^2}{3} = 379$$

From the above computation, it is clear that the minimum deviation from the normal curve is two-

crop region and therefore the area is dominated by two crops (Cotton and Wheat), rest of the crops is neglected. Hence, it is important that the region of Turkmenistan must cultivate other crops. **(fig. 2.7)**

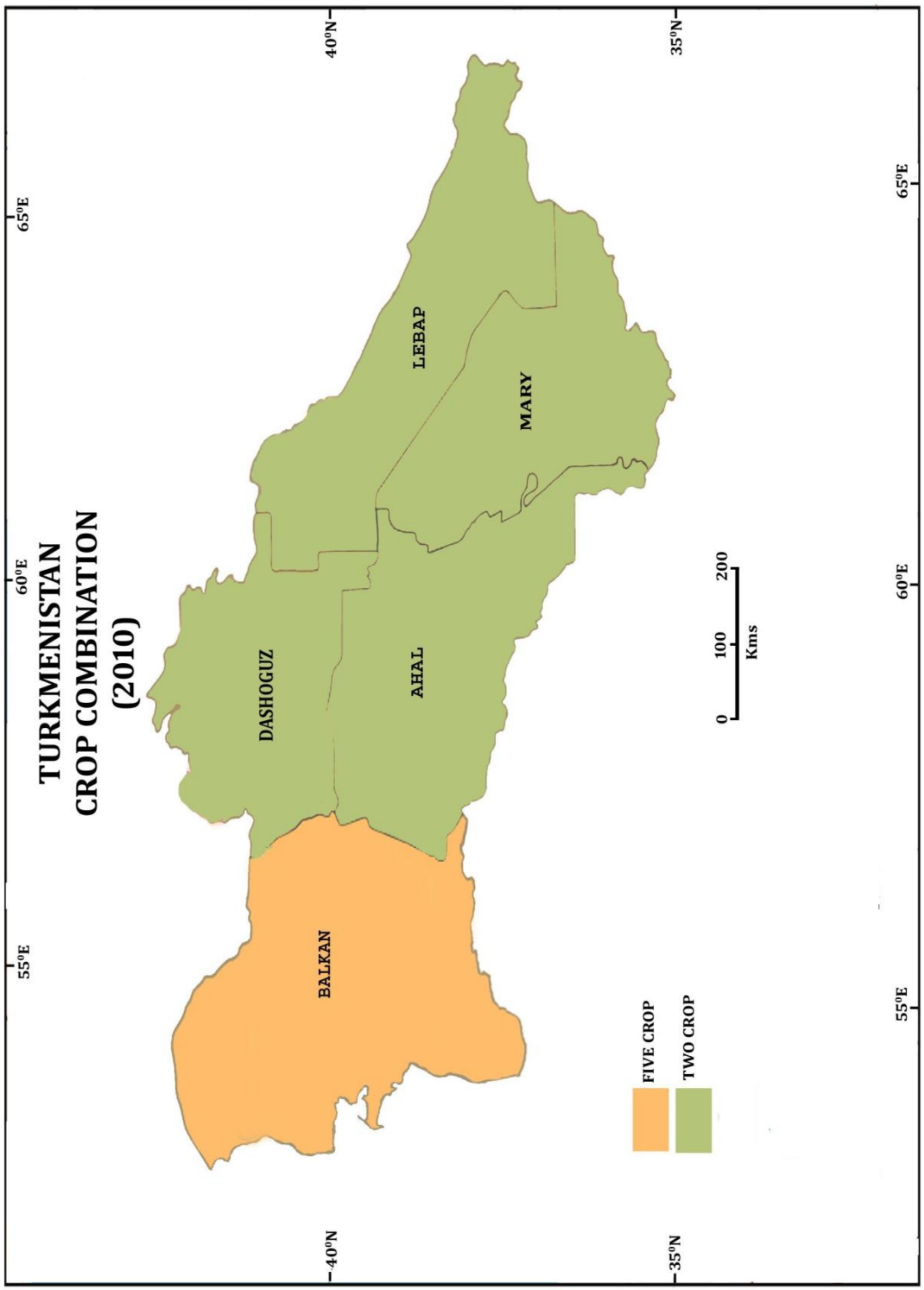


Fig. 2.7

Crop Diversification

Crop diversification is a concept which is opposite to crop specialization. The farmers all over the world, especially in the developing countries, try to grow several crops in their holding in an agricultural year. The level of crop diversification largely depends on the geo-climatic/social-economic conditions and technological development in a region. In general, higher the level of agricultural technology, lesser the degree of diversification. Moreover, the rich farmers prefer to specialize in agricultural enterprise while the poor and subsistent farmers are generally more interested in the diversification of crops.

Looking at the importance of crop diversification many geographers have developed techniques for the measurement of crop diversification and crop specialization. In general, it is assumed that if the number of crops grown in a component areal unit is larger (say about 10), each crop occupying about 10 percent of the cropped area, it would mean that the crop diversification is of a very high degree. Contrary to this, if a crop occupies 100 percent of the gross cropped area, the diversification is least and it will be a case of high degree of crop specialization.[10]

For the measurement of crop diversification, Bhatia (1965) developed a formula and it is expressed as:

Index of crop Diversification=

Percent of sown area under x crops

Number of x crops

It has been calculated from the table 2.4 that all the provinces of Turkmenistan are having high degree of diversification. The main advantage of the crop diversification is that it provides a relationship between the relative areal strength of the crops grown in the region. It is also important as it helps in the future planning and development of agriculture. All the regions in the republic of Turkmenistan having high degree of diversification and deserve special attention of planners for development of agriculture. A comprehensive plan for each of the regions of high diversification may go a long way in enhancing their agricultural productivity and in reducing the regional inequalities in agricultural development. There is increasing awareness among the experts of agriculture that crop diversification with suitable crop rotations is necessary for the maintenance of soil health and for making agriculture more productive and sustainable. **(fig.2.8)**

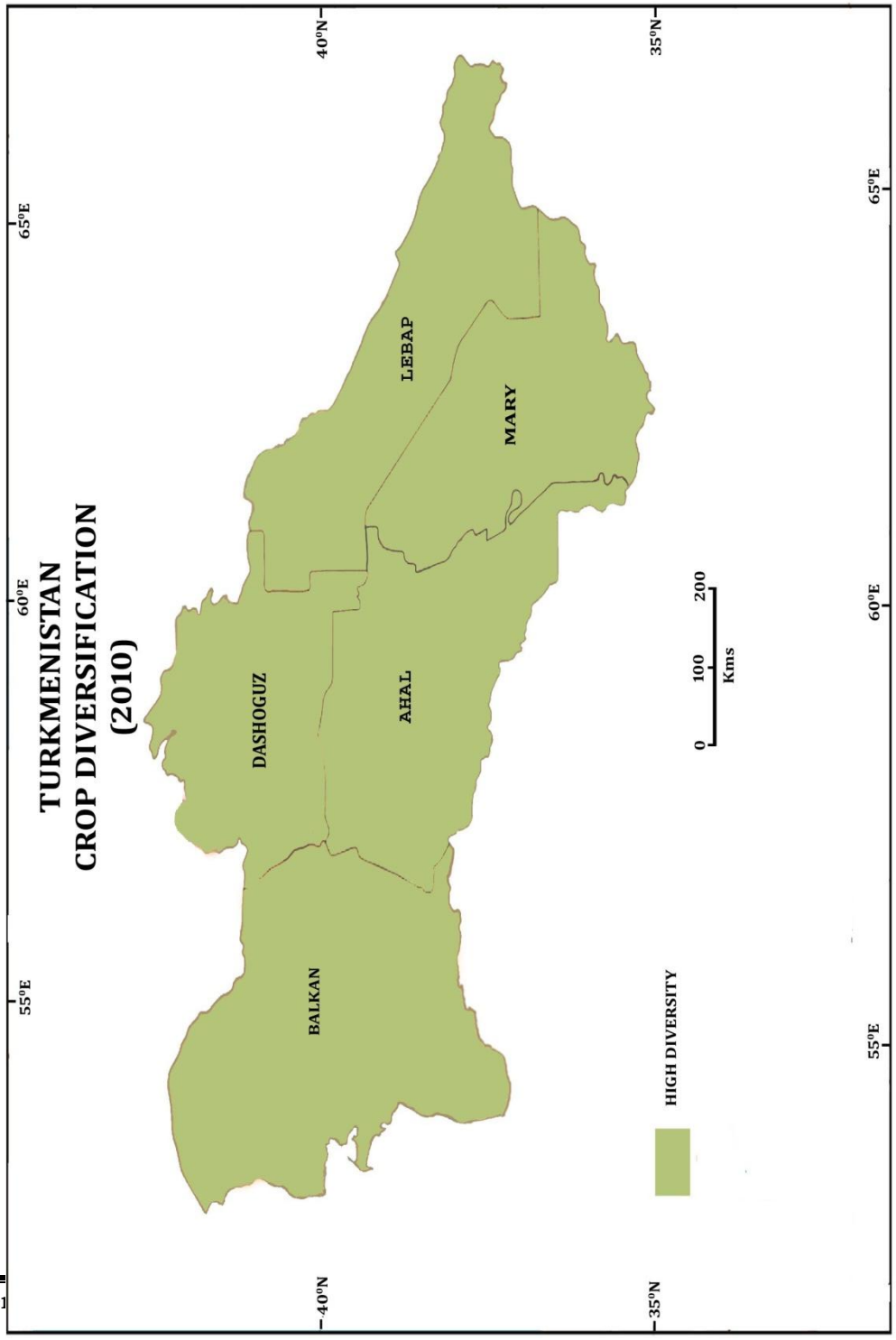

TURKMENISTAN
CROP DIVERSIFICATION
(2010)
LEBAP
MARY
DASHOGUZ
AHAL
BALKAN
HIGH DIVERSITY
0 100 200
Kms
40°N
35°N
55°E
60°E
65°E

Fig. 2.8

Crop Concentration

Crop concentration means the variations in the density of any crop in an area or region at a given point of time. The concentration of a crop in an area largely depends on its terrain, temperature, moisture and ecological conditions. Each crop has a maximum, minimum and optimum temperature. It has a tendency to have concentration in the areas of ideal agro-climatic conditions and the density declines as the geographical conditions become less conducive. It is because of the suitability of agro-climatic conditions that has high concentration in the black region. Delineation of crop concentration region helps in ascertaining the areas where a particular grows well even with the help of minimum inputs, and thus has great significance for agricultural development and planning.[11]

A number of statistical techniques have been evolved and applied for the demarcation of crop concentration regions. The percentage share of a crop in the total cropped area and the determination of relative density with the help of location quotient are some of the techniques that are frequently used for the demarcation of crop concentration regions.

The location quotient method may be expressed as under:

Index for the determination of crop concentration=

Area of x crop in the component area unit / **Area of x crop in the entire region/country**

$$\frac{\text{Area of all crops in the component area unit}}{\text{Area of x crop in the entire region/country}}$$

By applying the above technique, if the index value is greater than unity, the component areal unit accounts for a share greater than it would have had if the distribution were uniform in the entire region,

and therefore, the areal unit has a concentration of a great agricultural significance. After ascertaining the index values for the crops in the component areal units, they arranged in an ascending or descending order. The index scale is calculated dividing the array into equal parts to distinguish the very high, high, medium and very low concentrations. In general, higher the crop concentration index, higher is the value of interest in the production of that crop.

The main advantage of the location quotient technique for the delineation of crop concentration lies in the fact that it enables the geographers and planners to understand the areas of specialization of different crops grown in a region at a given point of time. The continuous cultivation of a particular crop in a unit or region, however, leads to progressive reduction in yield. This depletion of soil happens because the crop exhausts certain nutrients from the soil. Consequently, the natural fertility of the soil steadily declines. Rotation of crop with diverse choice, permissible under the given environmental conditions, therefore, needs to adopt to maintain the fertility of the soil. A scientific rotation of the crop not only needs agriculture a more remunerative occupation, but it also makes the agro-ecosystem more resilient and sustainable.

Crop Concentration in Turkmenistan (Province-wise)

$$\frac{\text{Area of x crop in the component area unit}}{\text{Area of all crops in the component area unit}} \times \frac{\text{Area of x crop in the entire region/country}}{\text{Area of x crop in the entire region/country}}$$

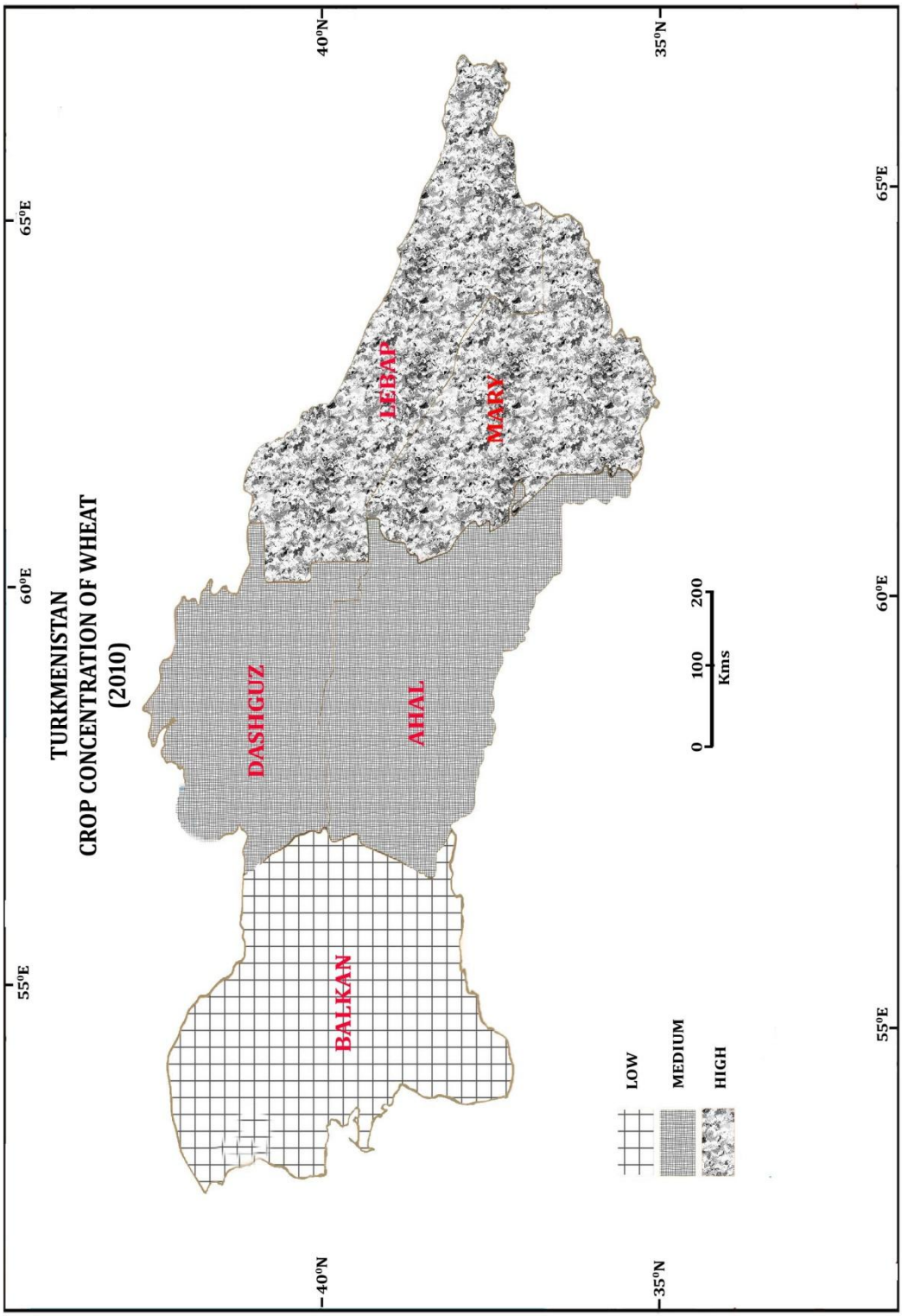

TURKMENISTAN
CROP CONCENTRATION OF WHEAT
(2010)
DASHGUZ
LEBAP
MARY
AHAL
BALKAN
LOW
MEDIUM
HIGH
0
100
200
Kms
40°N
35°N
55°E
60°E
65°E

Fig. 2.9

Table 2.8
Crop Concentration in Turkmenistan

WHEAT			
S. No	Value	Category	Name of the Region
1	>1.70	High	Ahal and Dasghuz
2	Between 1.65-1.70	Medium	Lebap and Mary
3	<1.65	Low	Balkan
		BARLEY	
1	>2.0	High	Lebap
2	Between 2.0-1.77	Medium	Ahal and Mary
3	<1.77	Low	Balkan and Dasghuz
		RICE	
1	>3.0	High	Balkan
2	Between 3.0-1.70	Medium	Lebap and Mary
3	<1.70	Low	Ahal and Dasghuz
		MAIZE	
1	>5.0	High	Balkan
2	Between 5.0-4.5	Medium	Dasghuz
3	<2.0	Low	Ahal, Lebap and Mary

As it is evident from table 2.8 that the provinces of Lebap and Mary ranks first in terms of crop concentration of wheat, these two provinces avail good irrigation facilities and their land is favourable for the cultivation of wheat. Therefore, most of the irrigated land has been devoted for the cultivation of Wheat. While as the regions of Ahal and Dashoguz fall medium category with regard to crop concentration of wheat other commercial crops such as cotton etc.

are grown in these regions. Balkan ranks third due to the fact that very meager percentage of irrigated land falls in this province following lack of irrigation facilities.

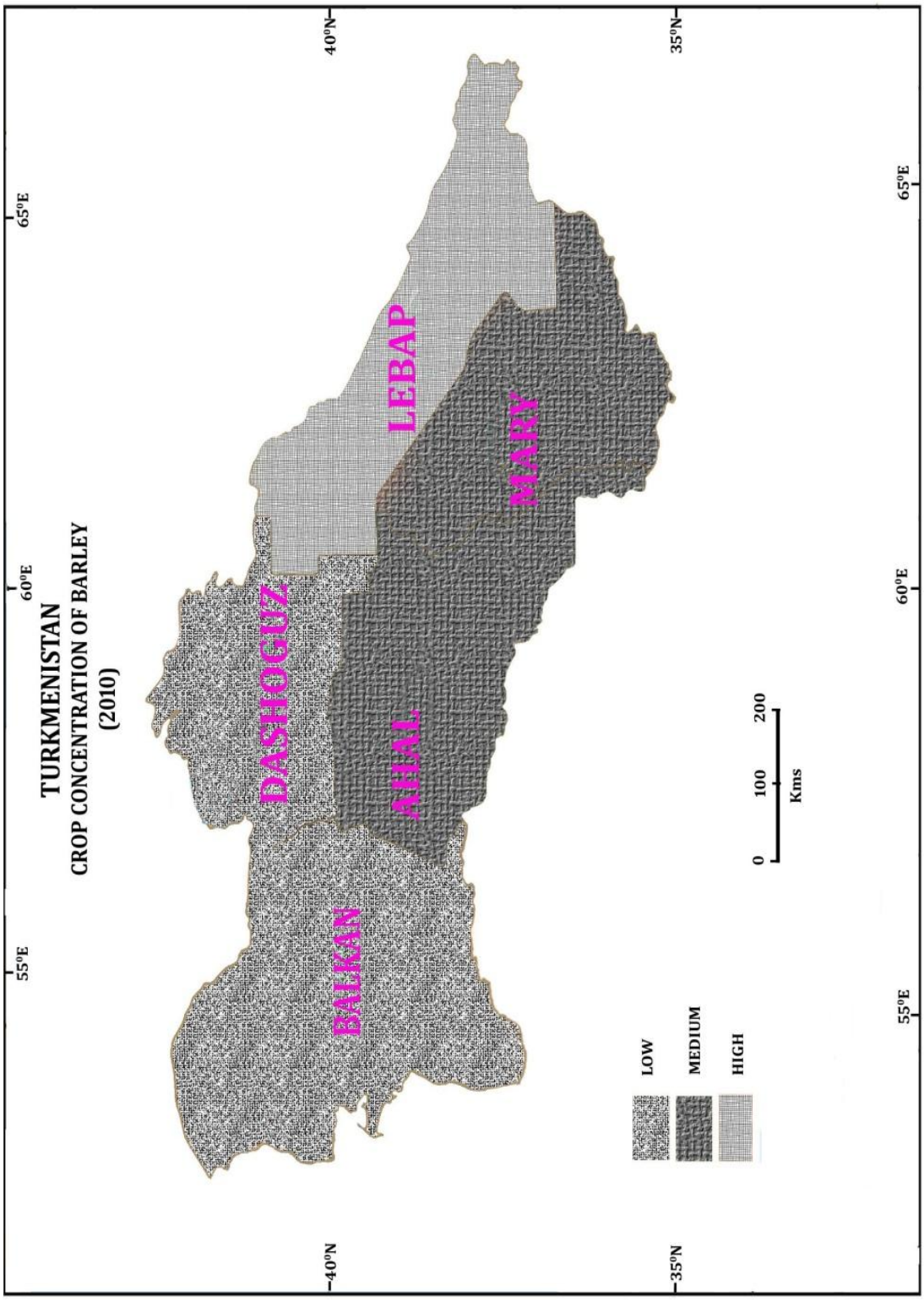


Fig. 2.10

Although, a small percentage of irrigated land has been devoted for the cultivation of Barley but the province of Lebap has the highest crop concentration of Barley in the republic and it is followed by the provinces of Ahal and Mary which show medium crop concentration of Barley while as low crop concentration of Barley is found in the regions of Balkan and Dashoguz.

The cultivation of rice needs heavy doses of water and this crop ranks second in terms of cereal crop production and it is most predominant in the provinces of Ahal and Dashoguz and they are followed by the regions of Lebap and Mary. The lowest concentration of Rice is observed in the province of Balkan which is located to the west of Turkmenistan. All the provinces of Turkmenistan have comparatively better irrigation facilities than the province of Balkan, that is why Balkan region has the lowest crop concentration of Rice.

Maize crop is normally rainfed crop and is grown in those areas which have low level of irrigation facilities as already discussed that the region of Balkan has lack of irrigation facilities though Karakum canal is being extended to this region for irrigational purposes. As a result this region has the highest crop concentration of Maize and it is followed by the Dashoguz region. Lebap, Mary and Ahal have the lowest crop concentration of Maize as these regions have irrigation facilities so they have devoted most of their land to cotton, wheat and rice crops.

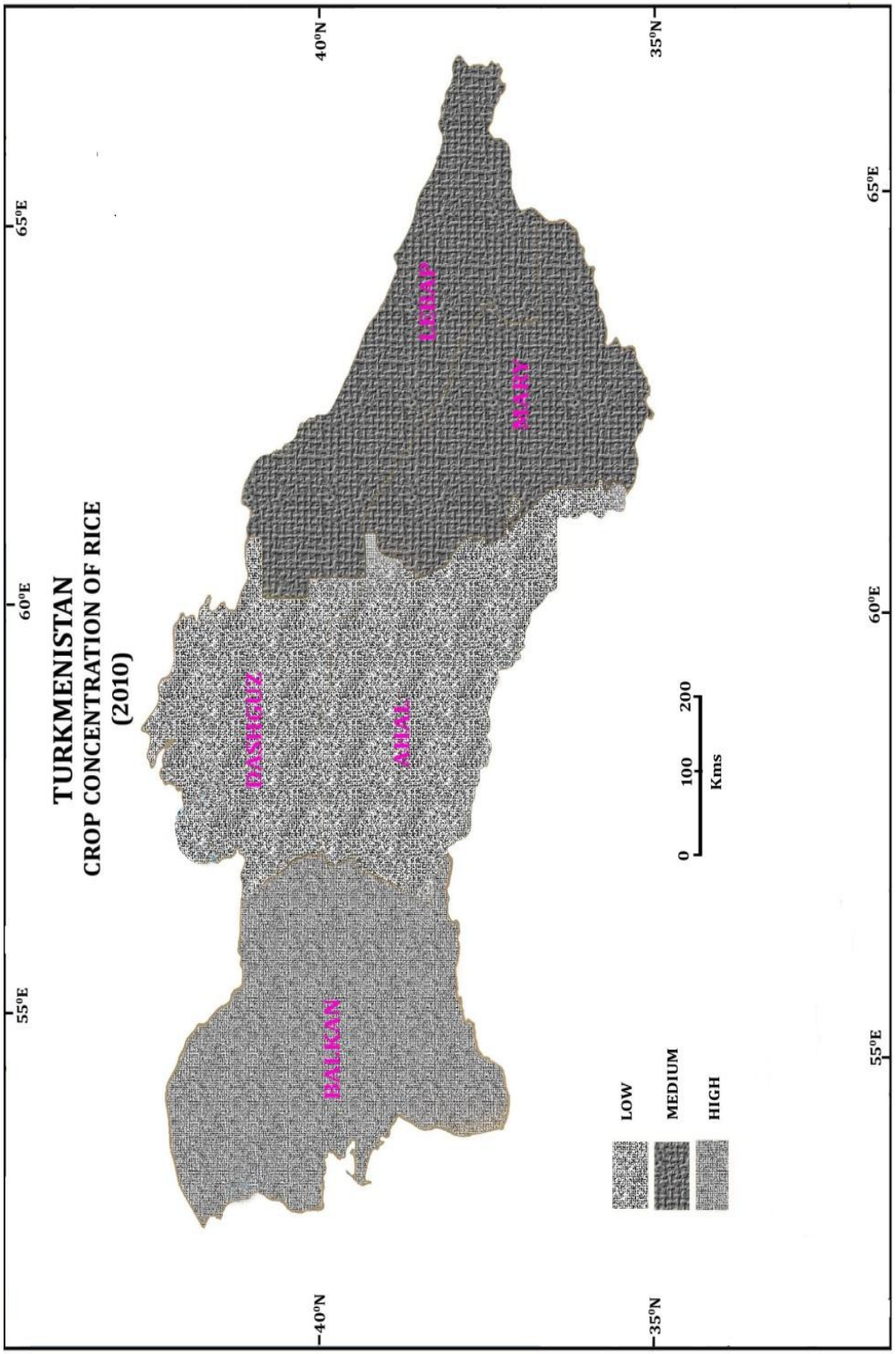

TURKMENISTAN
CROP CONCENTRATION OF RICE
(2010)
LEBAP
MARY
DASHGUZ
AHAL
BALKAN
LOW
MEDIUM
HIGH
0
100
200
Kms
40°N
35°N
65°E
60°E
55°E

Fig. 2.11

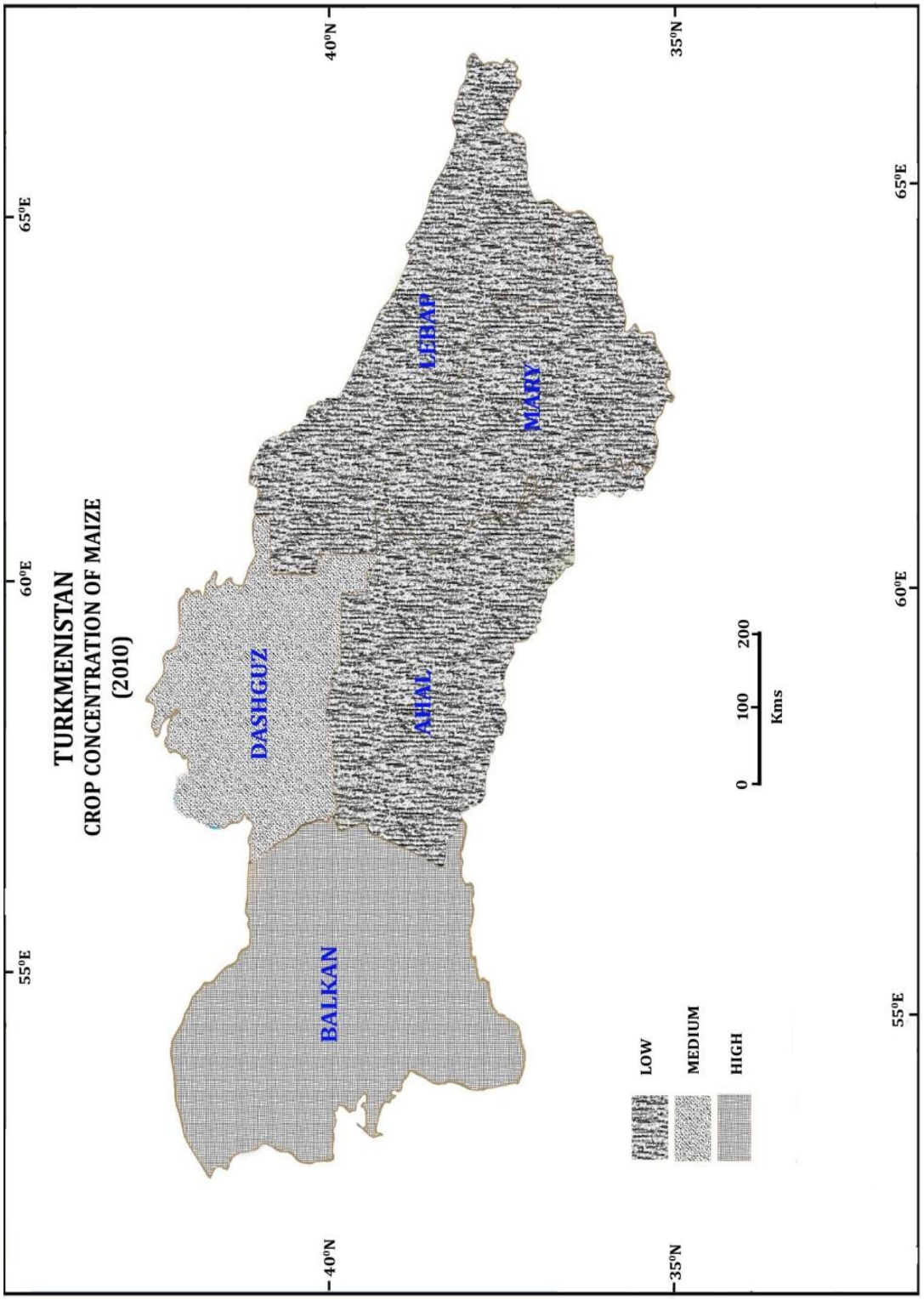

TURKMENISTAN
CROP CONCENTRATION OF MAIZE
(2010)
DASHGUZ
LEBAP
MARY
AHAL
BALKAN
LOW
MEDIUM
HIGH
0
100
200
Kms
40°N
35°N
55°E
60°E
65°E

Fig. 2.12

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Chapter-3

Production and Productivity of Food Crops

- Production and Yield of Cereals
- Production and Yield of Vegetables
- Production and Yield of Fruits
- Cereal Productivity
- Measurement of Productivity
- Importance of Agricultural Productivity
- Productivity Regions
- Spatial Variations in Cereal Crop Productivity
- Vegetable Productivity
- Fruit Productivity

Chapter - 3

Production and Productivity of Food Crops

The Soviet demise which has resulted in the independence of Turkmenistan has snatched some of the basic benefits and subsidies resulting, thereby, deteriorating their living standards. The unsustainable attempts of development leading to high inflation, lower purchasing power and other associated features have led to the poverty, malnutrition, increasing rate of infant mortality and other related issues. In the absence of subsidy on agricultural inputs and the harsh political attitude towards farmers, particularly, on the institutional side, has effected the regional economy especially the farm sector. The agricultural production as well as its yield level particularly of food crops has recorded a receding trend almost throughout since the independence of the country with some minor exceptions. The major components of food crops include cereals particularly wheat, Rice, Maize, Barley and some fruits and dairy products. However, after independence due to the decreasing purchasing power of consumers the trend of consuming dairy products and meat has shown an abrupt downward trend. So in the chapter the major focus will be on principle cereals.

Production and Yield of Cereals

Since independence food crops were given more importance than non-food crops in order to achieve self-sufficiency in terms of food. Consequently, production of cereals increased by 244 percent from 1990-2010. The republic has been able to decrease some percentage of imports by means of devoting more agricultural area to cereals. However, most of the agricultural land is of poor quality

owing to mismanagement of water which has led to soil salinization and waterlogging in the country, has led to the decline of yield level since independence. **(table 3.1)**

Table 3.1
Province-wise Production and Yield of Cereal Crops in Turkmenistan (1990-2010)

Province	Year	Production of cereal crops (000 tons)	Yield of Cereal Crops (tons/ha)	Percentage of growth in	
				Production	Yield
AHAL	1990	112	2.39	N.A	N.A
	1995	300	1.12	167.85	-113
	2000	355	1.62	18.33	44.64
	2005	560	2.03	57.76	25.30
	2010	410	1.57	-26.78	-44.61
BALKAN	1990	20	2.04	N.A	N.A
	1995	28	1.71	40.0	-16.17
	2000	48	1.45	71.42	-15.20
	2005	70	1.87	45.83	28.97
	2010	80	1.33	14.28	-28.87
DASGHUZ	1990	57	1.83	N.A	N.A
	1995	170	1.70	198.24	-7.10
	2000	182	1.29	7.05	-24.11
	2005	239	1.29	31.31	0.00
	2010	208	1.28	-7.94	-0.78
LEBAP	1990	98	2.45	N.A	N.A
	1995	238	1.82	142.85	-25.71
	2000	245	1.36	2.94	-25.27
	2005	351	1.70	43.26	25.00
	2010	271	1.38	-22.79	-18.82
MARY	1990	121	2.49	N.A	N.A
	1995	312	1.90	157.85	-23.70
	2000	405	1.80	29.80	-5.26
	2005	583	2.11	43.95	17.22
	2010	439	1.65	-24.69	-21.80

Source: Compiled and Computed on the basis of data from FAO, IMF, World Bank, Worldfact Book, Index Mundi, and Statistical Year Book of Turkmenistan.

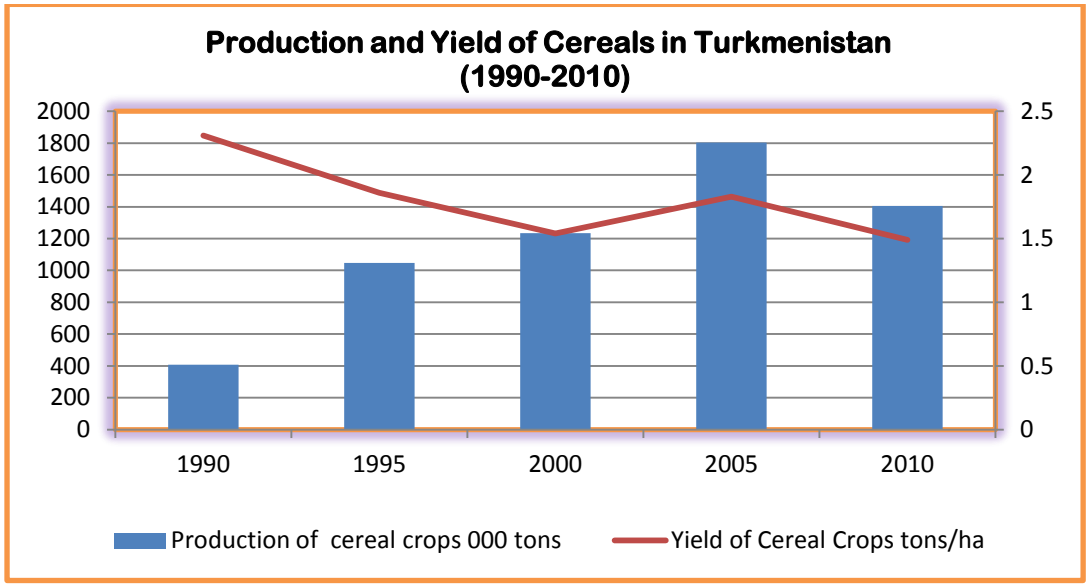
Production and Yield of Cereals in Turkmenistan
(1990-2010)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2.5
2
1.5
1
0.5
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.1

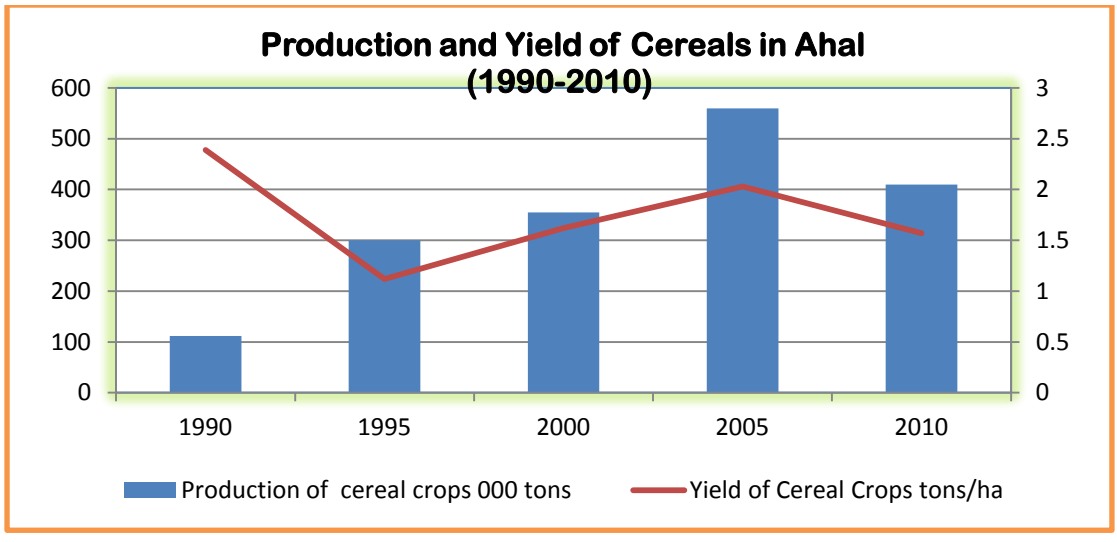
Production and Yield of Cereals in Ahal
(1990-2010)
600
500
400
300
200
100
0
3
2.5
2
1.5
1
0.5
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.2

It is evident from table 3.1 that production of cereals crops in all the provinces of Turkmenistan has shown an increasing trend from 1990-2010 owing to the fact that since independence the country has devoted more and more agricultural land towards grain cultivation with a view to attain food self-sufficiency. The table also indicates that yield of crops since 1990-2010 shown a downward trend with some exceptions in 2005 following favourable climatic conditions. The yield of crops vary because of difference in climate, soil types and inputs like fertilizers, irrigation, quality of seeds and other institutional factors. The province of Mary is leading in terms of both production and yield of cereals with the production of 439 thousand tons and a yield of 1.65 tons per hectare in 2010. The province of Ahal is the second largest producer of cereals and yield in the country. In 2010, the province of Ahal has produced 461 thousand tons of cereals with a yield of 1.57 tons per hectare.

The table further reveals that is huge variation in terms of both production and yield of cereals among provinces. **(fig. 3.1-3.6)** There are some provinces which are having yield more than the national average such as the provinces of Ahal and Mary. About 60 percent of the total cereal crop production is produced in the provinces of Ahal and Mary due to favourable climatic conditions, comparatively better soils and good irrigation facilities. Rest 40 percent of cereals are produced in other three provinces of Turkmenistan. Lowest yield of cereals was recorded in the province of Dashoguz following highly saline soils, waterlogging and soil diseases.

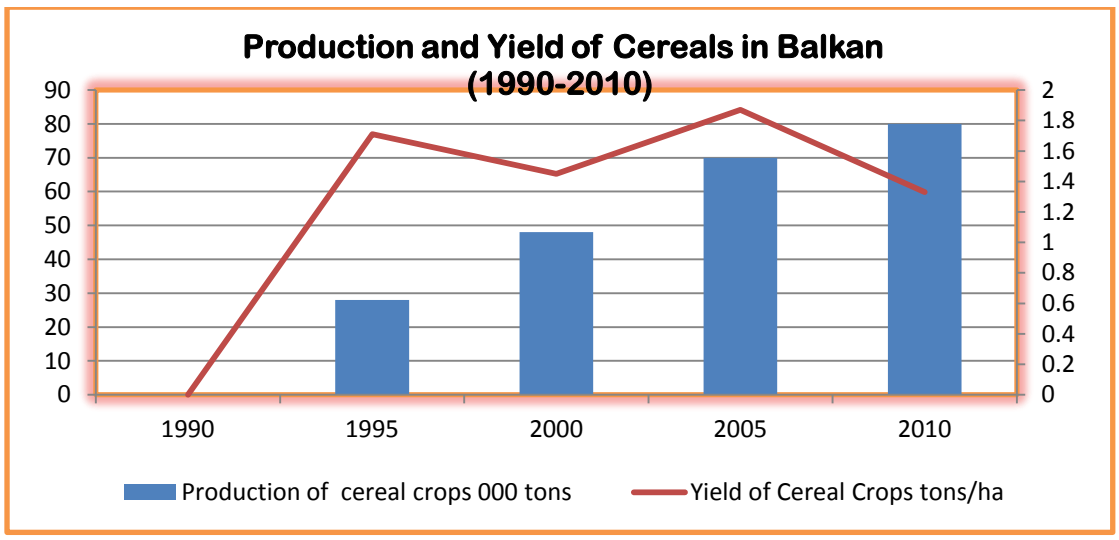
Production and Yield of Cereals in Balkan
(1990-2010)
90
80
70
60
50
40
30
20
10
0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.3

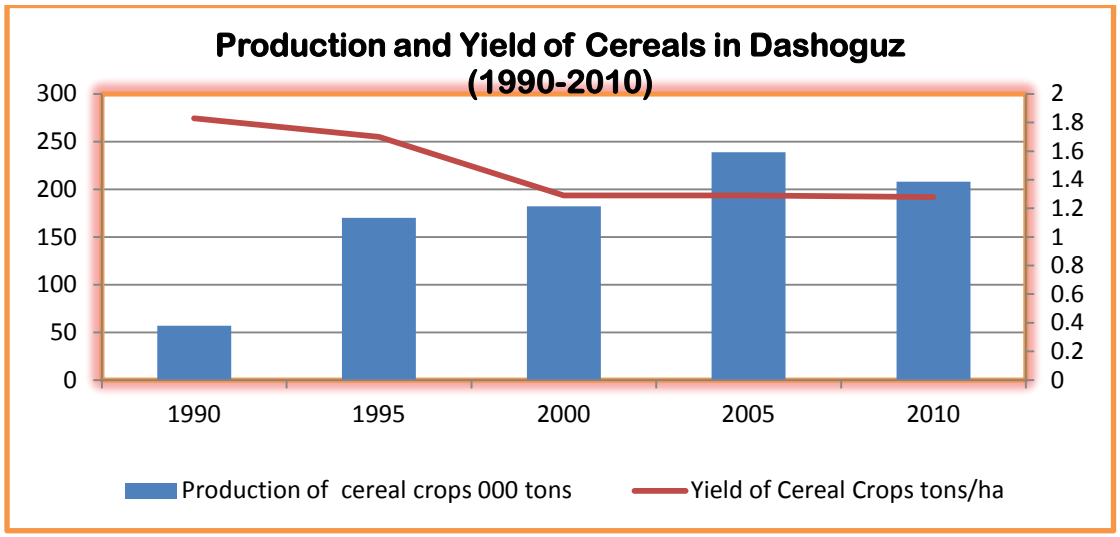
Production and Yield of Cereals in Dashoguz
(1990-2010)
300
250
200
150
100
50
0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.4

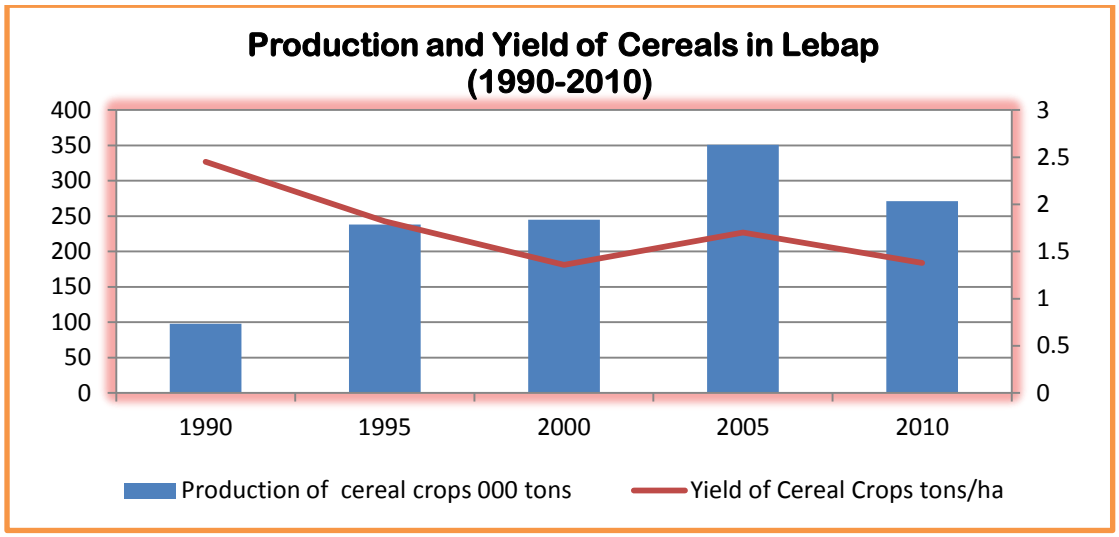
Production and Yield of Cereals in Lebap
(1990-2010)
400
350
300
250
200
150
100
50
0
3
2.5
2
1.5
1
0.5
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.5

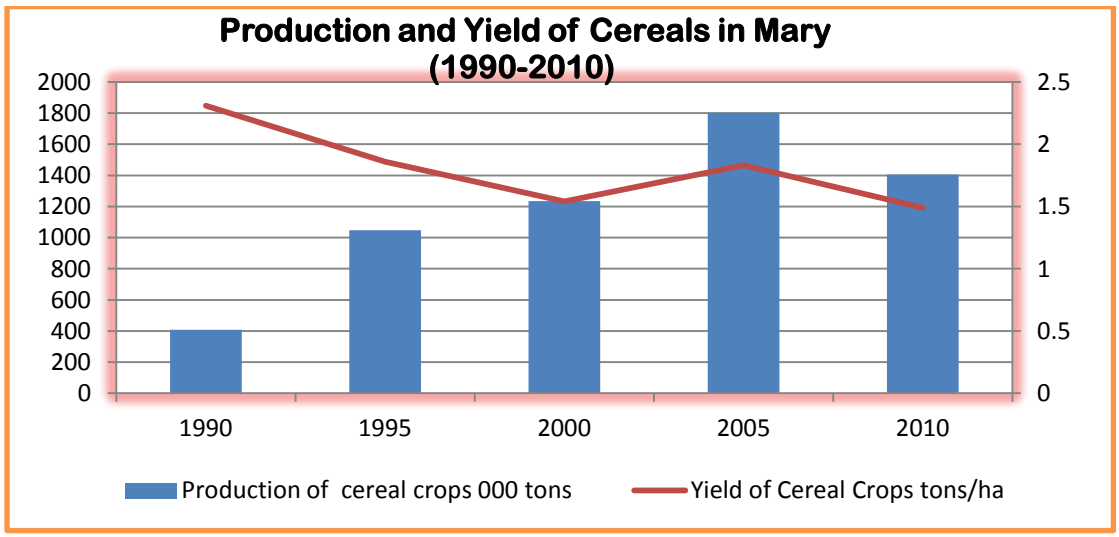
Production and Yield of Cereals in Mary
(1990-2010)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2.5
2
1.5
1
0.5
0
1990
1995
2000
2005
2010
Production of cereal crops 000 tons
Yield of Cereal Crops tons/ha

Fig. 3.6

Production and Yield of Vegetables

Besides, cereals, vegetable farming constitutes another segment of agricultural economy. Vegetables are an integral part of Turkmen's diet. The importance of vegetables is well known. Vegetables are the most sustainable and available natural sources of vitamins, minerals and fibers. Therefore, vegetable production is directly related to improving health, longevity and working availability of the population. This fact is being realized by the republic and production of vegetables is constantly increasing with the aim to ensure adequate supplies of vegetables for population. **(table 3.2)**

Table 3.2
Province-wise Production and Yield of Vegetables
(1990-2010)

Province	Year	Production of Vegetable (000 tons)	Yield of vegetables (tons/ha)	Percentage of growth in	
				Production	Yield
AHAL	1990	252	14.0	-	-
	2000	104	13.0	-58.73	-7.14
	2010	170	15.5	63.46	19.23
BALKAN	1990	37	12.25	-	-
	2000	36	12.0	2.70	-2.04
	2010	45	12.0	25	0.00
DASGHUZ	1990	108	12.0	-	-
	2000	83	11.86	-23.14	-1.16
	2010	92	11.5	10.84	-3.03
LEBAP	1990	141	12.8	-	-
	2000	96	12.0	-31.91	-6.25
	2010	109	12.1	13.54	0.83
MARY	1990	231	13.58	-	-
	2000	106	13.20	-54.11	-2.79
	2010	194	13.83	83.01	4.77

Source: Compiled and Computed on the basis of data from FAO, Statistical Year Book of Turkmenistan

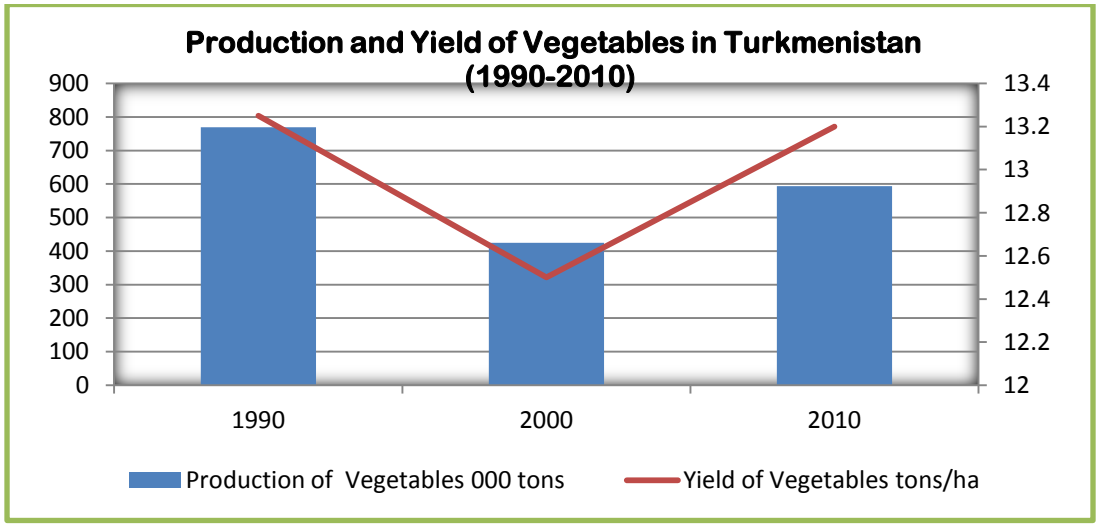
Production and Yield of Vegetables in Turkmenistan
(1990-2010)
900
800
700
600
500
400
300
200
100
0
13.4
13.2
13
12.8
12.6
12.4
12.2
12
1990
2000
2010
Production of Vegetables 000 tons
Yield of Vegetables tons/ha

Fig. 3.7

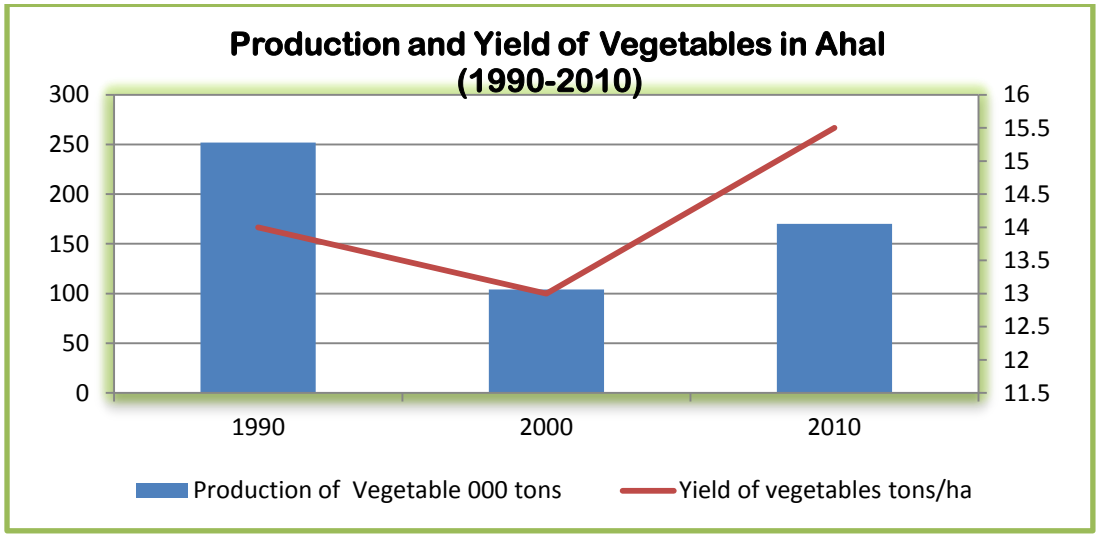
Production and Yield of Vegetables in Ahal
(1990-2010)
300
250
200
150
100
50
0
16
15.5
15
14.5
14
13.5
13
12.5
12
11.5
1990
2000
2010
Production of Vegetable 000 tons
Yield of vegetables tons/ha

Fig. 3.8

It is evident from table 3.2 that the production of vegetables had declined from 1990 to 2000 by 44 percent. The republic has shown marked fluctuations in terms of area and production of vegetables since independence. Production of vegetables increased from 425 thousand tons in 1990 to 610 thousand tons in 2010, increasing by 44 percent. The increase in production in all the provinces of the country may be a survival strategy as vegetable were not available in the public markets and a private marketing system was not established, farmers may have started producing vegetables in their home gardens to meet their daily vegetable requirements. Average yield of vegetables was recorded 13.20 thousand hectares in 2010 in the country. Though the yield of vegetables declined from 13.25 thousand tons in 1990 to 12.5 thousand tons in 2000 but has recovered from its decline because the household sector has become active in vegetable production. Moreover, farmers started learning themselves about vegetables techniques, especially crop protection technologies. This helped to bring the average level to the pre-reform levels in the country.

The table further depicts that maximum production and productivity of vegetables are experienced in the provinces of Ahal and Mary which produced about 26 and 28 percent of vegetables respectively. Third important producers of vegetables are Lebap and Dashoguz where 19 and 17 percent of vegetables are produced respectively. The lowest production of vegetables is produced in the province of Balkan which produced only 10 percent of vegetable production. Lowest yield of vegetables was recorded in the provinces of Lebap and Dashoguz respectively. **(fig. 3.7-3.12)**

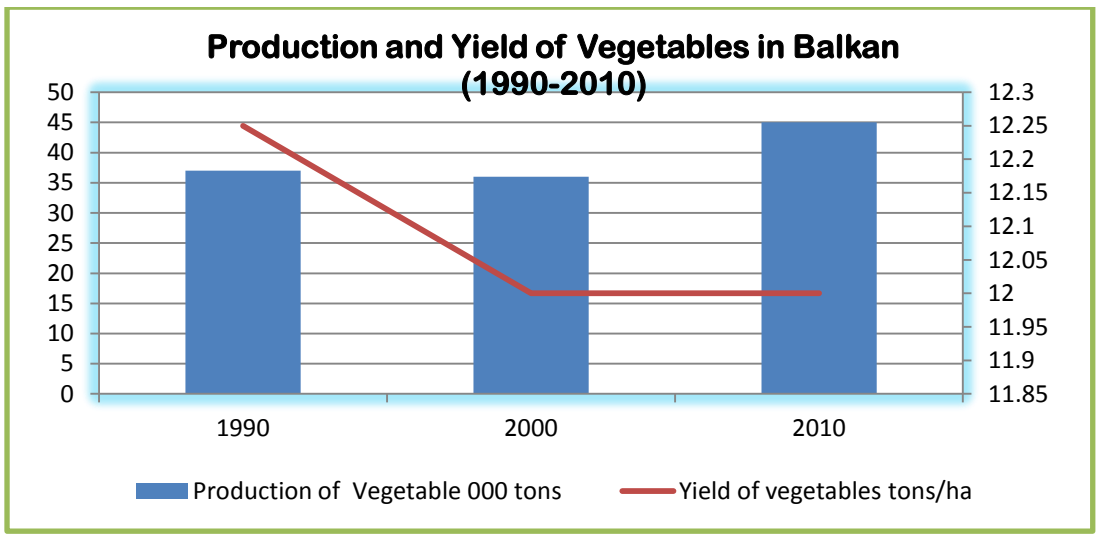

Fig. 3.9

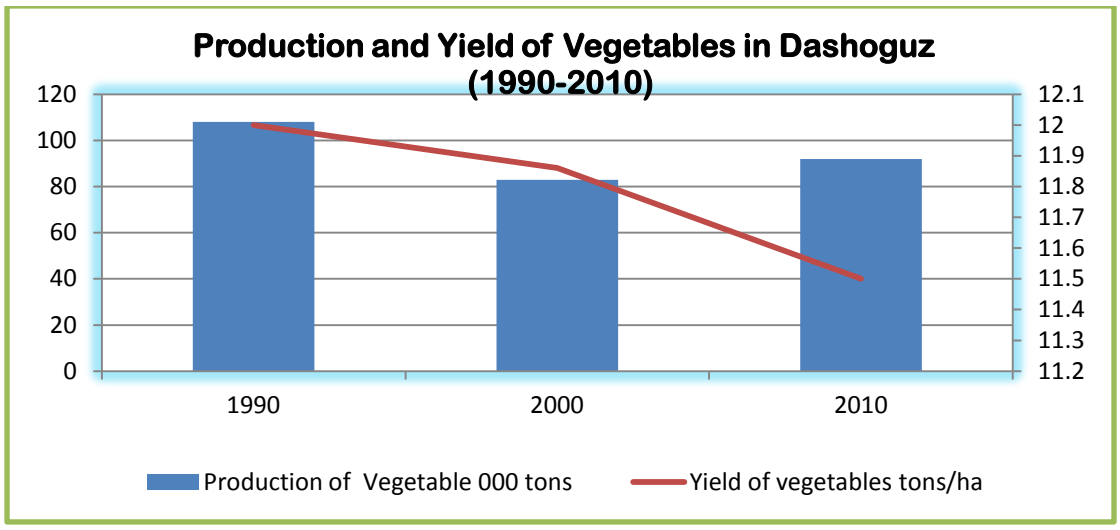

Fig. 3.10

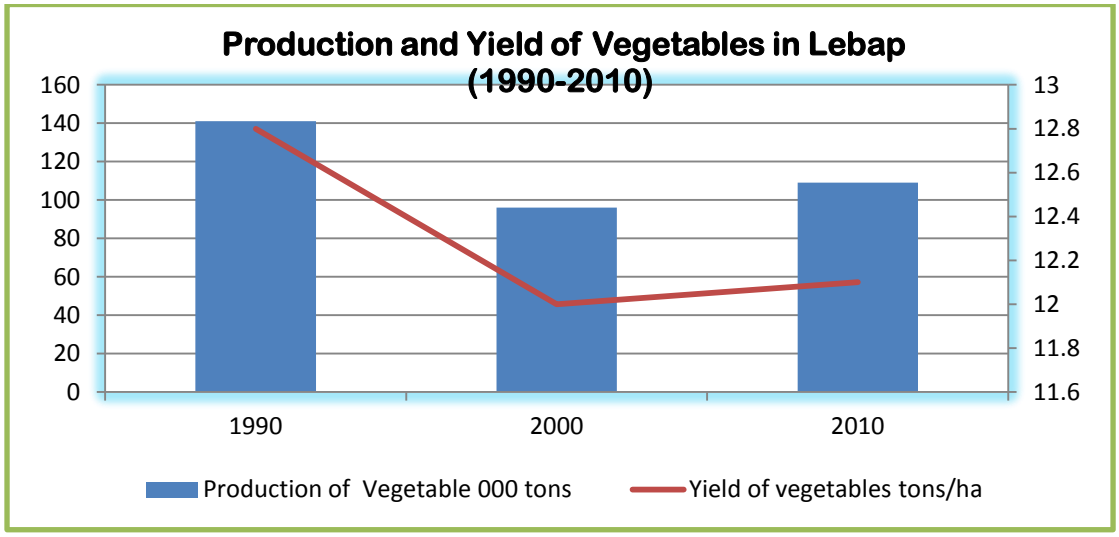

Fig. 3.11

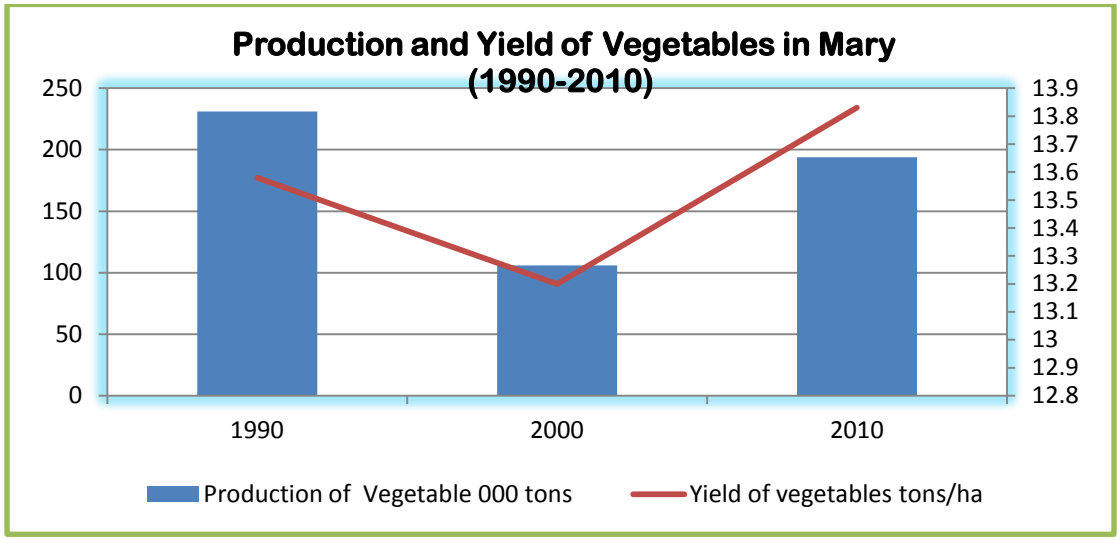

Fig. 3.12

Production and Yield of Fruits

In addition to vegetables, fruits are also grown in the republic in order to fulfill the basic needs of fruits. Production of fruits has shown positive change from 1990 onwards. **(table 3.3)**

Table 3.3
Province-wise Production and Yield of Fruits
(1990-2010)

Province	Year	Production of fruits (000 tons)	Yield of Fruits (tons/ha)	Percentage of growth in	
				Production	Yield
AHAL	1990	14	2.33	-	-
	2000	15	2.14	7.1	-8.15
	2010	27	2.70	80	26.16
BALKAN	1990	5	3.33	-	-
	2000	6.5	3.25	30.0	5.12
	2010	8.5	3.40	30.76	4.61
DASHUZ	1990	8	2.66	-	-
	2000	9	2.25	11.1	-15.41
	2010	10	2.00	11.1	-11.11
LEBAP	1990	10	2.22	-	-
	2000	12	2.40	10.1	8.1
	2010	13	1.62	11.1	-32.5
MARY	1990	13	1.53	-	-
	2000	17	2.83	30.7	84.96
	2010	24	3.00	41.1	8.12

Source: Compiled and Computed on the basis of data from FAO, Statistical Year Book of Turkmenistan.

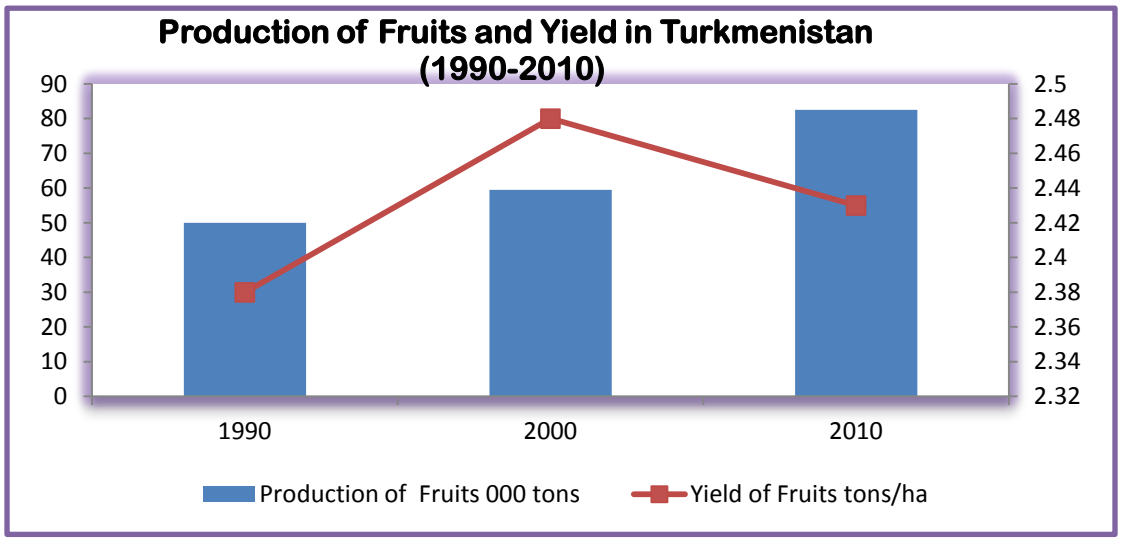

Fig. 3.13

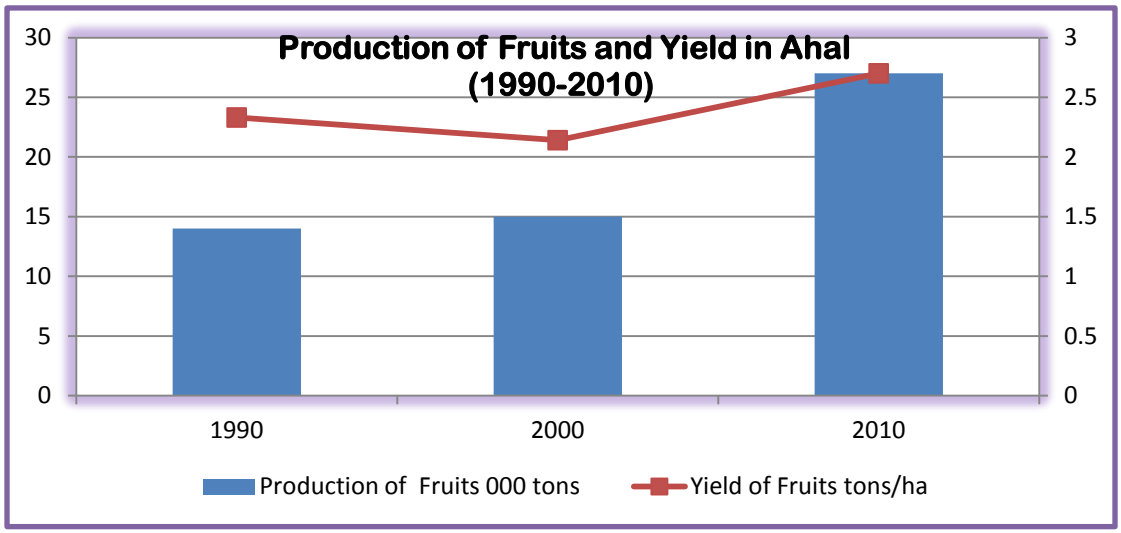

Fig. 3.14

The perusal of table 3.3 indicates that the fruits occupied 34 thousand hectares with a production of 82.5 thousand tons. The total allocation to the fruits in the country has in fact increased from 21 thousand hectares in 1990 to 34 thousand hectares, while the total production of fruits has also increased from 50 thousand tons in 1990 to 82.5 thousand tons in 2010. Both the area and production has registered an increase since independence when the area and production accounted for 61 and 65 per cent of the total area under fruit and their production respectively.

The table further reveals that a perusal of the province-wise area and production indicated that the province of Ahal continued to be the leading fruit producing province by accounting for 29.4 per cent of the area and 32.72 per cent of the production of fruits in the country. It was followed by Mary, which accounted for 29 per cent of the total production while third largest is Lebap, which contributed about 17 percent of the total fruit production.

The table further depicts that there are some provinces where yield of fruit crop is higher than the national average, while some provinces are having yield below national average. **(fig.3.13-3.18)** Highest yield of fruits, i.e. 3.4 tons per hectare was reported from Balkan followed by Mary at 3.00 tons per hectare during 2010. The lowest yield of fruits was observed in Lebap and Dashoguz, where it was 1.65 and 2.00 ton per hectare respectively which is lower than the national average.

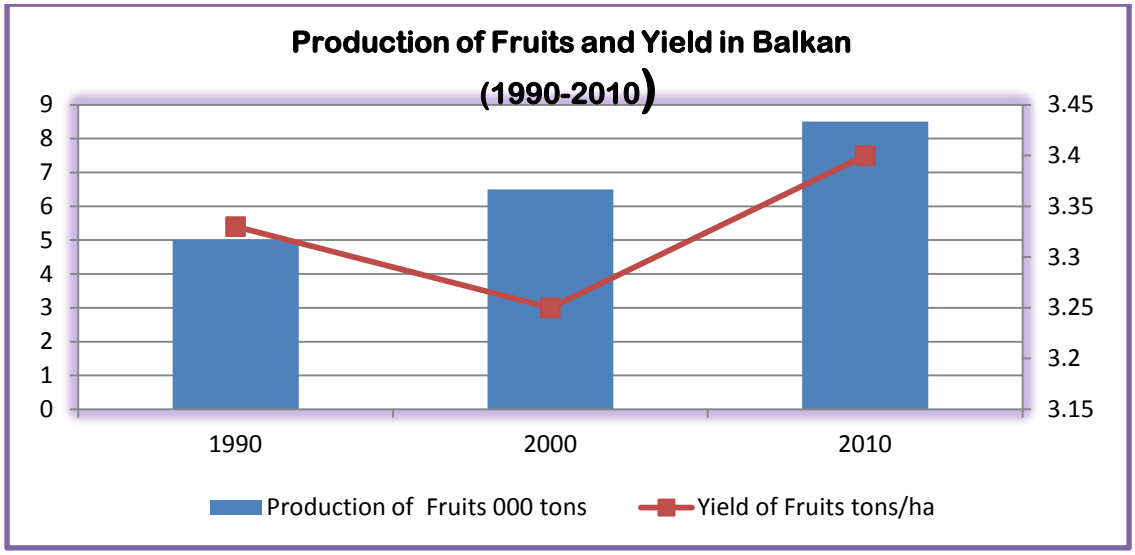

Fig. 3.15

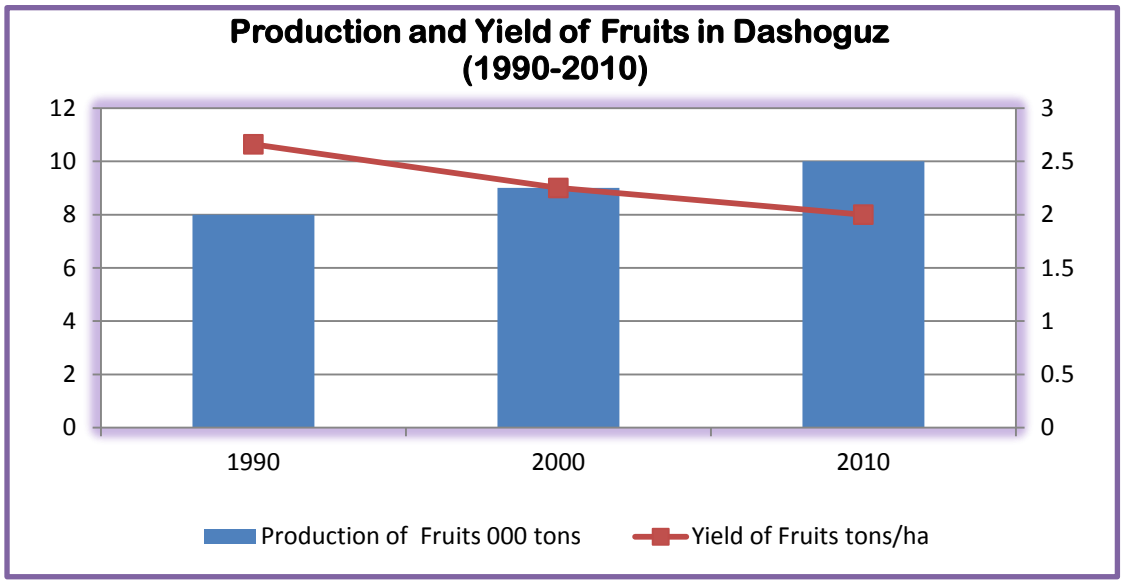

Fig. 3.16

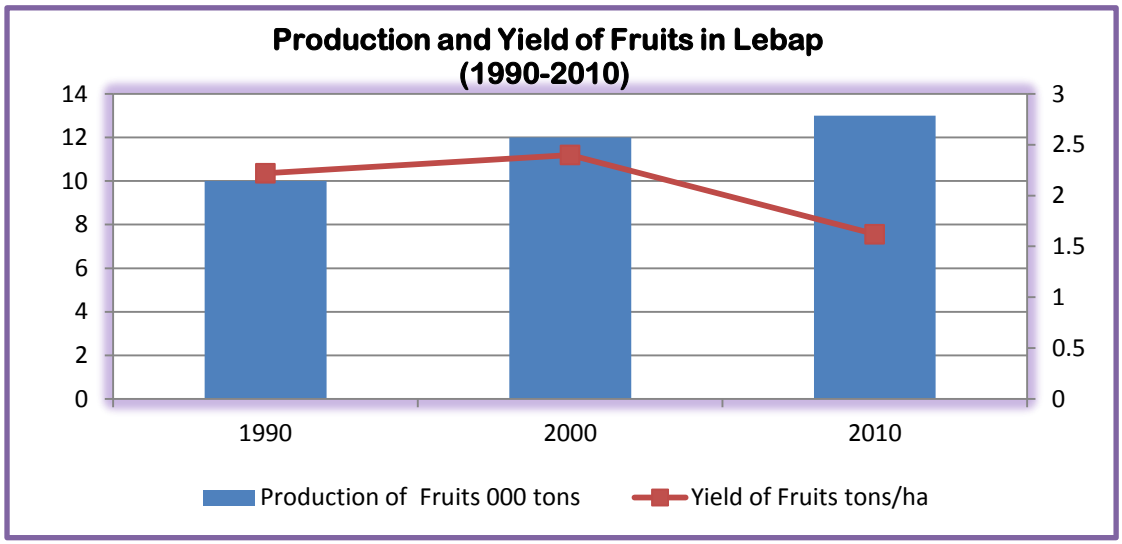

Fig. 3.17

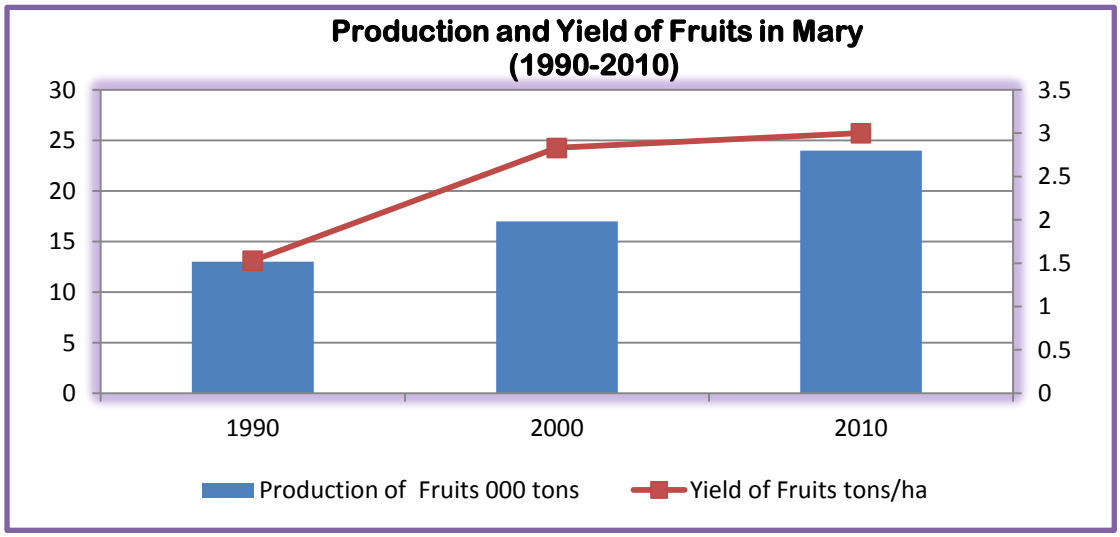

Fig. 3.18

Cereal Productivity

Rising agricultural productivity is central to economic development and the assessments of agricultural productivity has engaged attention of scholars working in different disciplines like geographers, economists and agricultural scientists for a long time. Productivity can be defined as a measure of the efficiency of production. Productivity is a ratio of what is produced to what is required to produce it. Usually this ratio is in the form of an average, expressing the total output divided by the total input. Productivity is a measure of output from a production process, per unit of input. According to Dewett,"productivity expresses the varying relationship between agricultural output and one of the major inputs like land, labour, capital and other complimentary factors remaining same". [1]

Productivity is not synonymous of fertility, it is generally used to express the power of agriculture in a particular region to produce without regard to whether that power is due to beauty of nature or due to efforts of man. On the other hand, fertility denotes the ability of soil to provide all the essential plant nutrients in available form and in a suitable balance for plant growth.[2]

Importance of Agricultural Productivity

The productivity is important for many reasons. Aside from providing more food, increasing the productivity of farms affects the region's prospects for growth and competitiveness on the agricultural market, income distribution and savings, and labour migration. An increase in a region's agricultural productivity implies a more efficient distribution of scarce resources. As farmers adopt

new techniques and differences in productivity arise, the more productive farmers benefit from an increase in their welfare while farmers who are not productive enough will exit the market to seek success elsewhere.

Increases in agricultural productivity lead also to agricultural growth and can help to alleviate poverty in poor living in rural areas, where agriculture often employs the greatest portion of the population. As farms become more productive, the wages earned by those who work in agriculture increase. At the same time, food prices decrease and food supplies become more stable. Labourers, therefore, have more money to spend on food as well as other products. This also leads to agricultural growth. People see that there is a greater opportunity earn their living by farming and are attracted to agriculture either as owners of farms themselves or as labourers.[3]

At the national level, productivity growth raises living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth is important to the firm because it means that the firm can meet its (perhaps growing) obligations to customers, suppliers, workers, shareholders, and governments (taxes and regulation), and still remain competitive or even improve its competitiveness in the market place. However, it is not only the people employed in agriculture who benefit from increases in agricultural productivity. Those employed in other sectors also enjoy lower food prices and a more stable food supply. Their wages may also increase. Agricultural productivity is becoming increasingly important as the world population continues to grow.[4]

Measurement of Productivity

Agricultural productivity is a measure of the efficiency with which inputs are used in agriculture to produce an output. When a given combination of inputs produces a maximum output, the productivity is said to be at its maximum. The measurement of agricultural productivity enables a comparison of relative performance of farmers between farms, between the types of farming and between geographical regions. The comparison of productivity goes on to the heart of economic performance and can provide the guidance for planning and development decisions (Kravis, 1976). There are various scholars who have contributed different ideas, methods and techniques to measure the agricultural productivity, like, Thompson (1926) measured relative productivity of British and Danish farms and express it in terms of gross output of crops and livestock. Kendall (1939) treated agricultural productivity as a mathematical problem and initiated a system of four coefficients (i) productivity coefficient, (ii) ranking coefficient, (iii) money value coefficient, and (iv) energy coefficient.[5]

Stamp (1952) applied Kendal's ranking coefficient technique on an international level to determine agricultural efficiency in a number of countries and by selecting some major crops. Stamp (1958) suggested, a method for measuring the agricultural productivity by converting the total agricultural productivity in calories.[6] Shafi (1960) applied the technique of 'ranking coefficient' of Kendall for measuring the agricultural efficiency in the state of Uttar Pradesh taking into account eight food crops grown in each of the forty-eight districts of the state. Agarwal (1965) has suggested 'factoral

approach' while measuring agricultural efficiency in Bastar district of Madhya Pradesh.[7]

Shafi (1965) assessed the productivity on the basis of labour engaged in agriculture. According to him it can be computed by dividing the gross production in any unit area by the number of man-hours. Shafi (1967) applied Stamp's 'standard nutrition unit' technique for measuring the efficiency of agriculture in India. Ruttan, et al. (1970) accounted for agricultural labour productivity differences in developed and of less-developed countries by using 'Cobb-Douglas production function'. Bhalla (1978) has considered output per persons (on constant average price) for measuring productivity of labour in agriculture taking in to account nineteen major crops during the trienniums 1962-65 and 1970-73.[8]

Jasbir et al. (1985) made an attempt to calculate the agricultural productivity by considering the labour productivity, expressed as gross agricultural output in terms of 'grain unit' (one grain unit is equal to100 kilograms of wheat) per hectare of cropped area or persons actively employed in agriculture. Where gross agricultural output (in rupees) was divided by the wheat support price for converting into a grain unit. Munir (1988) highlighting the weaknesses of Kendall's 'ranking coefficient' and Enyedi's Productivity Index methods attempted to apply Bhatia's and Shafi's methods in calculating the productivity indices of the Sub-Himalayan East region which lies in between the Ghaghara river in the south, and Nepal *tarai* in the north.[9]

Siddiqui et al. (1999) calculated the productivity indices of North Bihar Plain on the basis of Yang's method. Rahman (2003)

attempted to examine variations in crop productivity in North Bihar Plain considering 17 major crops grown in the districts of the region during the period of 1995-2000.[10]

The present study is based on Yang's 'Crop Yield Index' method due to the fact that it considers the yield of all crops compared with the average yield of crops in the region. Yang's 'Crop Yield Index' method has been applied to compute productivity of the present study by author keeping the nature of the problem and availability of data into consideration. The present study attempts to examine variations in agricultural productivity and relative changes that have occurred in agricultural production in different provinces of Turkmenistan. Agricultural productivity is controlled by physical, institutional and technological factors operating in the region. Measurement and comparative analysis of agricultural productivity enables us to outline the areas that are performing efficiently or less efficiently as compared to other farming areas.

The productivity indices of crops considered for each province were computed according to the methodology initiated by Yang (1965) i.e., the computation of Crop Yield Index. For the computation of an index, initially it is needed to take the yields of all the crops considered in the province and compare them with the average yields of the same corps grown in the region. Before computing the crop yields index for Turkmenistan, the average yield of each of crop cultivated in the entire region should be considered. Then, by dividing the yield per hectare of a crop in the district by the average yield of the same crop in the region, a percentage figure is obtained, which when multiplied by 100, gives an index number, as shown in column 5 of Table 3.4. By incorporating the area devoted

to each crop as a weight to multiply this with the percentage index, the products are obtained as listed in column 6 of the table. By adding the products (of column 6) and dividing the sum of products by the total of crop area in the province (the sum of column 4), the average index thus obtained is the desired crop index for the district, using area devoted for the cultivation of crop as a weight.

Table 3.4
Crop Productivity Index of Cereals in Ahal

Crop	Yield (Q/ha)		Area of crop in the province (000'ha)	Crop yield in the province as a (%)	Percentage multiplied by the area in hectares
	Average yield in the region	Yield in the province			
1	2	3	4	5	6
Wheat	17.0	16.40	219	96.47	21127
Barley	9.88	10.00	18	101.21	1821.78
Rice	17.61	15.00	20	85.17	1703.4
Maize	19.96	10.00	30	50.10	1503.0
Total			260		26155.18

Crop index for the province of Ahal is =26155.18
260 =100.59

Table 3.5
Crop Productivity Index of Cereals in Balkan

Crop	Yield (Q/ha)		Area of crop in the province (000'ha)	Crop yield in the province as a (%)	Percentage multiplied by the area in hectares
	Average yield in the region	Yield in the province			
1	2	3	4	5	6
Wheat	17.0	11.55	45	67.94	3057.35
Barley	9.88	10.00	10	101.21	1012.14
Rice	17.61	23.00	2	130.60	261.21
maize	19.96	10.00	3	50.10	150.30
Total			60		4481.00

Crop index for the province of Balkan is =4481.00
60 =74.68

Table 3.6
Crop Productivity Index of Cereals in Dashoguz

Crop	Yield (Q/ha)		Area of crop in the province (000'ha)	Crop yield in the province as a (%)	Percentage multiplied by the area in hectares
	Average yield in the region	Yield in the Province			
1	2	3	4	5	6
Wheat	17.0	12.92	139	76.00	10564
Barley	9.88	9.00	8	91.09	728.72
Rice	17.61	16.36	11	92.90	1021.9
maize	19.96	8.00	4	40.08	160.32
Total			162		12474.94

Crop index for the province of Dashoguz is =12474.94
192 =77.00

Table 3.7
Crop Productivity Index of Cereals in Lebap

Crop	Yield (Q/ha)		Area of crop in the province (000'ha)	Crop yield in the province as a (%)	Percentage multiplied by the area in hectares
	Average yield in the region	Yield in the Province			
1	2	3	4	5	6
Wheat	17.0	14.53	158	85.47	13504.26
Barley	9.88	9.00	15	91.09	1366.35
Rice	17.61	13.00	20	73.82	1476.43
maize	19.96	9.20	2	46.09	92.18
Total			195		16439.22

Crop index for the province of Lebap is =16439.22
195 =93.5

Table 3.8
Crop Productivity Index of Cereals in Mary

Name of the crop	Yield(Q/ha)		Area of crop in the province (000'ha)	Crop yield in the province as a (%)	Percentage multiplied by the area in hectares
	Average yield in the region	Yield in the Province			
1	2	3	4	5	6
Wheat	17.0	17.39	220	102.29	22504.70
Barley	9.88	10.00	18	101.21	1821.86
Rice	17.61	14.58	24	145.83	3500
maize	19.96	11.00	3	110.00	330
Total			265		28156.56

Crop index for the province of Mary is =28156.56
265 =106.25

Table 3.9
Crop Yield Indices for the Provinces

2005				2010				
S. No.	Index range	Category	Number of Provinces	Name of Provinces	Index range	Category	Number of Provinces	Name of Provinces
Cereal Crops								
1	High	Above 127	01	Mary	High	Above 106	01	Mary
2	Medium	127-111	03	Ahal, Balkan, Lebap	Medium	106-85	02	Ahal, Lebap
3	Low	Below 111	01	Dashoguz	Low	Below 85	02	Balkan, Dashoguz

Productivity Regions–Based on Composite Crop Yield Index (2005 and 2010)

Cereals are the most important crops grown in the region which cover an area of 942 thousand hectares (58.98 per cent) of the total cropped area. Rice and wheat together cover 91.93 percent

among cereal crops. In order to delineate the general pattern of productivity and demarcate high, medium and low productivity regions, a composite yield index has been computed for the provinces of the Turkmenistan. It is evident from the figure 3.19 that, high productivity with an index value of above 106 consists of only one province i.e. Mary in 2010. There were three provinces marked with medium productivity and show a range of variation in productivity index values between 106-85. The provinces belonging to medium productivity were namely, Ahal and Lebap. There was only one province include Dashoguz which shows low productivity with the yield index value of below 85 in 2010. However, the above table reveals that huge variations in terms of cereal crop productivity between the year 2005 and 2010. The year 2005 recorded high productivity than the period of 2010 because of the favourable climatic conditions while the climatic conditions became very worse and most parts of republic witnessed drought conditions. Due to climatic change from 2005 onwards, Turkmenistan has witnessed temperature to increase and annual precipitation to decrease every year, which has resulted decline in the flow of Amu darya and other small rivers by 10-15 percent. As it is evident from above that about 95 percent of agricultural land in Turkmenistan is irrigated by these rivers. As a consequence of scarcity of water, not only productivity and production have shown decline, but the area under different crops recorded decline.

Spatial Variation in Cereal Crop Productivity

On the basis of the above statistical technique, the data for the four cereal crops in each of the five provinces of the period (1990-2010)

have been analysed and the disparity in the levels of crop productivity have been calculated. The regional disparities in the levels of crop productivity are however due to the variations in soils, climate, topography, irrigation facilities and proportion of area under cultivation. The resultant levels of agricultural productivity are classified into following three categories.

High Productivity Region

It may be inferred from the analyses of fig. 3.19 that the province of Mary ranked the high level of agricultural productivity in terms of cereal crops during the period 2005 and 2010 respectively. The high level of productivity in the region is due to the fact that she has been mainly determined by agricultural infrastructural facilities (tractors, pump sets, fertilizers etc), educational facilities, employment opportunities, and means of transportation and banking. Besides, this province is located in the delta region of the Murgab river and is one of the major cities and cultural centers in Turkmenistan. Mary had access to Karakum Canal and the Murgab, and drains northwards into the Karakum desert. Despite having access to only a relatively small amount of water, the oases not only produced enough food to feed its large population but also to export to adjacent areas. The region's agricultural success was due partly to the land and water management strategies of the time. Land was divided into small plots that were intensively cultivated and watered on a regular basis.[10] Decisions on the amount of land to be sown were based on spring flow and in years of low discharge only essential lands were cultivated. Water gauges were also installed on every canal in the city and the distribution of water was carried out with great care. In charge of the system was the *Mirab*

(from the Arabic *mir* - master and *ab* - water) whose post was one of the highest in the state. Hourly reports on the level of water in the main canal were passed to his office and, based on this information instructions for following activities were circulated by messenger to the officials in charge of every off-take. [12]

Medium Productivity Region

Lebap and Ahal rank second in terms of cereal crop productivity in Turkmenistan. Medium level of productivity in the province of Lebap is mostly due to soil salinization. Soil salinization is caused by a number of factors however, the prominent one are the source of water pollution comes from Uzbekistan (Karshinsky area) where return waters from agriculture fields with considerable amounts of salts and pesticides flow into the Amu Darya River, Additional usage of fertilizers in agriculture contaminated not only soil but also water. Certain numbers of enterprises release different emissions to atmosphere. For example, the Turkmenabat city, the Phosphoric factory contaminates the atmosphere and discharge polluted waters into the Amu Darya River. The experts from the Ministry for Agriculture noted that regrettably less than 0.5 hectares was available for 1 person when size of farms should be at least 30 hectares. Not only land deficiency was a problem but also its quality which was uncertain. The national soil experts comparing the current and the Soviet Union times said that before soil samples were taken every 500 m for chemical analyses but today nobody cares about soil quality. In addition to this, imperfect land use management is also responsible for the decline of cereal crop productivity in this region. Imperfect land use management problems were related to imperfect land use practice such as the

absence of crop rotation, irrational water utilization, shortage of inputs, misuse of technical equipments and sowing not according to climatic conditions. Therefore, soil salinization and mismanagement of land resulted in the decline of crop yield. [13]

Low Productivity Region

The province of Dashoguz has recorded the lowest productivity of cereals. Dashoguz Province is located in the north of Turkmenistan. It has a mean annual precipitation of 77 mm and is the most severally affected province by irrigation induced salinity. Agricultural production in Dashoguz Province is based on irrigated wheat and cotton. The water source that feeds its irrigation systems is the Amu-Darya River. Land degradation, in particular soil salinization, is one of the major factors threatening the sustainability of irrigated agriculture in Dashoguz. Moreover, the region of Dashoguz, fed by the Amu Darya, a river that had particularly low water levels in 2008. In this region, majority of wheat fields have not received any water at all and the crops can survive only through the water from snowfall.[14]In addition to this recent estimates show that approximately 90 percent of the total 165,000 hectares of irrigated lands of the region are salt affected which has reduced potential yields of cotton and wheat crops by as much as 60 percent. This has resulted in lower farm incomes and increase in poverty. Dashoguz province of Turkmenistan is predominantly related to poor quality of water flowing from the up streams. Consequently, the use of marginal quality water for irrigation in the middle and lower stream reaches of river systems without proper outflow of salts is a major challenge. The presence of shallow groundwater tables further contributes to the salinization of irrigated lands. Approximately

70,000 ha of irrigated land in the region have groundwater tables within 2.0 m of the soil surface.[15]

Food production in Turkmenistan already faces many serious challenges. There is limited space available for crops and livestock due to the arid and semi-arid lands which are unsuitable for agriculture. The lack of prime agricultural land has lead to expansion into more marginal areas and heavy use of irrigation Land degradation is an ongoing problem as a result of land use changes such as waterlogging, overgrazing, and cropping practices; and other processes such as soil erosion, heavy rainfall events, flooding, salinization and desertification contribute yearly to restrictions in production.

The overall analysis shows that during the period 2005, there was only one province with low productivity, while during the period 2010, the number of provinces characterized with low productivity increased to two. Agricultural performance over a large part of the republic is characterized with marked productivity variations. These variations in productivity are influenced by the physical and socio-economic factors. Soil fertility as determined by the constituents of a number of nutrients play a vital role in enhancing crop growth and yield per hectare. In the region there is a substantial variation in respect of soil fertility. Among the socio-economic factors, the size of landholdings is also responsible for decision making of farmers. Therefore, it is needed that the productivity of crops per hectare be increased at least in medium and low productivity areas. Application of new agricultural technology brought with high-yielding varieties will be of great help.

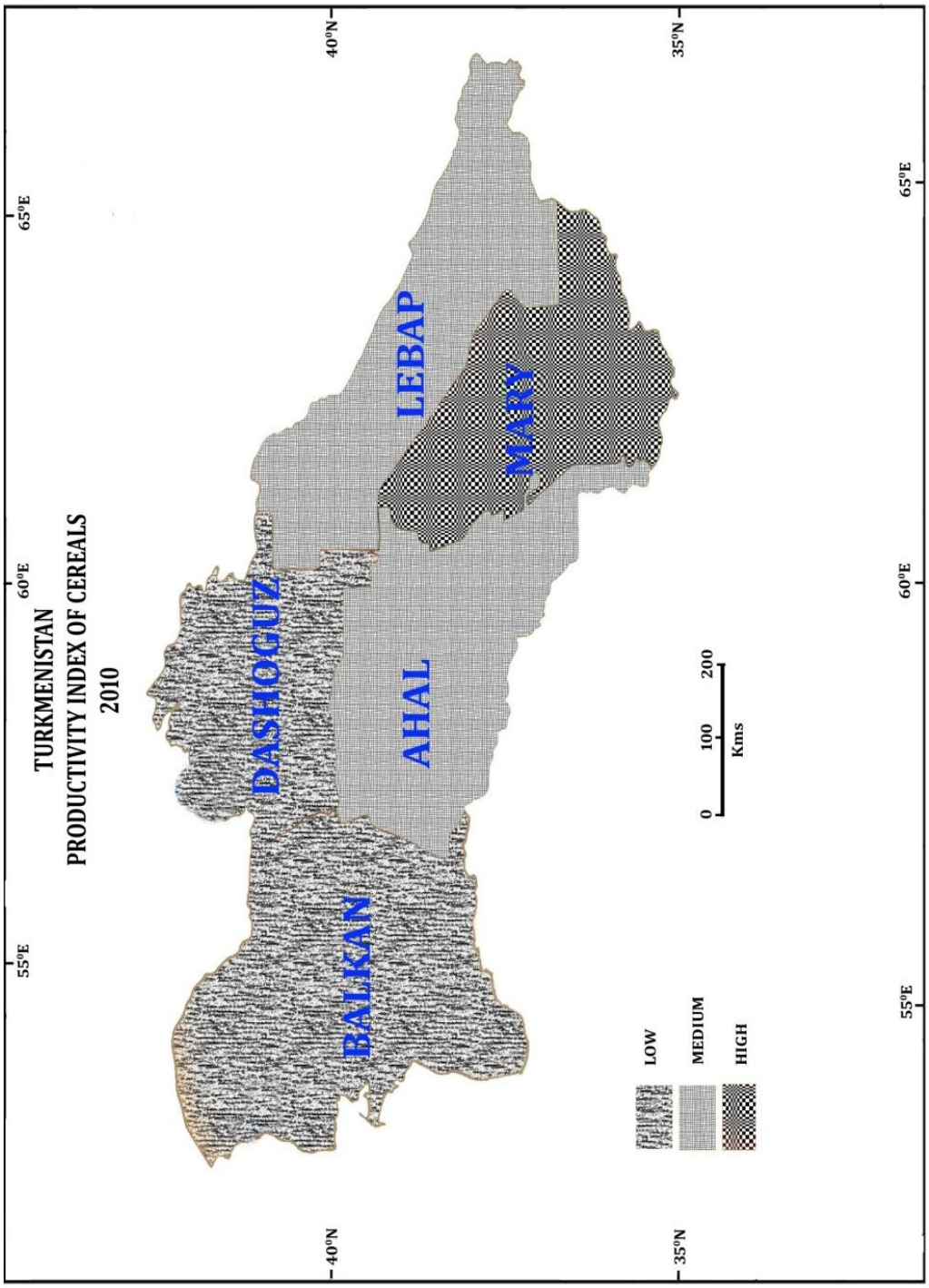
TURKMENISTAN
PRODUCTIVITY INDEX OF CEREALS
2010
DASHOGUZ
LEBAP
MARY
AHAL
BALKAN
LOW
MEDIUM
HIGH
0
100
200
Kms
40°N
35°N
55°E
60°E
65°E

Fig. 3.19

Vegetable Productivity

Besides, cereal crops, vegetables are also grown in all the provinces of Turkmenistan which form one of the important constituents of food in the region. Huge variations have been found in terms of production and productivity of vegetables. Therefore, Nelson method has been applied in order to deal with present levels and characteristics of agricultural production in terms of existing variations at macro level both in time and space.

Table 3.10
Vegetables: Growth in Area, Production, Yield
(1990-2010)

Province	2000			2010			% of growth in		
	Area (000'ha)	Production (000'tons)	Yield (tons/ha)	Area (000'ha)	Production (000'tons)	Yield (tons/ha)	Area	Production	Yield
Ahal	8	104	13	11	170	15.5	37	63	19
Balkan	3	36	12	3	45	15	0	25	25
Dashoguz	7	83	11.9	8	92	11.5	-12.5	11	-3
Lebap	8	96	12	9	109	12.1	11	14	1
Mary	8	106	13.20	14	194	14	75	83	6

Source: Compiled and computed on the basis of data from FOA, IMF and Statistical Year Book of Turkmenistan.

Table 3.11
Vegetables: Yield Level

Category	Area (000'ha)	Total Area (%)	Production 000'tons	Total Production (%)	Number of Provinces	Name of Province
A: 10-12	8	17.8	92	15.0	1	Dashoguz
B: 13-15	26	57.8	348	57.0	3	Balkan, Lebap and Mary
C: Above 15	11	24.4	170	28.0	1	Ahal

Source: Compiled and Computed by the author on the basis of table 3.10.

Table 3.12
Vegetables: Growth Level

Category	Area (000'ha)	Total Area (%)	Production (000'tons)	Total Production (%)	Number of Provinces	Name of Province
A: -4	8	17.8	92	15.0	1	Dashoguz
B: 1-6	23	51.1	303	49.7	2	Lebap and Mary
C: Above 20	14	31.1	215	35.3	2	Ahal and Balkan

Source: Compiled and Computed by the author on the basis of table 3.10.

Vegetables are also one of the most important crops cultivated in Turkmenistan. These are grown in all provinces of the country, particularly in the provinces of Ahal and Mary. Total area under vegetables during 2000-2001 was 34 thousand hectares. It is evident from the table 3.11 that there is a variation in the present growth rate of area of vegetables. High rate of growth was recorded by the provinces of Mary and Ahal 75 and 37 percent respectively. While as medium positive growth rate in area was shown by Lebap. Negative growth in area was seen (11%) in the province of Dashoguz and there was neither increase nor decrease in area in the province of Balkan. It is thus obvious that growth in area shows marked fluctuation.

The production of vegetables shown marked fluctuation within the republic of Turkmenistan, the growth rate of production varied from province to province. The high growth rate in production was recorded by Mary and Ahal. These provinces occupy the growth rate i.e. 83 and 63 percent respectively. While as, medium positive growth in the production of vegetables was found in the province of Balkan having an increase of 25 percent. On the other hand, low growth rate in production was observed in Dashoguz and Lebap

provinces. The main reason of low growth rate of production was reduction low yield in vegetable cultivation in these provinces.

However, it is seen from table above that high yield growth rate was shown in Balkan and Ahal provinces of Turkmenistan. On the other hand medium yield have recorded in Mary and Lebap where growth in yield increased by 6 percent and 1 percent respectively. It is also analyzed from the table that negative growth rate in yield was found in Dashoguz where yield has decreased by 3 percent. The reason behind this feature are use of traditional HYV, less utilization of fertilizers, lack of irrigation facilities, unawareness about scientific farming i.e. crop rotation etc. are the basic constraints of productivity of crops.

Vegetable yield level has been high in the provinces of Ahal and medium yield level has been recorded in the provinces of Balkan, Lebap and Mary. However, low yield level of vegetables was found in the province of Dashoguz. It may be pointed out 5 provinces grouped into three yield ranks (high, medium and low) only few of them show a positive and favourable growth. This is due to lack of farm management and organizational set up within the province. If the package of practices programme is adopted for the regional planning. It is essential to apply all the recommended inputs in a proper manner to maximum return from per hectare of cropped land. Growth level has revealed a high positive output in the provinces of Ahal and Balkan while medium growth level is found out in Lebap and Mary and negative growth level lies in the province of Dashoguz. (**fig. 3.20)**

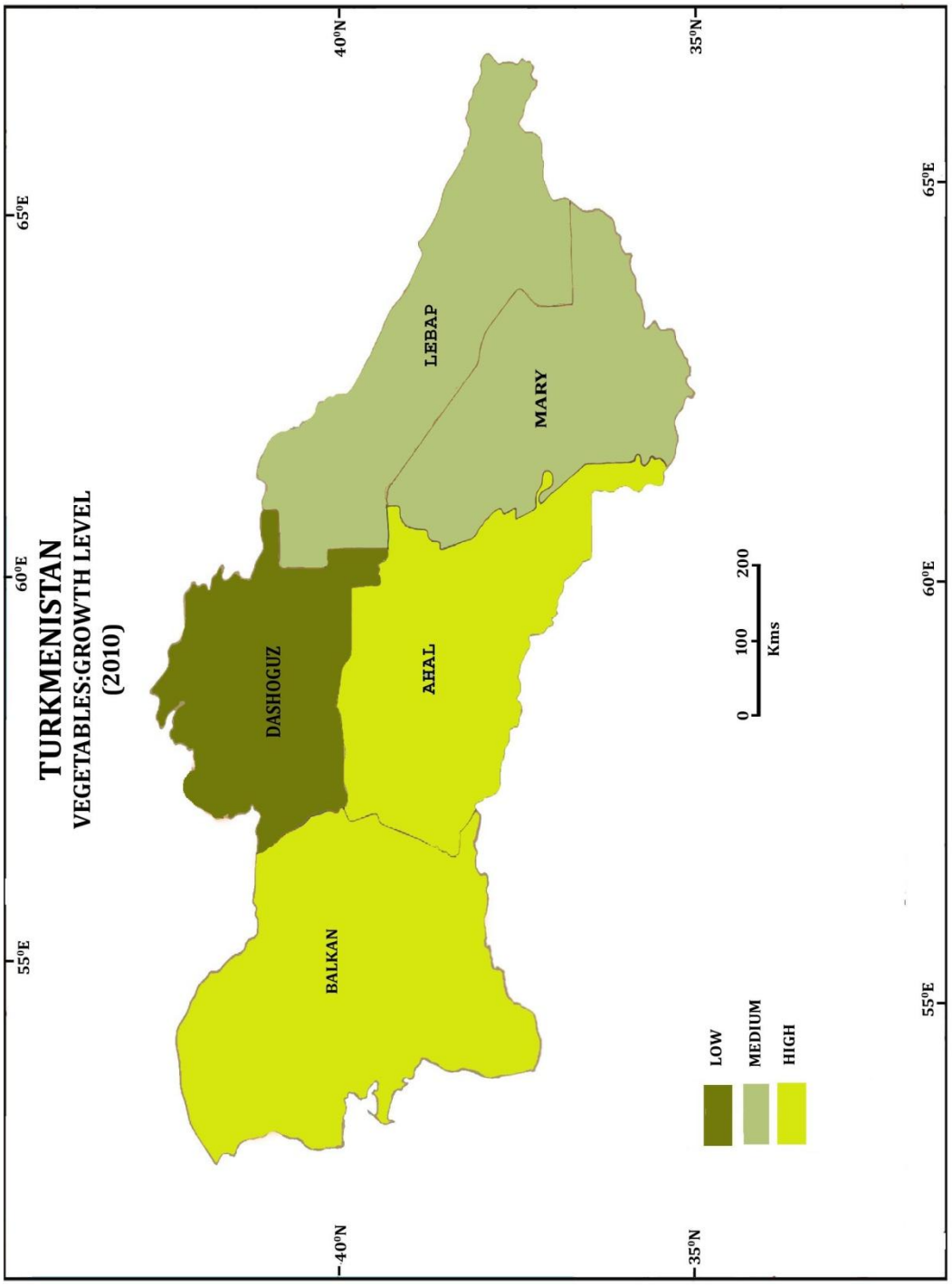
TURKMENISTAN
VEGETABLES:GROWTH LEVEL
(2010)
LEBAP
MARY
DASHOGUZ
AHAL
BALKAN
LOW
MEDIUM
HIGH
0
100
200
Kms
40°N
35°N
55°E
60°E
65°E

Fig. 3.20

Fruit Productivity

Fruit constitutes one of the important parts of diet and are grown in all the provinces of Turkmenistan. This crop is predominantly grown south and south-eastern regions of Turkmenistan. In these regions fruit occupies an area of about 77 percent of during 2010. From 1990-2010 area under fruits has been substantially increased from 24 thousand hectares to 34 thousand hectares exhibiting an increase of 42 percent.

Table 3.13
Fruits: Growth in Area, Production, Yield
(1990-2010)

Province	2000			2010			% of growth in		
	Area (000'ha)	Production (000'tons)	Yield (tons/ha)	Area (000ha)	Production (000'tons)	Yield (tons/ha)	Area	Production	Yield
Ahal	7	15	2.14	10	27	2.70	43	80	+26
Balkan	2	6.5	3.25	2.5	8.5	3.40	25	31	+4.6
Dashguz	4	9	2.25	5.0	10	2.00	25	11	-11
Lebap	5	12	2.40	8.5	13	1.53	70	18	-32
Mary	6	17	2.83	8.0	24.5	3.06	33	44	+8

Source: Compiled and computed on the basis of data from FOA, IMF and Statistical Year Book of Turkmenistan.

Table 3.14
Fruits: Yield Level

Category	Area (000'ha)	Total Area (%)	Production (000'tons)	Total Production (%)	Number of Provinces	Name of Province
A -10_ -35	13.5	39.7	23	27.5	2	Dashoguz and Lebap
B 4-10	10.5	30.9	33	40.0	2	Mary and Balkan
C Above 10	10	29.4	27	32.5	1	Ahal

Source: Compiled and Computed by the author on the basis of table 3.13.

Table 3.15
Fruits: Growth Level

Category	Area (000'ha)	Total Area (%)	Production (000'tons)	Total Production (%)	Number of Provinces	Name of Province
A: -11_-32	13.5	39.7	23	27.5	2	Dashoguz and Lebap
B: 4-8	10.5	30.9	33	40.0	2	Balkan and Mary
C: above 8	10	29.4	27	32.5	1	Ahal

Source: Compiled and Computed by the author on the basis of table 3.13.

Table depicts that there is great variation in the present growth rate area of fruits in the republic. High growth rate in area was recorded in Ahal, while as medium positive growth in area was shown by Mary and Balkan. On the other hand negative growth in area was found in Dashoguz and Lebap.

Similarly, the production of fruits has shown an increasing trend in various provinces of Turkmenistan. The table 3.9 reveals that the production of fruits has increased by 59.5 thousand tons in 1990 to 83 thousand tons in 2010 exhibiting an increase of about 40 percent. The high positive growth in production was recorded by the province of Ahal, while as provinces like Balkan and Mary has recorded medium growth in production. On the other hand, negative growth rate in terms of production was observed in the provinces of Dashoguz and Lebap. **(fig. 3.21)**

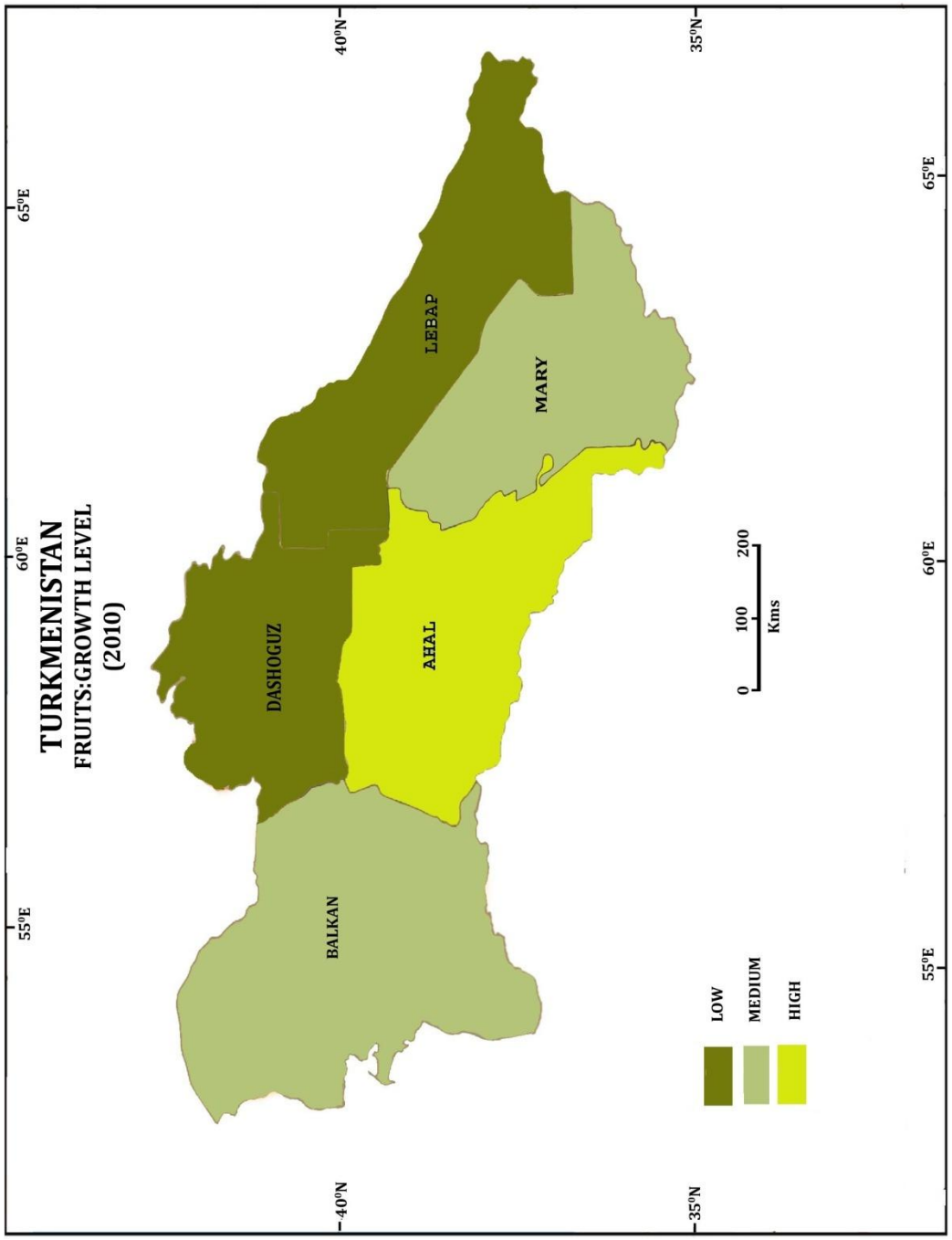
TURKMENISTAN
FRUITS:GROWTH LEVEL
(2010)
LEBAP
MARY
DASHOGUZ
AHAL
BALKAN
0
100
200
Kms
LOW
MEDIUM
HIGH
40°N
35°N
55°E
60°E
65°E

Fig. 3.21

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Chapter-4

Regional Population and Food Consumption

- Population
- Population Growth
- Size and Distribution
- Migration Trends
- Provinces of Turkmenistan
- Density of Population
- Irrigated Land and Rural Population
- Per Head Area under Cereal Crops
- Per Head Cereal Consumption
- Cereal Surplus and Deficit Provinces
- Other Food Supplements
- Composite Index

Chapter-4

Regional Population and Food Consumption

In order to achieve self-sufficiency in food products, a balance has to be maintained between food supply and population. Since the country distant away from planned economy, this balance has been disturbed. Although production of some cereals has increased as a result of expansion in cropland but the productivity levels have marked decreasing trends mainly because of in-access to agricultural inputs. Simultaneously, although the growth rate of population has decreased in some sub-regions but even then the balance between consumption and production is somewhat not achievable. The study has shown that the population particularly rural masses though consume higher dozes of wheat as compared to other regions as a result of proportionately better production of wheat, but in no way this consumption level qualifies the WHO or other institutional consumption criteria. Moreover, in addition to cereals, the other food supplements of the region like vegetables and fruits have shown a marked variation particularly in favour of urban masses especially in case of latter supplement.

Population

As per the World Bank figures are concerned, the total population of Turkmenistan is 5.6 million in 2010 with a sex ratio of 1002 females per thousand males. The juvenile dependency and senile dependency has recorded 1541 thousand (27.5%) and 230 thousand (4.1%) respectively.[1]

Population Growth

Turkmenistan's population grew at an exceptionally high rate of 4 percent per annum between 1990 and 1995, but the growth rate slowed down sharply between 2000 and 2010. Overall, between 1990 and 2010 the population grew at an annual average rate of 2.4 percent, rising from 3.7 million to 5.6 million **(Fig.4.1)**. The population projections up to 2015 in the *National Program of Socio-economic Development of Turkmenistan 2011-2030* are based on an average annual growth of less than 2 percent, presumably reflecting the observed slowdown in the secular trend. The population is projected to rise from 5.6 million in 2010 to 6.4 million in 2015 at an annual average growth rate of 1.8 percent.[2]

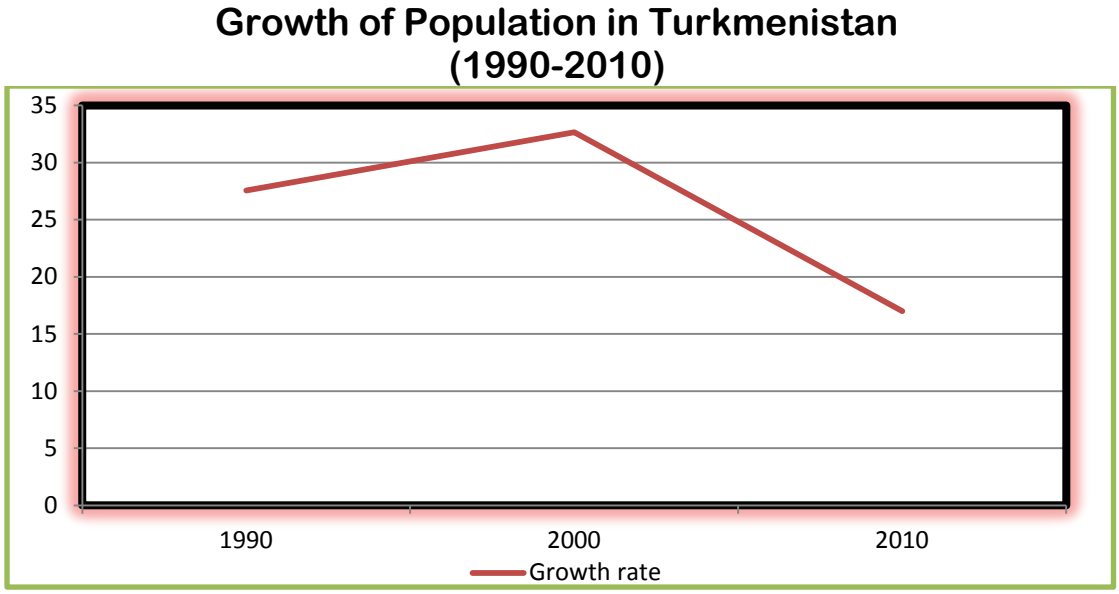

Fig. 4.1

Size and Distribution

According to the World Bank the population of Turkmenistan amounted to 56 02, 000 people in 2010 making it the fifth most sparsely populated in Central Asian States. Population density increased in the republic from one person per square kilometre in

1957 to 9.2 persons per square kilometre in 1995 while the average population density has increased to 11.40 persons km^2 in 2010. Density varies drastically between desert areas and oases, where it often exceeds 100 persons per square kilometre. The most densely populated areas are the southern, eastern and north-eastern oases; the least populated are in the republic's west; in central desert areas there is only one person per several square kilometres. The major causes responsible for variation in terms of density from region is the favourable climatic conditions, accessibility, sound agricultural base, accessibility to water, fertility of soils, irrigation facilities, opportunities for employment etc. [3]

Migration Trends

In 1989 about 45 percent of the population was classified as urban, a drop of 3 percent since 1979. Prior to the arrival of Russians in the late nineteenth century, Turkmenistan had very few urban areas, and many of the large towns and cities that exist today were developed after the 1930s. Ashkhabad, the capital and largest city in Turkmenistan, has a population of about 420,000. The second-largest city, Mary on the Amu Darya, has about 165,000 people. Other major cities are Turkmenbashy on the Caspian sea coast, Mary in the southeast, and Dashoguz in the northeast. Because much of the Russian population only came to Turkmenistan in the Soviet period, separate Russian quarters or neighbourhoods did not develop in Turkmenistan's cities as they did elsewhere in Central Asia. This fact, combined with a relatively small Slavic population, has led to integration of Turkmen and Slavs in neighbourhoods and housing projects. Apart from the outflow of small numbers of Russians immediately following Turkmenistan's independence, neither out-migration nor in-migration is a significant factor for

Turkmenistan's population. In 1992 there were 19,035 emigrants from Turkmenistan to the Russian Federation and 7,069 immigrants to Turkmenistan. [4]

Age structure is a vital component of the country. So far the age structure in the republic is concerned, it is dominated by the age group of 15-64 years. **(table 4.1)**

Table 4.1
Age Structure of Turkmenistan
(1990-2010)

Year	0-14 (000 people)	%age	15-64 (000 people)	%age	Above 65 (000 people)	%age	Total (000 people)	Growth Change (%)
1990	1264	35.0	2202	61.0	145	4.0	3611	+27.55
2000	1480	30.9	3114	65.0	196	4.1	4790	+32.66
2010	1541	27.5	3833	68.4	230	4.1	5604	+16.99

Sources: Compiled and Computed on the basis of data from CIS Statistics CD-ROM 2008-13 (1991-2000 revised from latest census data); 2001-2007 from Statistical Year Book of Turkmenistan 2006, Ashgabat, 2009.

It is evident from the above table that age group between 0-14 has shown decline by about 8 percent due to decrease in the birth rate of population. However, the age group between 14-64 showed increase from 61 percent in 1990 to 68 percent in 2010, while the age group of more than 65 years remained stable. The table further reveals that one of typical features of the modern demographic situation in Turkmenistan is the stable trend of decreasing the birth rate. The quantitative composition of each rural family shows that after 1991 the birth rate curve drastically descends, and the birth rate decreased more than two times in comparing with the demographic situation upto 1995. It should be noted that prior to the beginning of the 2000, fertility was rising, but later the demographic situation has abruptly changed towards a decreasing trend. Turkmenistan is not an exclusion from the trends prevalent

over the entire post-Soviet territory related to decline in the birth rate after disintegration of the Soviet Union. Decline in the birth rate is typical for both rural and urban areas. In the future, increase in the average life interval is mainly related to reducing infant mortality during first and second year of life. Just in these ages, there are reserves for decreasing the mortality rate, which can be realized in full.[5]

Turkmenistan is an agrarian county where about 58 percent of the total population lives in rural area who derive their livelihood from agriculture. **(table 4.2)**

Table 4.2
Rural-Urban Composition of Population in Turkmenistan
(1990-2010)

Year	Rural (000 people)	Percentage of urban population	Urban (000 people)	Percentage of urban population	Total (000 people)
1990	1985	54.9	1626	45.1	3611
1995	2453	55.3	1982	44.7	4435
2000	2702	56.4	2088	43.6	4790
2005	3133	58.0	2269	42.0	5402
2010	3245	57.9	2359	42.1	5604

Source: Compiled and Computed on the basis of data from CIA World Factbook and Statistical Year Book of Turkmenistan.

It is evident from the table 4.2 that the republic of Turkmenistan is highly agrarian because of high share of rural population and high share of agricultural labour in total labour force. Turkmenistan's high agrarian index is primarily attributable to its high share of rural population (almost 60%) and high share of rural employment (almost 50% of all employed). The share of agriculture in GDP is relatively low in Turkmenistan (less than 20%) because of the

considerable contribution of its oil and gas exports to national income as most of the national revenue is generated through the export of gas and oil.

Provinces of Turkmenistan

Republic of Turkmenistan comprises of five provinces. These are as under:

Ahal

Ahal province is located to the south-centre of the country, bordering Iran and Afghanistan along the Kopetdag Range. Its area is 95,600 km^2 and population of 1,350,000 with a density of 14.12 persons per km^2 in 2010. In 2000, Ahal Province accounted for 14 percent of Turkmenistan's population, 11 percent of the total number of employed, 23 percent of agricultural production (by value), and 31 percent of the country's total industrial production.

Agriculture of Ahal is irrigated by the Karakum Canal, which stretches all the way across the province from east to west, tracking Turkmenistan's southern border. Another water source is Tedjen River, which flows north from Afghanistan in the south-east corner of the province, passing through two large reservoirs south of the city of Tedjen. Ahal Province is administratively divided into 8 districts with 2 cities.[6]

Balkan

Balkan Province is one of the provinces of Turkmenistan. It is in the far west of the country, bordering Uzbekistan, Kazakhstan, the Caspian Sea, and Iran. It has an area of 139,500 km^2 and a population of approximately 422,000 people with a population density of 3.02 persons per km^2.

Balkan Province has significant energy reserves, which account for 94 percent of Turkmenistan's natural gas production and 12 percent of its petroleum production. It also generates 18 percent of the country's electric power. Due to the very low water supply, agriculture is negligible, and only 4.5 percent of Turkmenistan's arable lands are within the province. Balkan Province is administratively divided into 6 districts with 7 cities.[7]

Dashoguz

Dashoguz Province is situated to the north of the country, bordering Uzbekistan. The area of the province is 73,600 km^2, and the total population is 1,235,000 and having a density of 16.77 persons per km^2 2010. The province is mostly desert, and is experiencing severe environmental degradation as a result of the Aral Sea ecological catastrophe. Increased soil salinity has ruined thousands of square kilometres of farmland. Dashoguz Province is administratively divided into 8 districts with 2 cities. [8]

Lebap

Lebap Province lies to the northeast of the country, bordering Uzbekistan along the Amu Darya. It has an area of 94,800 square kilometres, and a population of 1,206,000 people in 2010. It contains the Repetek Nature Reserve and the Kugitang Nature Reserve, which has Turkmenistan's highest mountain, Aýrybaba (3137 meters). Lebap Province is administratively divided into 16 districts with 3 cities.[9]

Mary

Mary Province is one of the provinces of Turkmenistan. It is in the south-east of the country, bordering Afghanistan. Its capital is the city of Mary. Its area is 87,700 km^2 and population 1,391,000. In

2000, Mary Province accounted for 23 percent of Turkmenistan's population, 19 percent of the total number of employed, 26 percent of agricultural production (by value), and 21 percent of the country's total industrial production. The region's industries include natural gas extraction, electric power generation, textiles, carpet weaving, chemical and food industry. In 2001 it accounted for 74 percent of Turkmenistan's electricity generation 26 percent of natural gas extraction. According to other sources, Mary Province accounts for 81 percent of fertilizer production, 40 percent of textiles, 81 percent of leather, and 23 percent of footwear. Mary agriculture produces 31 percent of Turkmenistan's cotton fibres and 32 percent of its vegetable oil.[10]

Agriculture in Mary Province is irrigated by the Karakum Canal, which runs east to west through the centre of the province, and by the Murgab River, which runs south to north, entering the province from Afghanistan. While the northern portion of the province is within the Central Asian southern desert eco-region, the southern portion of the province is characterized by a savanna of pistachio and desert sedges. Mary Province is administratively divided into 12 districts with 1 city.

Area, Distribution and Density of Population (Province-wise)

Though, Turkmenistan occupies a geographical area of 499120 km^2 but it constitutes a very small proportion of population due to harsh climatic conditions, low rainfall, scarcity of water, lack of irrigation facilities, and meagre percentage of cultivable land available for cultivation. The country is having a very sparse density of population. However, there is marked variation in terms of density of population from province to province. There are some provinces

where very high density is found due to favourable geographical conditions, while as some areas are sparsely populated. **(table 4.3)**

Table 4.3
Province-wise Area, Distribution and Density of Population
(1990-2010)

Province	Year	Geographical area Km^2	Population (000'persons)	Temporal change (%age)	Density persons/km^2
AHAL	1990	95600	892	N.A	9.33
	1995	-do-	1070	19.95	11.19
	2000	-do-	1160	8.41	12.13
	2005	-do-	1256	8.27	13.13
	2010	-do-	1350	7.84	14.12
BALKAN	1990	139,500	311	N.A	2.22
	1995	-do-	353	13.5	2.53
	2000	-do-	377	6.79	2.70
	2005	-do-	399	5.83	2.86
	2010	-do-	422	5.76	3.02
DASHOGUZ	1990	73,600	741	N.A	10.06
	1995	-do-	945	27.5	12.83
	2000	-do-	1030	8.99	13.99
	2005	-do-	1128	9.51	15.32
	2010	-do-	1235	9.48	16.77
LEBAP	1990	94,800	765	N.A	8.06
	1995	-do-	965	26.14	10.17
	2000	-do-	1042	7.97	10.99
	2005	-do-	1125	7.96	11.86
	2010	-do-	1206	6.16	12.72
MARY	1990	87,700	901	N.A	10.27
	1995	-do-	1102	22.30	12.56
	2000	-do-	1190	8.05	13.56
	2005	-do-	1293	8.65	14.74
	2010	-do-	1391	7.16	15.86

Sources: Compiled and Computed on the basis of data from CIS Statistics, Statistical Year Book Turkmenistan 2006, Ashkhabad, 2009.

Density of Population

It is evident from the table 4.3 that there is huge diversity on the basis of geographical area, population and density of population from province to province. On an average, the density of population at national level in Turkmenistan is 11.40 persons per km^2 2010. However, the density of population in all the provinces is not uniform. It varies from province to province. It depends on several factors. Province of Balkan which is located to the west of Turkmenistan covers largest geographical area of 139,500 km^2 but supports a nominal population of 422 thousand persons in 2010 with a population density of 3 person km^2 while as the province of Dashoguz occupies the lowest geographical area in the region and has a population of 1,235,000 and having a density of 16.77 persons per km^2. Similarly, the geographical area in the province of Mary is 87,700 km^2 and accounts a population of 1,391,000 with a density of population of 15.86 persons per km^2. It leads to the conclusion that where climate is better e.g. the regions that lies to the southern part of Turkmenistan, the density is more than other parts of the republic where climate is neither too hot nor too cold. Another factor is whether the land is too much effected by the salinization and waterlogging. Still another factor is availability of land for agricultural purposes and other purposes. Since 80 percent of the geographical land in the region is covered by the Karakum desert. Therefore, density of population is related to the productive capacity of the soil. In the areas where land is flat, soils fertile and water supply from rainfall or irrigation adequate, population is dense. These variables have led to three levels of densities which are discussed as under:

High Density (15-20). High densities of population occur in the provinces of Dashoguz and Mary. The highest density in 2010 was found in the province of Dashoguz (16.77 persons per sq. km) due to the fact it is located on the banks of river Amu darya while as the average population density in the province of Mary has been experienced as 15.36 persons per square kilometre, but it reaches 150-200 per square kilometre in the most developed oases.

Medium Density (10-15). More than one third area of Turkmenistan has medium density. It occupies the region of Ahal and Lebap where the average densities of population have been estimated as 12.72 and 14.12 persons per km^2 respectively in 2010 slightly higher than the national average.

Low Density (Below 15). Generally speaking very low densities occur in the border lands and deserts of Turkmenistan and the areas that are agriculturally backward. The density of population in province of Balkan is estimated as 3 persons per square kilometre and it is the lowest in the republic of Turkmenistan. **(fig.4.2)**

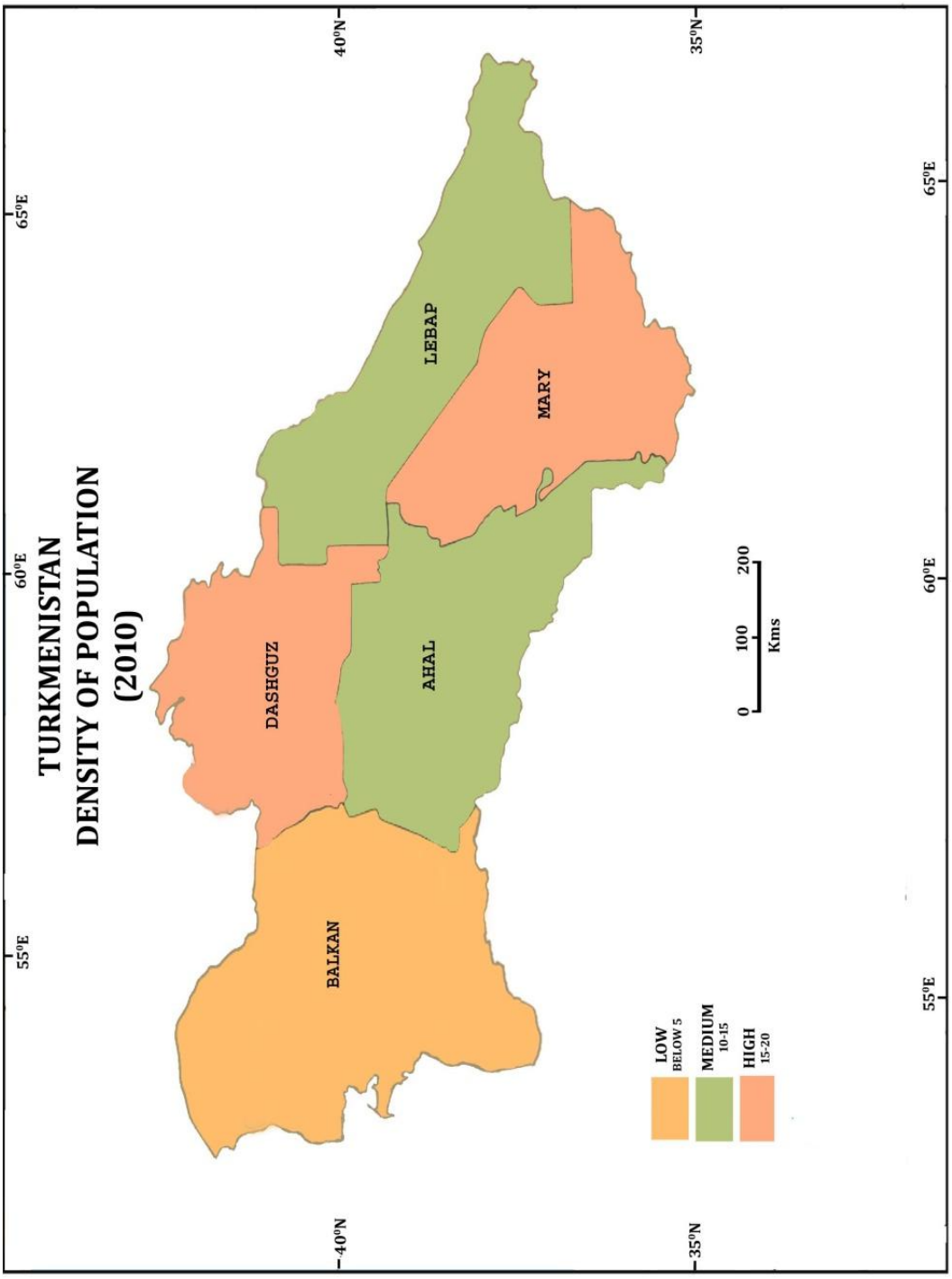
TURKMENISTAN
DENSITY OF POPULATION
(2010)
LEBAP
MARY
DASHGUZ
AHAL
BALKAN
LOW
BELOW 5
MEDIUM
10-15
HIGH
15-20
0
100
200
Kms
40°N
35°N
65°E
60°E
55°E

Fig. 4.2

Irrigated Land and Rural Population

Since Turkmenistan is predominantly rural country mainly depending on agriculture in turn depends upon irrigation owing to the fact that the landscape is mostly sandy. So, a positive correlation exists between irrigation and availability of food products for the population. Within the population rural masses play a significant role in providing foodstuffs not only for rural areas but for the urban areas as well. So the following table has been consolidated in order to show temporal variation in per head irrigated land. **(table 4.4)**

Table 4.4
Irrigated Land and Rural Population
(1990-2010)

Year	Total irrigated land, (000'ha)	Population (000)	Rural population, (000)	Irrigated land per rural person (ha)
1990	1329	3714	2027	0.66
1995	1771	4587	2526	0.70
2000	1793	5369	2906	0.62
2010	1696	5602	3133	0.50

Source: Compiled and Computed on the basis of data fromNatsional'nyi institut statistiki i infomatsii Turkmenistana.

It is evident from the table 4.4 that the expansion of irrigated area virtually ceased in 1995, the rural population continued to grow (at an average annual rate of 2 percent between 1995 and 2010. The per capita endowment of irrigated land accordingly increased from 0.5 hectares to 0.7 hectares during the three decades of rapid growth of irrigation networks (1965-1995), and then dropped back to the level of 1965-1970 (about 0.50 ha per rural person. Overall, both the population and the total irrigated area roughly tripled

between 1965 and 2010. While the expanding irrigation has not kept up with population growth, it inevitably had serious environmental implications manifested in increased soil salinity and rising groundwater table. Budgetary constraints have prevented the government from ensuring adequate maintenance of the expanding irrigation system.

Per Head Area under Cereal Crops

During the post-independence period of Turkmenistan state policy makers have increased the range of crops with the aim of making of the country self-sufficient in terms of food. Area planted to grains, particularly wheat has almost tripled since independence. **(table 4.5)**

Table 4.5
Area under Cereal Crops in Turkmenistan (per head)
(1990-2010)

Year	Total cropped area (000'ha)	Area per head (ha)	Temporal variation percentage	Area under cereal crops (000'ha)	Cereal crops per head (ha)	Temporal variation in percentage
1990	1239	0.343	N.A	176	0.048	N.A
1995	1408	0.317	-7.5	561	0.12	148.45
2000	1500	0.313	-1.26	797	0.16	33.33
2005	2002	0.384	22.68	981	0.18	12.5
2010	1597	0.284	-26.04	942	0.16	-11.11

Source: Compiled and Computed on the basis of data from the CIA World Factbook, FAO, World Bank, Statistical Year Book of Turkmenistan and United States Department of Agriculture.

The above table 4.5 shows that before independence, the Central Asian Republics were economically interdependent on each other and on the Soviet Union. The production of food and agricultural commodities were mainly organized and planned through a central

planning process, which supported the input supply and the output disposal systems. In terms of cereals, certain countries were net exporters (i.e., Kazakhstan) and certain countries were net importers (i.e., Turkmenistan, Uzbekistan and Tajikistan). Uzbekistan and Turkmenistan used to be the key cotton producers in the Former Soviet Union. During the last two decades Turkmenistan has been increasing cereal production on account of increase of area under cereal crops that is evident from the Table 4.5 which shows that the area under cereal crops have increased by 435 percent over a period of just 20 years. Similarly, the area under cereal crops per head also show positive change which increased from 0.048 hectares per head in 1990 to 0.16 hectares in 2010. The table also demonstrates that the area under cereal crops had declined by 4 percent between the periods of 2005-2011. Drought led to the decline of area and production during this period. Among other factors held responsible for the decline are climate change, untimely rains and governmental policies. Consequently, the share of area under cereal crops per head has also shown decline by 11 percent. After analysing the per head temporal variations in cereal acreage on national level, now let us examine such a situation at its sub-regional or province level.

An enormous expansion in the area sown to cereals particularly wheat was recorded in all the provinces of Turkmenistan. Since one of the main objectives of the new government led by Saparmyrat Niyazov was the *'grain programme'* which aimed to make the republic self-sufficient in terms of cereals. But there is heterogeneity in terms of area under cereals among provinces, there are some provinces which cover the largest geographical land

but constitute little cultivable land due to physical, climatic and geographical constraints. **(table 4.6)**

Table 4.6
Province-wise Area under Cereals in Turkmenistan (per head)
(1990-2010)

Province	Year	Area under cereal crops 000 (ha)	Temporal change in (%age)	Share of area under cereal crops per head (ha)	Temporal change in (%age)
AHAL	1990	46.7	N.A	0.052	N.A
	1995	149.1	219.2	0.13	150
	2000	218.4	46.7	0.18	38.46
	2005	275.3	26.05	0.21	16.66
	2010	260	-3.70	0.19	-9.52
BALKAN	1990	9.8	N.A	0.031	N.A
	1995	16.3	66.32	0.046	48.38
	2000	33.1	103.06	0.087	89.13
	2005	37.3	42.90	0.12	37.93
	2010	60	26.84	0.14	16.66
DASHOGUZ	1990	31	N.A	0.041	N.A
	1995	100	222.5	0.10	143.90
	2000	140.5	40.5	0.13	30.0
	2005	185.1	28.18	0.15	15.38
	2010	162	-4.5	0.13	-13.33
LEBAP	1990	40	N.A	0.052	N.A
	1995	130.6	226.5	0.13	150
	2000	180	3782	0.17	30.76
	2005	206.6	14.77	0.18	5.88
	2010	195	-5.33	0.16	-11.11
MARY	1990	48.5	N.A	0.053	N.A
	1995	164	238.14	0.14	164.15
	2000	225	37.19	0.18	28.57
	2005	275.7	22.53	0.21	16.66
	2010	265	-3.78	0.19	-9.52

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

The data in table 4.6 illustrates that the area under cereals have witnessed sharp increase among all the provinces of Turkmenistan since its independence. The above table indicates that during the first five years after independence, highest percentage of area sown to cereals was experienced in the province of Ahal (169% from 1990-1995). Although, the area in the province sown to cereals continued to raise upto 2005, but it decreased after 2005 period due to severe drought conditions prevailed throughout the country. Mary and Lebap provinces occupied second and third position respectively in terms of area sown to cereals where area under cereals was raised by 164 and 150 percent from 1990-1995 respectively. Dashoguz comes 4th in terms of area devoted to cereals (143%) in 1990-1995. The province of Balkan lies to the extreme west of Turkmenistan and experiences the lowest area under cereals and other crops during the period of 1990-1995 due to lack of irrigation facilities. However, there is continues increase in terms of cultivated land particularly under cereal crops u
pto 1995 due to the extension of the Karakum Canal. All the provinces of Turkmenistan except Balkan have recorded decline in terms of area devoted to cereal crops during the period between 2005 to 2010 due to drought conditions, institutional and governmental policies.

Per Head Production of Cereals

As a result of increase in the area sown to food crops, it is obvious that production of cereal crops also recorded increase which increased by 244 percent. The raise of cereal production was done by virtue of more area devoted to food crops not by increase of yield. Due to increase in food crops, the average production of food crops per head has also increased from 0.113 tons in 1990 to 0.251

tons per head in 2010. Production of cereal crops showed fluctuations from 1990 to 2010 due to change in climatic and other factors. Due to favourable climatic conditions the production and productivity increased and at the time of droughts, the production and productivity has shown decline. **(table 4.7)**

Table 4.7
Production of Cereals in Turkmenistan (per head)
(1990-2010)

Year	Production of Cereals (000 tons)	Production of Cereals per head (tons)	Temporal Change in %age	
			Production of Cereal (000 tons)	Production of Cereals per head (tons)
1990	408	0.112.98	N.A	N.A
1995	1048	0.236.30	156.86	110.71
2000	1235	0.257.83	17.84	9.11
2005	1803	0.346.18	45.99	34.26
2010	1406	0.250.89	-22.01	-27.78

Source: Compiled and Computed on the basis of data from the CIA World Factbook, FAO, World Bank, Statistical Year Book of Turkmenistan and United States Department of Agriculture.

Table 4.7 reveals that the production of cereal crops has increased by 244 per cent over a period of two decades. Same is true with the production of cereals per head which has increased from 0.113 per head tons to 346 kilogram per head in 2005. However, the production of cereals declined by 22 percent from 2005 to 2010 due to climate change and other government policies. The production of food crops increased on account of the crisis of soaring food prices particularly in the past few years which has revived the debate over food security, and underscored the need of shift to the modern concept of greater self-sufficiency instead of relying on imports. It is realized that food security is a major factor for sustainable and

stable and social development of humankind in Turkmenistan. Therefore, the country has launched a number of programmes aimed at achieving complete food self-sufficiency and increasing food production in technical crops. Targets for outlined in the president's *"Ten Years of Prosperity"* economic reform program envisaged agricultural production. Grain production was assigned particular importance. After analysing per head temporal variations in cereal production on national level, now let us examine such a situation at its sub-regional or province level.

Almost all the provinces of Turkmenistan witnessed a sharp increase in terms of area sown to cereal crops which has led to the increase in the production of cereal crops in all the provinces of the country. With the result, production of cereals per head also showed positive change. **(table 4.8)**

Table 4.8
Province-wise Production of Cereals in Turkmenistan (per head)
(1990-2010)

Province	Year	Production of cereal crops 000 tons	Temporal change in (%)	Production of cereal crops per head tons	Temporal change in (%)
AHAL	1990	112	N.A	0.125	N.A
	1995	300	167.85	0.280	124
	2000	355	18.33	0.303	8.21
	2005	560	57.76	0.444	46.53
	2010	410	-26.78	0.303	-31.75
BALKAN	1990	20	N.A	0.064	N.A
	1995	28	40.0	0.079	27.43
	2000	48	71.42	0.127	6075
	2005	70	45.83	0.175	37.79
	2010	80	-14.28	0.190	8.57
DASHOGUZ	1990	57	N.A	0.076	N.A
	1995	170	198.24	0.180	136.84
	2000	182	7.05	0.177	-1.66
	2005	239	31.31	0.212	19.77
	2010	208	-7.94	0.168	-20.75
LEBAP	1990	98	N.A	0.128	N.A
	1995	238	142.85	0.246	92.18
	2000	245	2.94	0.235	-4.47
	2005	351	43.26	0.312	32.76
	2010	271	-22.79	0.225	-27.89
MARY	1990	121	N.A	0.134	N.A
	1995	312	157.85	0.283	111.20
	2000	405	29.80	0.340	20.14
	2005	583	43.95	0.451	32.64
	2010	439	-24.69	0.316	-29.93

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

Table 4.8 demonstrates that from 1990-1995, the production of cereals particularly wheat has shown sharp increase in all the provinces by 141 percent. The raise of cereal production was done by virtue of more area devoted to cereals instead of cotton. However, the production of cereals started to slow down from 1995 onwards due to lesser area devoted to it and the republic was not able to raise the grain yield. Due to increase in cereals, the average production of cereals per head has also increased from 0.105 tons in 1990 to 0.214 tons in 1995 and it has reached to 0.240 tons per head in 2010. The highest production of cereals per head was recorded in the province of Mary 0.316 in 2010, it is followed by Ahal, Lebap and Balkan with 0.303 tons, 225 tons and 190 tons per head respectively. The province of Dashoguz has the lowest per capita production of cereals in 2010. So far as the region wise cereal production is concerned, the largest producer of cereals in the republic is the province of Mary which has recorded an increase from 121 thousand tons in 1990 to 312 thousand tons in 1995. The highest production of cereals in the province is on account of the largest land area sown to cereals and due to comparatively better yield than other provinces. The production of cereals continued to increase since 1995 due to increase in area till 2005. The production of cereals, however, showed negative trend since 2005 onwards following the combination of weak development of the private sector and poor incentives for agricultural production has reduced the willingness of rural population to invest in land and due to severe drought conditions in the 2008 and 2009. The second producer of cereals in the republic are Ahal province where grain production has increased from 112 thousand tons in 1990 to 300 thousand tons in 1995 and the production of cereals reached to 410 thousand tons in

2010. The third largest producer of cereals in the republic is Lebap and her production has increased from 98 thousand tons to 271 thousand tons in 2010. The fourth largest in terms of cereal production is Dashoguz while Balkan province has the lowest production of cereals due to least irrigated area sown to cereals.

Per Head Cereal Consumption

Production of cereal crops has increased mainly on account of increase in area under cereals. Consequently, consumption of cereal per head has also increase independence in Turkmenistan. **(table 4.9)**

Table 4.9
Consumption of Cereals in Turkmenistan (per head)
(1990-2010)

Year	Consumption of cereal (000 tons)	Per head Consumption of cereals (tons) per year	Temporal change in (%)	
			Consumptions of Cereals (000 tons)	Per head Consumptions of Cereals (Tons)
1990	922	0.255	N.A	N.A
1995	1446	0.326	56.83	27.84
2000	1532	0.298	5.94	-8.58
2005	1633	0.294	6.59	-1.34
2010	1732	0.295	6.06	0.34

Source: Compiled and Computed on the basis of data from the CIA World Factbook, FAO, World Bank, Statistical Year Book of Turkmenistan and United States Department of Agriculture

Since the consumption of cereals vary from country to country and region to region, similarly, its consumption varies from person to person; from man to woman, child to old man, female worker to male worker, white colour worker to agricultural labour. It is evident from the table 4.9 that the average consumption level of cereals

especially wheat is above the average level of some regions but the matter of the fact is that in Turkmen population particularly in rural areas the cereals are the principal component of food consumption. Table 4.9 also shows that the average annual consumption of cereals have increased by 28 percent from 1990 to 1995 due to the sudden change in the cropping pattern which was inclined towards the cereals as it is evident that the area under cereals and its production have increased by 148 percent and 111 percent during this period respectively. However, the consumption of cereals have again shown decline by 9 percent due to the fact that the food supply was not able to keep pace with the population growth. After analysing per head temporal variations in cereal consumption on national level, now let us examine such a situation at its sub-regional or province level.

All the provinces of the republic witnessed a sharp increase in terms of cereal consumption as a result of increase in area and production of cereals since 1990. **(table 4.10)**

Table 4.10
Province-wise Consumption of Cereals in Turkmenistan (per head)
(1990-2010)

Province	Year	Availability of cereals (000 tons)	Temporal change in %age	Per head Consumption of cereals (tons) per year	Temporal change in (%)
AHAL	1990	232	N.A	0.260	N.A
	1995	340	46.55	0.318	16.11
	2000	359	5.58	0.309	-2.83
	2005	383	6.68	0.305	-1.31
	2010	405	0.75	0.300	-1.64
BALKAN	1990	78	N.A	0.250	N.A
	1995	117	50.00	0.330	32.00
	2000	124	5.98	0.329	-0.30
	2005	128	3.22	0.320	-2.73
	2010	135	5.46	0.320	0.00
DASHOGUZ	1990	193	N.A	0.260	N.A
	1995	312	61.65	0.330	26.92
	2000	340	8.97	0.330	0.00
	2005	359	5.59	0.318	-3.63
	2010	389	8.36	0.318	0.00
LEBAP	1990	195	N.A	0.255	N.A
	1995	324	66.15	0.335	31.37
	2000	344	6.17	0.330	-1.51
	2005	370	9.59	0.330	0.00
	2010	386	4.32	0.320	-3.03
MARY	1990	224	N.A	0.248	N.A
	1995	353	57.59	0.320	29.03
	2000	365	3.40	0.306	-4.37
	2005	407	11.50	0.304	-0.65
	2010	431	5.90	0.300	-1.31

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

Table 4.10 clearly indicates that the consumption of cereals has abruptly increased since the independence in Turkmenistan. This change had been witnessed in almost all the provinces of the republic. The average annual consumption of cereals had increased

by 27 percent from1990-1995 and it determines the sharp increase in the consumption of cereals. However, from 1995-2010, the consumption of cereals fell by 5.7 percent in the province of Ahal, 0.30 percent in Balkan, 3.0 percent in Dashoguz, 4.5 in Lebap and 6.25 percent in Mary. It is evident from the table that the highest consumption of cereals are observed in the provinces of Balkan, Dashoguz and Lebap due to low level of economic development, they mostly depend on cereals while lowest consumption of cereals are experienced in the provinces of Ahal and Mary. Since there is inverse relationship between the consumption of cereals and development, higher the development, lower the consumption of cereals and vice versa. Although, cereal continues to be the important constituent of a household food basket, its share is declining. The structural shift in consumption pattern is on account of the consumption diversification effect because of easy access to supply, changed tastes and preferences. Increasing urbanization and economic growth reduces per capita demand for cereals and increase the demand for non-cereal food items. The provinces of Ahal and Mary are the more urbanized regions of the republic than other provinces. Therefore, the per capita demand of cereals is comparatively lower than other parts of the country.

From the above discussion, it is clear that the republic focussed on food self-sufficiency. The area sown to wheat increased by 435 percent while its production increased by 245 percent since 1990 to 2010. Similarly, the area under cereal crops per head increased by 233 percent from 1990 to 2010 while production of cereals per head by 14 percent since 1990. Due to the efforts of the respective governments of the country to achieve self-sufficiency in terms of foodgrains, the republic has not been able to achieve complete food

self-sufficiency. The republic had, however, been able to reduce the imports of cereal crops by 80 percent. **(table 4.11)**

Table 4.11
Deficit/surplus of Cereals in Turkmenistan (per head)
(1990-2010)

Year	Production of cereal 000 tons	Consumption of cereal (000 tons)	Deficit (000 tons)	Surplus (000 tons)	Deficit (%)	Surplus (%)
1990	408	922	-514		-55.74	
1995	1048	1446	-398		-27.52	
2000	1235	1532	-297		-19.39	
2005	1803	1633		+170		10.41
2010	1406	1732	-326		-18.82	

Source: Compiled and Computed on the basis of data from the CIA World Factbook, FAO, World Bank, Statistical Year Book of Turkmenistan.

The republic of Turkmenistan was highly depended on imports before independence which is evident from the table that in 1990 the region was dependent on imports by 56 percent, the republic has able to decline the percentage of imports in 2010 by virtue of increase of area under cereals and its production. **(fig.4.3)** However, the republic is not able to be self-sufficient in cereals though lot of efforts have been made by the respective governments since its independence. After analysing per head temporal variations in cereal consumption on national level, now let us examine such a situation at its sub-regional or province level.

On the basis of above facts and figures huge disparities and diversities in terms of production, consumption and deficit/surplus have been found out from region to region. There are some provinces where large irrigated area is devoted for cereal cultivation and some areas with low irrigated area sown to food crops due to lack of irrigation facilities. **(table 4.12)**

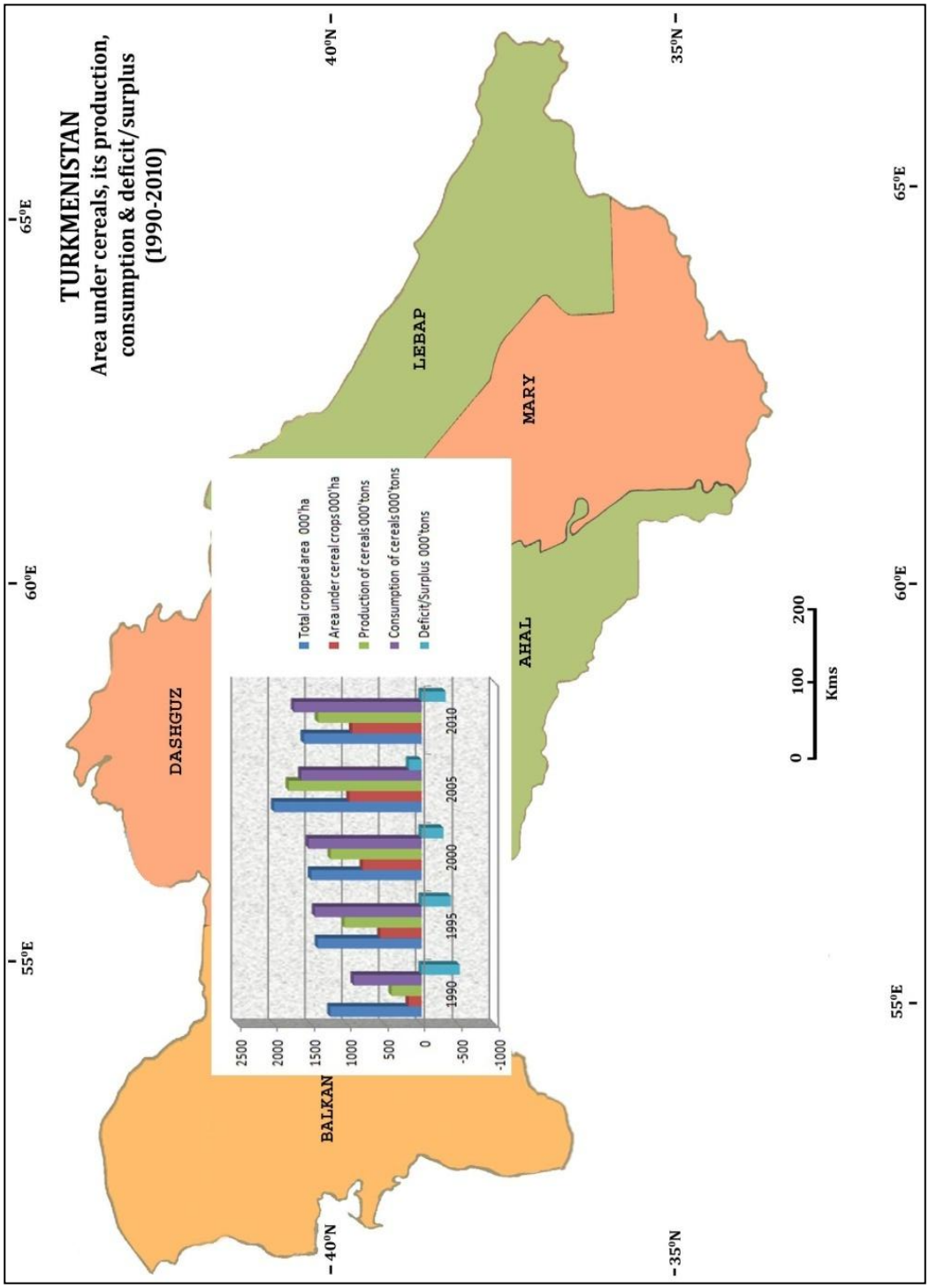
TURKMENISTAN
Area under cereals, its production, consumption & deficit/surplus (1990-2010)
65°E
60°E
55°E
40°N
35°N
LEBAP
MARY
AHAL
DASHGUZ
BALKAN
Total cropped area '000'ha
Area under cereal crops '000'ha
Production of cereals '000'tons
Consumption of cereals '000'tons
Deficit/Surplus '000'tons
2500
2000
1500
1000
500
0
-500
-1000
1990
1995
2000
2005
2010
0
100
200
Kms

Fig. 4.3

Table 4.16
Composite Index of Food Consumption
(1990-2010)

Province	Year	Consumption of							
		Cereals per head per year (tons)	Rank	Vegetables per head per year (tons)	Rank	Fruits per head per year (tons)	Rank	Food Crops	%Change
AHAL	1990	0.260	1.02	0.205	1.07	0.018	1.17	3.26	-
	2000	0.309	0.96	0.180	1.27	0.014	0.94	3.17	-2.76
	2010	0.300	0.96	0.191	1.15	0.020	1.14	3.25	2.52
BALKAN	1990	0.250	0.98	0.160	0.84	0.018	1.17	2.99	-
	2000	0.329	1.02	0.140	0.98	0.024	1.62	3.62	21.07
	2010	0.320	1.03	0.160	0.97	0.022	1.25	3.25	-1022
DASHOGUZ	1990	0.260	1.02	0.190	0.99	0.012	0.78	2.79	-
	2000	0.330	1.03	0.110	0.77	0.010	0.67	2.47	-11.46
	2010	0.318	1.02	0.120	0.73	0.011	0.62	2.37	-4.04
LEBAP	1990	0.255	1.01	0.190	0.99	0.015	0.97	2.97	-
	2000	0.330	1.03	0.110	0.98	0.012	0.81	2.82	-5.05
	2010	0.320	1.03	0.120	0.90	0.013	0.74	2.67	-5.31
MARY	1990	0.248	0.97	0.210	1.10	0.014	0.91	2.98	-
	2000	0.306	0.95	0.140	0.98	0.014	0.94	2.87	-3.69
	2010	0.300	0.96	0.205	1.24	0.022	1.25	3.45	20.20

Source: Compiled and Computed by the author on the basis of tables 4.9, 4.14 and 4.15.

The perusal of table 4.12 reveals that there are some provinces having deficiency in terms of cereals while few provinces are surplus in terms of cereal production. Deficit and surplus regions are discussed as under:

Cereal Surplus and Deficit Provinces

Deficit Provinces

- **High Deficit Provinces (50 percent)**

Though the production of cereals have witnessed increase in the republic of Turkmenistan since independence. However, it was particularly due to the increase in the area under cereals not by other measures and methods. The republic is yet to achieve food self-sufficiency and she is bound to import it from neighbouring countries. It has been found out that there are three deficit regions (Dashoguz, Balkan and Lebap) in terms of cereals in the republic. However, the province of Dashoguz had been found out the very high deficit region of cereals due to the fact that it has got the lowest yield of cereals in the republic. With the result, the province has to import cereals to meet its foodgrain demands.

- **Medium Deficit Provinces (40 percent)**

Province of Balkan was considered as the highest deficit region of cereals of Turkmenistan till 2000. However, since 2000 onwards, the province of Balkan has been able to bring more area under cereals by virtue of the extension of Karakum Canal to the region. As a result, the productions of food crops have started to increase and are expected to increase more in future. Although, the efforts have been made to reduce the dependency of cereals by bringing more area under food crops but the region is still deficit by 40 percent in cereals which is very high. The region has got the

potential to be self-sufficient in terms of food crops because the region occupies maximum geographical area in the republic.

- **Low Deficit Provinces (30 percent)**

The province of Lebap is found the low deficit region of Turkmenistan in terms of cereals. Though, the area under food crops has increased by 388 percent since independence. However, the region is yet to be self-sufficient in food crops the reasons being that it has not been able to increase the productivity of food crops due to heavy salinization and waterlogging.

Table 4.13
Province-wise Surplus of Cereals in Turkmenistan (per head)
(2005-2010)

Province	Year	Production of cereals (000'tons)	Growth rate in (%)	Consumption of cereals (000'tons)	Temporal change in (%)	Deficit/ Surplus (000'tons)	Surplus (%)
AHAL	2005	560	57.76	383	6.68	+177	+46.20
	2010	410	26.78	405	0.75	+1.23	+1.23
MARY	2005	583	43.95	407	11.50	+176	+43.27
	2010	439	24.69	431	5.90	+108	+1.86

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

Cereal Surplus Provinces

- **High Surplus provinces**

The province of Mary is surplus in cereals in the republic by about 2 percent due to the fact that the region has got comparatively maximum land under food crops and better yield. Firstly, the main advantage of Mary province is the abundance of water for irrigational facilities as well as easy access to fertilizers and pesticides. These things have helped it to improve the productivity and production of crops. Secondly, the provinces of Mary and Ahal

are the more urbanized region of the republic than other provinces. Therefore, the per capita demand of cereals is comparatively lower than other parts of the country.

- **Low Surplus Provinces**

The province of Ahal was also deficit in cereals till 2005. However, the state does provide farmers with seed and fertilizers from time to time which in turn results in better yields than other provinces. The province has also been able to increase area under food crops and has been able to maintain its good productivity. Consequently, the province of Ahal not only became self-sufficient in cereals in 2010 but it has now its surplus in cereal crop production.**(fig.4.4)**

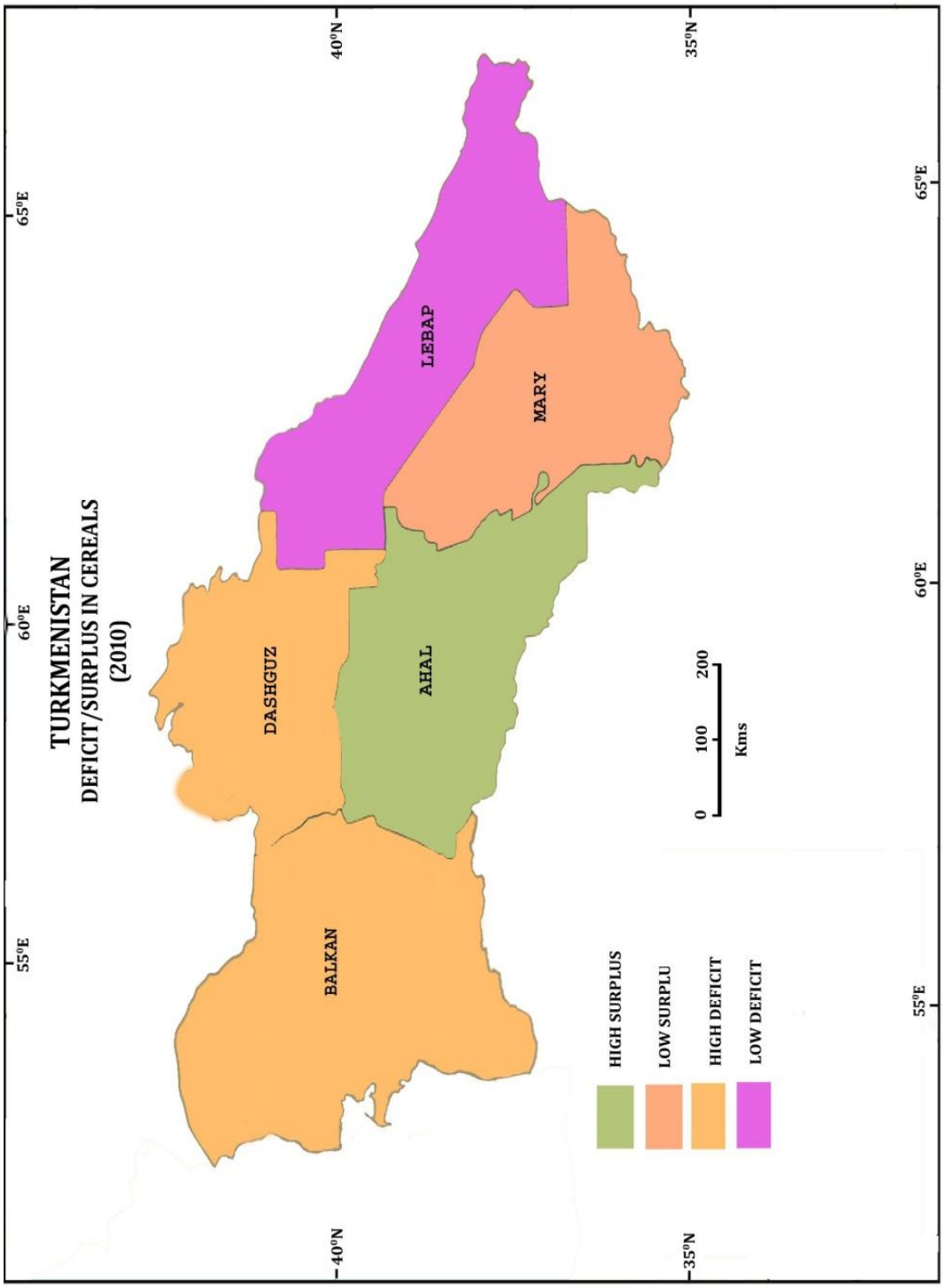
TURKMENISTAN
DEFICIT/SURPLUS IN CEREALS
(2010)
LEBAP
MARY
DASHGUZ
AHAL
BALKAN
HIGH SURPLUS
LOW SURPLU
HIGH DEFICIT
LOW DEFICIT
0
100
200
Kms
40°N
35°N
65°E
60°E
55°E

Fig. 4.4

Other Food Supplements

In addition to the mentioned cereal items, the population of Turkmenistan consume some non-cereal items which include fruits, vegetables and some dairy products. The temporal variation of supplementing these items in dietary habits reveals that prior to independence regional population particularly in urban areas where habitual of adding their calorie intake by adding the mentioned items in their diet. During the Soviet period also although there were intra-regional variations in the calorie intake but doubtlessly the intake was higher as compared to the post-independence period. Since independence the spatio-temporal variation of supplementing the cereals with fruits, vegetables and dairy products show that the areas with favourable agro-climatic setting as well as the years of favourable socio-climatic situation have shown higher intake of such items enhancing them by their calorie intake. An effort has been made in this section of the study to show the figures and analyse them in the desired manner.

Vegetables

Vegetables forms one of the important constituent of food. The production as well as productivity has increased in the republic from the period 2000 as vegetables are produced in the household farms. **(table 4.14)**

Table 4.14
Area and production of Vegetables per head (Province-wise)
(1990-2010)

Province	Year	Area under Vegetables (000'ha)	Per head Area of Vegetables (tons)	Production of Vegetables (000 tons)	Per head Production of Vegetables (tons)
AHAL	1990	18	0.0235	252	0.282
	2000	8	0.0068	104	0.089
	2010	11	0.0081	170	0.125
BALKAN	1990	3	0.0128	37	0.118
	2000	3	0.0079	36	0.095
	2010	3	0.0071	45	0.106
DASHOGUZ	1990	9	0.0188	108	0.145
	2000	7	0.0067	83	0.080
	2010	8	0.0064	92	0.075
LEBAP	1990	11	0.0196	141	0.184
	2000	8	0.0076	96	0.092
	2010	9	0.0074	109	0.090
MARY	1990	17	0.0266	231	0.256
	2000	8	0.0067	106	0.089
	2010	14	0.0100	194	0.139

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

In addition to cereals, vegetables play an important role in the diet of people living in the country. However, its production is not meeting the recommended consumption level of 210 kg per capita per year for maintaining good health. Table 4.14 shows the trend of area under vegetable cultivation has declined by 22.5 percent in all the provinces of Turkmenistan. With the result production of vegetables had also declined by 23 percent. Though there have been some improvements in the area and production of vegetable

cultivation from 2000 onwards. Many factors have caused the republic to struggle in producing an adequate supply of vegetables for the population; these include rapid population growth, detrimental climatic conditions, and extensive post-harvest losses due to poor storage and transportation infrastructure. Another reason for the differences in yield among republics in the region is that farmers in some regions are using low yielding varieties, yields vary considerably among different provinces. This is partially due to the inconsistent quality of seed used in open field vegetable cultivation throughout the region. In republic where farmers have access to higher quality seeds, yields have improved in the range of 20–25 percent.[11]

Fruits

Besides, vegetables, fruits are an essential part of a healthy diet. These are full of antioxidants and low in calories and fat content. Fruits are packed full of goodness and often contain a number of essential vitamins and minerals that cannot be found in other types of foods or they may contain higher levels of these nutrients than other foods. Fruits remain an important source of nutrients. Almost everyone needs to eat more fruits and vegetables. It is recommended that fruits are critical to promoting good health. To get the amount that is recommended, most of the people need to increase the amount of fruits. **(table 4.15)**

Table 4.15
Area and Production of Fruits per head (Province-wise)
(1990-2010)

Province	Year	Area under Fruits (000 tons ha)	Area under Fruits per head (tons)	Production of (Fruits 000 tons)	Production of Fruits per head (tons)
AHAL	1990	6	0.0067	14	0.015
	2000	7	0.0060	15	0.013
	2010	10	0.0074	27	0.020
BALKAN	1990	1.5	0.0048	5	0.016
	2000	2	0.0053	6.5	0.021
	2010	2.5	0.0061	8.5	0.020
DASHOGUZ	1990	3	0.0040	8	0.010
	2000	4	0.0038	9	0.0087
	2010	5	0.0040	10	0.0080
LEBAP	1990	4.5	0.0058	10	0.013
	2000	5	0.0047	12	0.010
	2010	8.5	0.0066	13	0.011
MARY	1990	6	0.0066	13	0.014
	2000	6	0.0050	17	0.014
	2010	8	0.0060	24.5	0.017

Source: Compiled and Computed on the basis of data from the United States Department of Agriculture, FAO, and Statistical Year book of Turkmenistan.

It is due to this fact that the country has started to increase the area and production of fruits which is evident from the table 4.15. The area under fruits showed an increase since 1990 onwards in all the republic of Turkmenistan. In the province of Ahal, area has increased by 66 percent from 1990, and in the province of Balkan an increase of 100 percent is witnessed from 1990 due to favourable climatic conditions for this crop. About 50 percent of increase in terms of area sown to fruits is recorded in Mary

province. While the area under fruits in the provinces of Dashoguz and Lebap increased by 66 and 77 percent respectively. Production of fruits has also shown an increasing trend since the independence of the republic due to increase of area devoted to fruit cultivation. Though the area and production of the fruit increased since 1990, the country does not meet the recommended need of fruits per capita for its population.

Dairy Products

Although dairy products are also a constituent of food in the study region but there is no continuous and reliable information and data available on it. Some fragmented information reveals that the country uses some dairy products in their food but the intake is almost negligible especially in rural areas.

Composite Index of Food Consumption

In order to find the overall consumption level of food products in Turkmenistan, the major three components i.e., cereals, vegetables and fruits have been clubbed together and presented in table 4.16.

Table 4.16
Composite Index of Food Consumption
(1990-2010)

Province	Year	Consumption of							
		Cereals per head per year (tons)	Rank	Vegetables per head per year (tons)	Rank	Fruits per head per year (tons)	Rank	Food Crops	%Change
AHAL	1990	0.260	1.02	0.205	1.07	0.018	1.17	3.26	-
	2000	0.309	0.96	0.180	1.27	0.014	0.94	3.17	-2.76
	2010	0.300	0.96	0.191	1.15	0.020	1.14	3.25	2.52
BALKAN	1990	0.250	0.98	0.160	0.84	0.018	1.17	2.99	-
	2000	0.329	1.02	0.140	0.98	0.024	1.62	3.62	21.07
	2010	0.320	1.03	0.160	0.97	0.022	1.25	3.25	-1022
DASHOGUZ	1990	0.260	1.02	0.190	0.99	0.012	0.78	2.79	-
	2000	0.330	1.03	0.110	0.77	0.010	0.67	2.47	-11.46
	2010	0.318	1.02	0.120	0.73	0.011	0.62	2.37	-4.04
LEBAP	1990	0.255	1.01	0.190	0.99	0.015	0.97	2.97	-
	2000	0.330	1.03	0.110	0.98	0.012	0.81	2.82	-5.05
	2010	0.320	1.03	0.120	0.90	0.013	0.74	2.67	-5.31
MARY	1990	0.248	0.97	0.210	1.10	0.014	0.91	2.98	-
	2000	0.306	0.95	0.140	0.98	0.014	0.94	2.87	-3.69
	2010	0.300	0.96	0.205	1.24	0.022	1.25	3.45	20.20

Source: Compiled and Computed by the author on the basis of tables 4.9, 4.14 and 4.15.

It is evident from table 4.16 that since independence of Turkmenistan, per capita consumption of cereals have shown an increasing trend in all the provinces of the country. This change is experienced due to the fact that after independence, the government of Turkmenistan has increased cereal production on account of increase in area in order to achieve food self-sufficiency. But the other food supplements which are one of the important constituents of diet such as vegetables and fruits have been neglected due to rising poverty except the provinces of Mary and Ahal where standard of living is comparatively better than other provinces due to better geo-climatic setting and higher urbanization. It means that there exists positive correlation between purchasing power parity and consumption of food, higher the income better the diet and lower the level of income lower the level of diet. The table further reveals that per capita consumption of cereals in the provinces of Mary and Ahal are comparatively lower than other provinces. Since, there is inverse relationship between the consumption of cereals and development, higher the socio-economic development, lower the consumption of cereals and vice versa. The structural shift is on account of the consumption diversification effect because of easy supply, changed tastes and preferences. These two provinces being the most urbanized areas, so increasing urbanization and economic growth has reduced per capita demand of cereals while the per capita demand of other food supplements like vegetables and fruits have increased. It is also evident from the table that there has been negative temporal change in all provinces of Turkmenistan from 1990-2010. However, the provinces of Mary and Ahal showed positive change in terms of

overall food consumption from 2000-2010 by 20 percent and 2.5 percent respectively. The province of Balkan which lies to the extreme west of the republic ranks third in terms of consumption of food crops, highest consumption being cereals. Balkan province also showed a positive change from 1990 to 2000 but again there was negative change in terms of food consumption. Positive change was recorded on account of increase in the per capita consumption of cereals during this period.

So far as the per capita consumption of cereals and other food supplements in Lebap is concerned, consumption of cereal has increased from 0.255 tons per head to 0.320 tons per head and the consumption of vegetable and fruits have shown dismal picture. Overall food consumption in the province has shown negative trend due to escalating poverty since independence. Lebap province ranks third after Balkan in overall consumption of food crops. Since the province of Dashoguz is located in the north of Turkmenistan, it is backward both agriculturally and industrially due to less favourable physical setting. In addition to this, mismanagement of irrigation has resulted in heavy soil salinization and waterlogging which resulted in low productivity and production of crops, thus, hampering the regional development. The table further shows that the level of income and access to food is directly correlated. Therefore, per capita consumption of other food supplements is negligible. The province of Dashoguz consumes lowest overall food supplements in the country.

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Chapter-5

Food Security; Issues and Challenges

- Urban Rural Divide
- Regional Dimensions of Food Poverty
- Prevalence of malnutrition in Children
- Food Security Prospects
- Extensive Measures
- Wasteland Management
- Intensive Measures
- Improving Soil Fertility
- Agricultural Implements
- Irrigation and Productivity Potentials
- Karez
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Chapter-5

Food Security; Issues and Challenges

Food security is an important component of regional development. Even in the era of globalization and the fast changing world order, the secured food has been envisaged as a basic ingredient of sustainable development. The preceding analysis of facts and figures about the availability of food products and their consumption alongwith the regional structure of Turkmenistan, will form the basic perspective of this chapter. The purchasing power of the people in the study region which determines the access to food, shows that a positive correlation exists positive correlation between purchasing power and food security.

The superimposition of some facts and figures analysed in the preceding chapters lead to the region being more or less self-sufficient in cereal products. The other important components of food like fruits, vegetables, dairy products etc. show a dismal picture both in space and time, particularly in case of rural areas. So far as food security is concerned, the region as a whole reflects some grave internal as well as inter-regional variations. The malnutrition, low calorie intake, imbalanced food and intake of some low graded food items due to incidence of poverty, clearly indicate the higher intensity of food insecurity in the region which since independence is being felt and addressed by respective governments, farmers and other concerned agencies.

Over the past two decades, since independence from the former Soviet Union in 1991, the Republic of Turkmenistan experienced

rising poverty, food insecurity and malnutrition. At a macro level, the national income of the republic has been deteriorating. This is evident from the declining annual gross domestic product (GDP) growth rates which are among the lowest in the world.

Lower incomes are clearly one of the most important determinants of food insecurity. As the access to food is strongly related to the level of income, poverty measures could give an accurate indication of the likelihood of food insufficiency at the household level. However, the pertinence and the usefulness of income-based poverty measures as indicators of food access, depend on the ability of these measures to take into account the different kinds of income and resources of households. It has become well known that the traditional and restrictive measures based on wages and monetary income give a poor picture of poverty as well as of food access, particularly when the informal economy and self employment constitute the source of income of an important part of the population.[1]

Before the transition, the great majority of the Turkmen population did not suffer from food insecurity and absolute poverty, even though Turkmenistan was considered as the poorest republic of the former Soviet Union. During the Soviet period, there was no official poverty line. Instead, the literature about poverty used a concept of "socially acceptable standard of living" based on a desirable diet and conditions of living. According to data on income distribution based on Soviet Household Based Survey,[2] Turkmenistan had, before transition, the second highest proportion of ''needy'' population among the FSU after Tajikistan: in 1990, about 15 percent of the Turkmen population lived below the "accounting" social minimum line. **(table 5.1)**

Table 5.1
Total Number of Poor and Average Income Per Capita ($PPP)
(1990-2010)

Year	Population (000)	Total number of Poor	Poverty head count (%)	Average Income per capita ($Purchasing Power Parity per year)
1990	3611	541	15	225
2000	4790	2634	55	155
2010	5604	2802	50	180

Source: Compiled and Computed on the basis of Data from World Factbook, FAO and World Bank, Household Based Survey, 2010.

It is evident from the table 5.1 that sharp increases in poverty in the first few years of independence at the beginning of the transition have been recorded. Based on the international poverty line of Purchasing Power Parity $ per capita per day and using per capita income as a welfare indicator, the poverty rate, increased from 15 percent in 1990 to 55 percent in 2000 and reduced to 50 percent in 2010. The above indicators show that poverty and malnutrition in the country have increased significantly following the dissolution of former Soviet Union that has affected a substantial proportion of the population. The primary reason for the increase of poverty in the republic following their independence is the deterioration of macro-economic environment, as characterized by decrease in national output and high inflation. Because of the lack of subsidized inputs and assured markets for their production, this increased level of poverty in the study region has reduced living standards, which have further resulted in high levels of food insecurity and malnutrition. It is due to poverty issues, challenges and constraints that the republic face in her efforts to reduce food insecurity and poverty.[3] However, World Bank official says that

Turkmenistan's economy will contract in future, and that the country is considered to be "highly exposed" to further poverty risks because its poverty level is above 50 percent.

Turkmenistan lags behind from other Central Asian countries in economic reform, as revealed by the European Bank for Reconstruction and Development. By most accounts, living standards in Turkmenistan have not dropped as dramatically since 1991 as they have in other former Soviet republics, although conditions are worsening. During the Soviet era, Turkmenistan was considered one of the poorest republics, with roughly 15 percent of the population living below the official poverty line in 1990. The CIA *World Factbook* reported that 55 percent and 50 percent of population was below poverty line during 2000 and 2010 respectively. Since the collapse of the Soviet Union, uneven economic developments have served to create a tiny stratum of the population in Turkmenistan that holds most of the wealth. For the average Turkmenistan citizen, the availability of food and consumer goods has declined while prices have risen. Most people continue to receive their income from state employment. Wages are based upon the old Soviet method, with people working in industry, since independence, Turkmenistan has experienced significant increases in the rural population. This growth is expected to aggravate economic conditions in rural areas. Worsening economic conditions might force many to leave the rural areas to find work in the country's urban centres. Turkmenistan's cities are not able to accommodate rural migrants seeking employment in urban industries, however, thereby keeping wages below subsistence levels. With incomes averaging around in 200 US dollars a month, Turkmenistan’s people do not appear to be benefiting from the

country's natural gas wealth as a result of a number of factors, which would have otherwise alleviated their income levels.

At the international level, the World Bank often uses $1 a day for cross-country comparisons, which has since 1990 come to be regarded as providing the absolute minimum standard of living. The $1-a-day poverty line (in 1985 PPP) was chosen based on the average of the poverty lines of 10 low-income countries, all of which were located wholly, or in part, within the tropics. It was updated later using 1993 PPP to $1.075 a day. In its 2000 and 2005 reports on poverty in Central and Eastern Europe and the CIS countries, the World Bank considers that the $1-a-day absolute poverty line is inappropriate because of the cold climate and other features of the countries in the Region. As a result, a line of PPP $2.15 per person per day was taken to measure the extent of the absolute material poverty in these countries, corresponding approximately to the cost of a very meager food basket, plus an allowance for heating, lighting and other essential non-food items. The low purchasing power parity had led to the food poverty and extreme food poverty. The concept of absolute poverty used in the different poverty surveys refers to the inability to meet the "basic subsistence needs", that are the amount of food providing a minimal daily caloric intake of 2200 calories/person/day, in addition to some non-food basic needs as clothing, heating and lighting.[4] The absolute poverty line is worked out as the current cost of the subsistence consumption basket in a country: (i) the average basic foodstuffs expenditure needed to meet basic caloric requirements (taking into account the products available on the market and the consumption patterns of the average population) and (ii) the cost of essential non-food goods and services. Moreover, an *extreme poverty line (or*

food poverty) is estimated as the cost of this food basket providing the minimum nutritional requirement of 2200 Kilo calories. **(table 5.2)**

Table 5.2
Poverty and Extreme Food Poverty Rates in Turkmenistan
(1990-2010)

Category	1990	2000	2010
Food Poverty (below 2100 calories)	20.62	28.12	27.14
Extreme Food Poverty (below 1500 calories)	6.34	8.58	9.0

Source: World Bank, Household Based Survey

It is evident from the table 5.2 that there is increase in terms of both food poverty and extreme food poverty since 1990, meaning, thereby, a large number of people are close to the food poverty line and therefore, might be considered as highly vulnerable to small risks and shocks, such as recession. However, there are large variations in terms of food poverty and extreme food poverty between rural and urban areas.

Urban Rural Divide

Most of the poor and food poor are in rural areas. With 58 percent of the Turkmen population living in rural areas, as per the data that around 43 percent of the food poor and of the extremely food poor live in rural areas. **(Table 5.3)**

Table 5.3
Poverty and Extreme Food Poverty Rates in Urban and Rural Areas in the Republic (1990-2010)

	Incidence of Food Poverty			Incidence of Extreme Food Poverty		
	1990	2000	2010	1990	2000	2010
Urban	12.5	22.8	21.8	4.1	6.9	7.2
Rural	28.5	34.6	32.4	8.2	10.1	10.8
National	20.62	28.12	27.14	6.34	8.58	9.0

Source: Source: Compiled and Computed on the basis of data from World Factbook, FAO and World Bank, 2010.

Table 5.3 indicates that most of the poverty analyses underline the gap between urban and rural areas and the higher incidence of poverty and food poverty among the rural population. As it can be seen from the table above, the incidence of food poverty is 21.8 percent in urban areas compared to 32.4 percent in rural areas while it is 27.14 percent at national level. Similarly, the rate of extreme food poverty in rural area (10.8%) is higher than in urban areas (7.1%). The poverty incidence, based on poverty line of $PPP 2.15, shows a wider difference. The poverty rate, in 2010, was 60 percent in rural areas, compared with 40 percent in urban areas.

It has been observed through various data that agricultural workers living in high food poverty due to low productivity, underemployment and greater informality of employment arrangements in agricultural sector are certainly contributing to the high rate of poverty and food poverty among the agricultural workers. However, the major factor that contributes to the very low wages and revenues and to high rate of food poverty among agricultural workers is the implicit taxation of Cotton and Grain. This taxation takes place through the low state procurement prices and

marketing policy in cotton and wheat, and the overvalued exchange rate. On the other hand, cotton is exported and the revenues, resulting from the differential between the very low procurement prices paid to farmers and the high tariffs obtained in the international market, are monopolized by the government. According to the World Bank assessment, farms receive one third of the actual value of the cotton they produce.

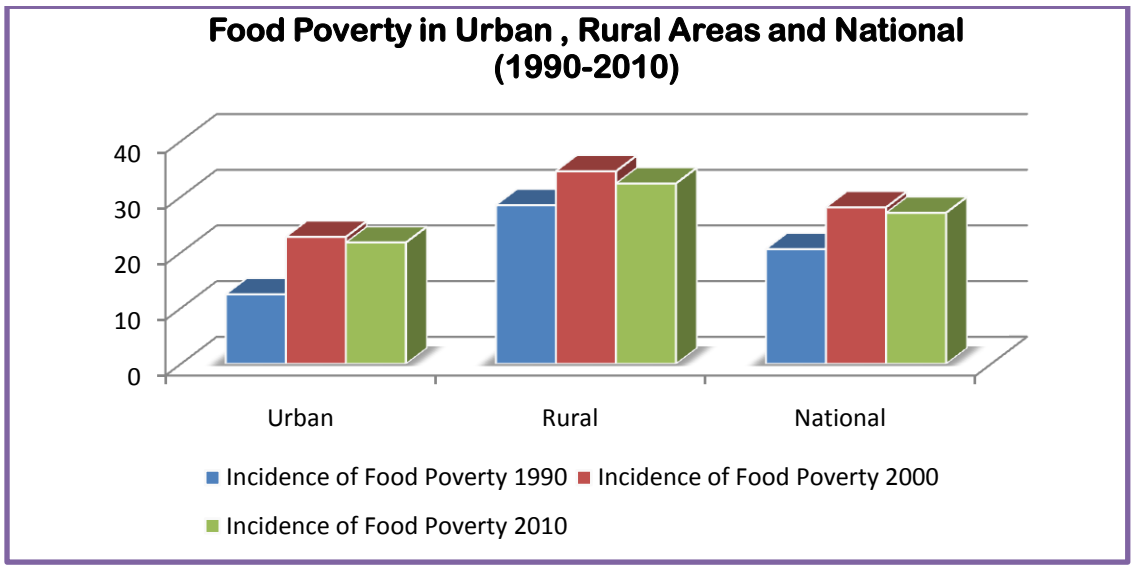


Fig. 5.1

Regional Dimension of Food Poverty

There are large disparities in terms of food poverty across provinces in the republic of Turkmenistan. Thus, it is clearly shown in the Table 5.4 that there are some provinces which have poverty below national average and few where food poverty is higher than the national average.

Table 5.4
Province-wise Food Poverty and Extreme Food Poverty Rates
(1990-2010)

Province	Incidence of food poverty			Incidence of extreme of food poverty		
	1990	2000	2010	1990	2000	2010
Ahal	15.7	22.5	20.6	4.3	6.1	5.5
Balkan	22.9	34.6	31.8	8.9	10	7.4
Dasghuz	28.4	37.4	40.2	8.4	15.4	14.5
Lebap	23.6	25.7	25.6	5.6	6.1	12.8
Mary	14.1	20.4	17.5	4.5	5.3	4.8
National	20.62	28.12	27.14	6.34	8.58	9.0

Source: Compiled and Computed on the basis of data from World Factbook, FAO and World Bank, 2010.

The gap between regions is clearly more important than the urban/rural difference. As the table 5.4 shows, the poverty rates in Dasghuz (40.2%) and in Balkan (31.8%) are significantly higher than in Ahal (20.6%), Lebap (25.6%) and Mary (17.5%), and the national average in 2010. However, the provinces of Ahal and Mary have lower incidence of food poverty than the national average. The gap is even more pronounced when looking at the rates of extreme food poverty, it is 4.8 percent in Mary, 5.5 percent in Ahal while it is 12.8 percent in Lebap followed by 14.5 percent in Dasghuz province.

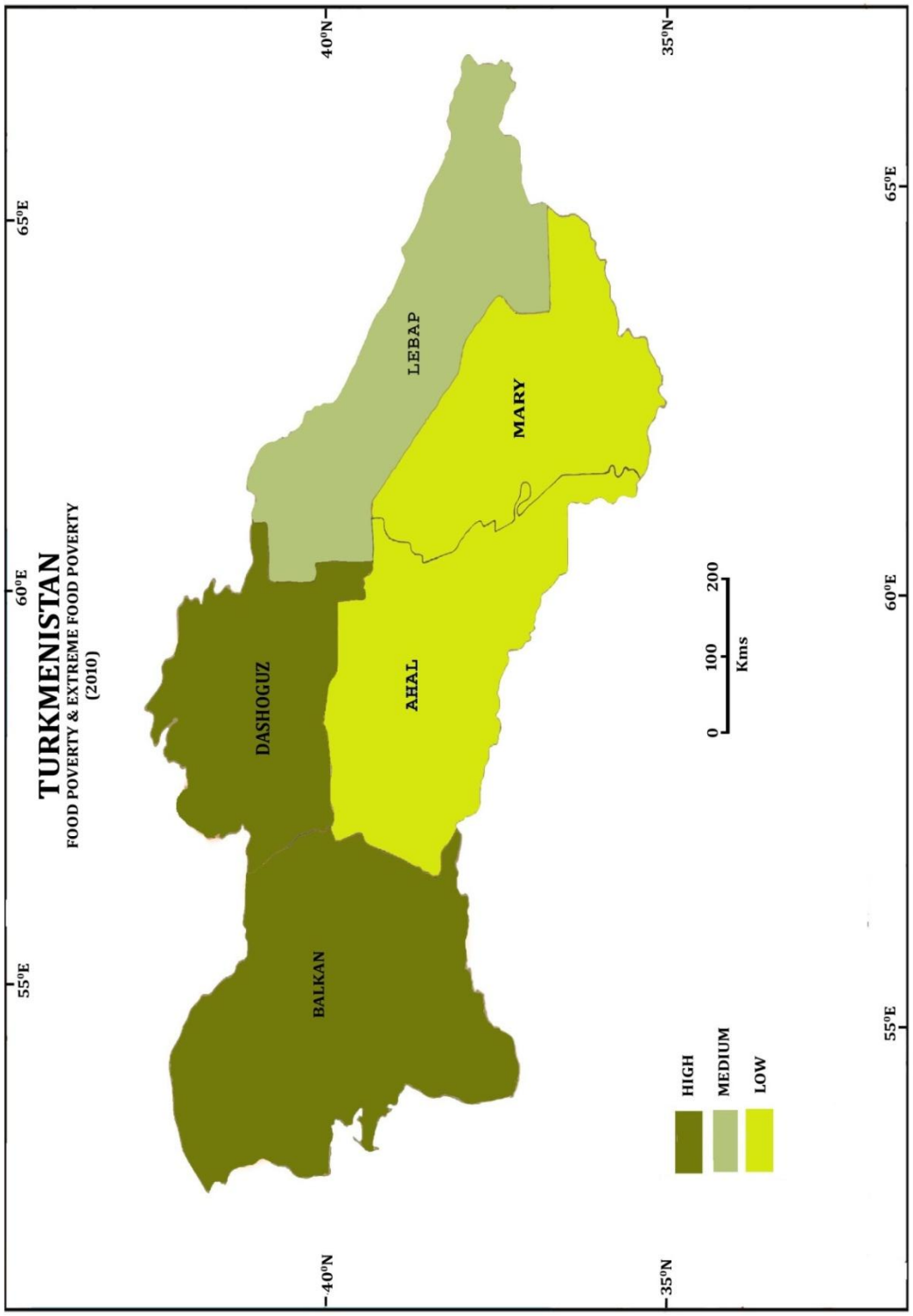

TURKMENISTAN
FOOD POVERTY & EXTREME FOOD POVERTY
(2010)
LEBAP
MARY
AHAL
DASHOGUZ
BALKAN
HIGH
MEDIUM
LOW
0 100 200
Kms
40°N
35°N
65°E
60°E
55°E

Fig. 5.2

The notion of absolute poverty is closely related to food insecurity and undernourishment. Poverty has many dimensions. The most obvious one is hunger. Having enough nutritional intake is considered a necessary condition for being free from poverty. Therefore, poverty lines are developed to ensure that incomes are sufficient to provide minimum nutritional needs – usually defined in calorific terms and serve to define the cut off between the poor and the non-poor. Those households that exceed the basic income poverty criterion should therefore not be expected to suffer from hunger. However, it is not correct to associate hunger with lack of calories alone. Although being hungry–a basic and apparent condition of poverty is usually associated with lack of food, the quality of the food consumed has long-term implications for health, longevity and human productivity. Calories are perhaps the most basic of nutritional needs and absence of enough calories constitutes an essential dimension of hunger; but other nutrients are also important. If hunger is thus defined more broadly as absence of sufficient nutrient intake for long-term good health, then the nexus between income poverty, hunger and health is wider still those who are income poor are also therefore likely to be in a state of hunger as they are not expected to be having even the basic calorie intake necessary to be free from hunger. Poverty and hunger are thus inextricably inter-linked. A vicious cycle of poverty, hunger and disease traps the vulnerable in perpetual poverty. The fulfillment of basic nutritional requirements is a necessary pre-requisite for individuals to break out of this strangle hold, realize their human potential and to participate fully in social and economic processes. **(table 5.5)**

Table 5.5
Per Capita Calorie Intake between Rural and Urban Areas
(1990-2010)

Food Group	All households			Urban areas			Rural areas		
	1990	2000	2010	1990	2000	2010	1990	2000	2010
Cereals	1329	1220	1420	1472	1414	1462	1420	1208	1338
Vegetables	62	63	63	67	63	62	63	53	63
Meat	150	80	90	125	82	120	90	50	60
Vegetable oils	278	186	204	280	170	205	204	146	156
Eggs	12	12	12	15	10	12	12	12	12
Fish	1.00	1.00	1.00	2.50	1.00	1.00	1.00	1.00	1.00
Milk	228	130	130	240	110	190	120	70	80
Miscellaneous	58	60	70	66.5	60	58	70	60	60
Total calories	2118	1752	1990	2268	1910	2210	1980	1600	1770

Source: Compiled and Computed on the basis of data from World Factbook, UNICEF, WHO, FAO and World Bank, 2010.

Table 5.5 indicates that there is decline in terms of calorie intake particularly in dairy and meat products. Data available suggest a decline in household food security following independence. The decreasing level of consumption in the republic was accompanied by changes in diet composition. In particular, on non-food items declined more than spending on food, and while expenditures on bakery and bakery products changed little, meat and dairy product consumption fell to a large extent. During the period 1990-2010 in Turkmenistan, dairy products declined by 40 percent. Overall protein consumption has also declined sharply. Deteriorating economic conditions and escalating poverty has contributed significant reduction in the mentioned items. Table further reveals that huge variations in terms of food consumption kcal per person per day from 1990 to 2010. There has been a net decrease in the available daily energy supply in Turkmenistan from 2118 in 1990 to

1752 in 2000 calorie/capita/day. However, there was little improvement in terms of calorie intake and poverty following bumper cereal crop production on account of favourable climatic conditions in 2005 in the region. However, since 2008 onwards climatic conditions have become worse, droughts are common which led to the decrease with regard to both irrigated area and productivity and production of crops. The average daily calorie supply per capita amounted to 1990 kcal in 2010, but wide variations exist between urban and rural area. However, according to dieticians, human needs 2200 kcal, 100 g of protein, 100 g of fat, and 400 g of carbohydrate for normal nourishment. Actual food consumption was estimated to be 2118 kcal in 1990, 1752 kcal in 2000, and 1990 kcal at present. It means that most of people are undernourished particularly people living in rural areas. The republic has achieved mixed results with regard to food supply and consumption. There is a concentration of poverty among nomadic populations with small herds and semi-arid-land shepherds. A smaller group of extremely poor includes widows, sick and disabled older people, who depend heavily on direct state support. Malnutrition and lack of medical services, especially in rural areas remains a serious health problem in the republic.

The results of the low purchasing power and incidence of poverty are presented in the table above. They show that:

- More than one quarter of the population (27.14%) have, in 2010, total food consumption below the value of 2200 Cal per capita per day.
- Nine percent of the population consumes below 1500 calories per capita per day. This rate of extreme food poverty and its persistence are all the more alarming and can lead to serious health consequences.

Prevalence of Malnutrition in Children

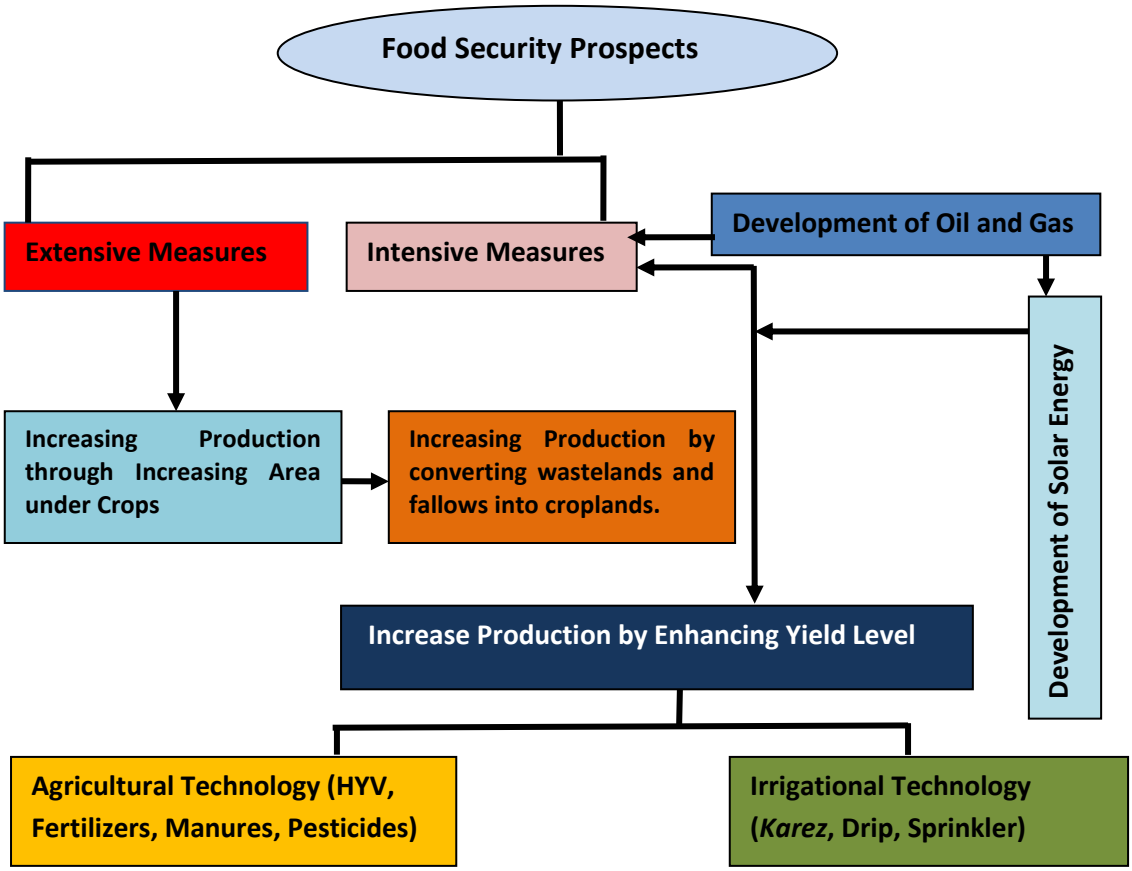
The direct impact of poverty has been observed in all sections and in all spheres of life, but the future nation builders i.e. children have been effected much. Prevalence of child malnutrition is the percentage of children under age of five years whose height for age (stunting) is more than two standard deviations below the median for the international reference population ages 0-59 months. In Turkmenistan, around 24 per cent of all children below the age of three are too small for their age, 13 per cent are underweight and at least 12 per cent are wasted. Many of these children are severely malnourished. The prevalence of malnutrition varies across provinces, with Dashoguz recording the highest rate (25 per cent) and Ahal among the lowest (17 per cent). Malnutrition in children is not affected by food intake alone; it is also influenced by access to health services, quality of care for the child and pregnant mother as well as good hygiene practices. Girls are more at risk of malnutrition than boys because of their lower social status. Malnutrition in early childhood has serious, long-term consequences because it impedes motor, sensory, cognitive, social and emotional development. Malnourished children are less likely to perform well in school and more likely to grow into malnourished adults, at greater risk of disease and early death. Child malnutrition has several social, economic and health consequences for the individuals, families and countries. In particular, malnutrition has a direct and strong connection with the incidence and spread of infectious diseases. It is great cause of concern that about 24 percent are still under-height. Policy makers need to focus on provinces where malnutrition levels are very high and where conditions causing malnutrition prevails.

Food Security Prospects

The ugly predictions about the future development of Turkmenistan can be neutralized, to a large extent, by managing its major resources i.e. agriculture and hydrocarbon, properly and using them judiciously. After examining its regional structure mainly climate, soil and relief and analyzing it with existing agricultural production, yield level, there appears some hope of improving production and productivity through different measures. Also, land use and cropping pattern can also be modified in favour of more profitable and sustained products, particularly cereals and other allied products. With a vigil on population growth, and simultaneously, to work for more sustained and suitable food products, income levels and purchasing power of the people can be increased, dwarfing the most prevalent social stigmas like malnutrition of children, illegal economic activities and other related socio-economic issues.

The hydrocarbon being a non-renewable resource which can exhaust anytime depending upon the incidence magnitude and use proficiency, agriculture is the only sustained resource in whose security lies the real development of the country. Agricultural sector which has some region-specific prospects as well as some limitations, can be developed through a set of inter-related measures which include local-non-local integrated initiatives. The intensive and extensive agriculture has something more to offer which can improve per capita income of farmers of the region, in particular, and the nation, in general. Apart from the area-specific farming technology, Turkmenistan has much potentials of developing its agricultural sector by attracting the foreign investors to invest in hydrocarbon sector, and a part of the revenue generated can be invested into developing the agricultural

infrastructure. Moreover, Turkmenistan has much potentials for developing solar energy, which also can help to develop the agricultural sector through mitigating the absence of hydro-power needs. In addition, the agro-institutional measures also can go a long way in reducing the food insecurity threat in the country.



It has become inevitable for the republic to improve the food situation in the country in order to cop up with the increasing population. Turkmenistan has much potential to improve the food situation in the country through the development of food sector. However, food sector can be improved with the help of two broad measures i.e. extensive and intensive measures.

Extensive Measures

Production of food in the country can be increased by converting wastelands and fallows into croplands. Turkmenistan is an arid and semi-arid country where about 80 percent of the total land is covered by Karakum desert while as inefficient and faulty irrigation system rendered lot of cultivable land into wastelands.

Wasteland Management

Management of wastelands has become inevitable in the country to increase the food production as only four percent of the total land is suitable for agricultural purposes while major portion of the country is deserty. Hence, it is imperative that the country should convert wastelands into croplands but simultaneously ecological balance has to be maintained. **(table 5.6)**

Table 5.6
Sprawl of Wastelands due to Inefficient Water Use
(1990-2010)

Indicators	1990	2000	2010
Water consumption for agricultural use km^3.	18.66	20.43	17.86
Wastelands (000'ha)	50	98	100

Source: Compiled on the basis of data from Rossyskaya Gazeta, Vedomstvennoye, Prilozheniye, Ekonomiehesky Soyoz and N-Orlovsky and L-Orlovsky.

It is evident from table 5.6 that wastelands increased from 50 thousand hectares in 1990 to 100 thousand hectare in 2010 due to merciless and inefficient water-use. The development of wastelands has already ruined a good acreage of cultivable land, if unchecked will continue to affect the remaining land also. In short, unless the country adequately safeguards the area of good land we may

eventually face a serious shortage of land and food. It is, therefore, imperative that the republic should move in the direction of an integrated approach for the conservation and development of land resources. The methods which are adopted for the reclamation measure should take into account the causes which led to the development and deteriorating soil conditions of the land in association with morphometric, climatic, hydrological parameters, including suitability and quality of the soil for producing a particular crop. These factors have to be fully considered before appreciating any technique or methods of reclamation measures of any types of wasteland. Thus, in practice reclamation measures of such deteriorated lands have to properly judged in the light of basic conditions with special attention paid to environmental factors in association with anthropogenic factors which are responsible for the development of different wasteland types.

Further, the concept of sustainable development involves rational and successful management of resources either natural or human through technology and efficient energy systems to satisfy human needs by maintaining or enhancing quality of environment. The growth, production and their equitable distribution and protection of environment are equally relevant for improving the quality of human life and fragile ecosystem. There is a growing awareness about the need to substitute current production system with a more sustainable and irrigated system.

Intensive Measures

Production of food crops of Turkmenistan can also be increased through improvement of yield of crops. However, in order to improve yield levels, a number of factors are involved in the process such as improving soil fertility through the application of fertilizers,

manures, pesticides etc. Moreover, the introduction of high yielding varieties as well as soil relevant crops can also prove helpful in improving the food situation. The situation can also be improved through the application of irrigation technology. It simply means that both agriculture as well as irrigation technology need to be developed in order to get the desired results.

So far as the magnitude of fallow land is concerned, Turkmenistan has 4 percent of its agricultural land as fallows as per the records available for 2010. Before, 2010 such figures have shown fluctuations from time and from region to region depending upon changing climatic variables, attitude of farmers and decision making process of political leaderships. An analysis of data and information on fallow lands reveal that these lands can be converted into cropland after crop rotations which have the added ability to regain soil fertility. So a serious attempt in this direction will go a long way in solving the food problems within the republic.

Improving Soil Fertility

Population growth will continue to outstrip growth in food production for a long time to come unless serious action is taken to accelerate agricultural productivity and reduce growth of population. Fertilizer is a critical input for improving production and increasing crop yield. Chemical fertilizers have been primary means of enhancing soil fertility in agriculture. Farmers in Turkmenistan use very low levels of fertilizers **(table 5.7)**

Table 5.7
Use of Fertilizers and Productivity of Food Crops
(1990-2010)

Year	Fertilizers (kg/ha)	Yield (tons/ha)
1990	20	2.31
1995	3	1.86
2000	5	1.54
2005	4	1.83
2010	7	1.49

Source: FOASTAT

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad \rho = 0.280$$

After the application of Spearman's correlation, there seems positive correlation between the independent variable of fertilizers and the dependent variable of agricultural production in the republic and the calculated value of "p" comes 0.280. Agriculture in the republic faces a growing soil productivity crisis. Unsustainable farming activities have severely depleted soil nutrients throughout much of the region. The intensive use of inputs is one of the primary means used to smooth out variations in growing conditions in the hopes of obtaining desired yields. The table further indicates that fertilizer use in the country meanwhile is by far the lowest of any developing region. Farmers apply about 7 kg per hectare of fertilizer in Turkmenistan, compared to 56 kg per hectare in Kazakhstan, 104 kg per hectare in South Asia, and 142 kg per hectare in Southeast Asia. Low fertilizer use and inappropriate land and water management contribute to Turkmen's lagging agricultural productivity growth and the related decline in food production per capita. In Turkmenistan, cereal crop yields average about 1.49 tons

per hectare which is very low if it is compared with the region having similar agro-climatic condition such as Uzbekistan and Kazakhstan. However, there are some provinces having yields in cereals crops with more than 2 tons per hectare such as Mary and Ahal partly due to good irrigation facilities, good climatic condition and good quality of soil and most importantly easy access to fertilizers and pesticides. Other provinces like Dashoguz, Balkan and Lebap are food deficit owing to low productivity of cereal crops than other provinces of Turkmenistan.[7] Differences in land quality and climate are the part of the reason, but so is province's low fertilizer input, removing subsidies in the absence of credit and remunerative out prices has resulted in falling demand for the input. Low level of fertilizers has resulted in low crop yields.

Timely availability of chemical fertilizers, use of High Yielding Varieties and insecticides at the time of sowing and maturity are necessary to improve the soil fertility as well as productivity of crops. The increased use of fertilizers has great regional potential for boosting food production and promoting agricultural development. Furthermore, increased and efficient fertilizer use can help reverse the declining trend in per capita cereal production experienced in many provinces of the country, (Dashoguz, Lebap and Balkan) without having adverse environmental consequences. An attempt has been made to see the role of innovation of new technology for agricultural development in Turkmenistan. Technical aspects are one of the important forces which alter the structure of agricultural production process. In order to improve crop yield, all the provinces of the republic should increase fertilizer input per unit area in general but Balkan, Dashoguz and Lebap in particular. Adequate and timely supply of necessary nutrients not only improve crop yields, but will also provide relatively higher amount of crop

residue, which can be used as organic matter to improve soil health and prevent soil degradation. Future increases in food must come primarily from higher yields per unit of land rather from land expanse.

Agricultural Implements

There are a number of implements whose growing intensity in Turkmenistan can also help to ease the situation of food insecurity, which includes tractors, threshers and harvesters and other advanced machinery. Turkmenistan is lucky enough to have big state farms where such implements and associated technology can yield better. Although, in the absence of subsidy and other support to farmers, such technology is not possible to be used by everyone. However, the financial assistance extended by banks and other credit organization can come forward to help the needy ones. **(table 5.8)**

Table 5.8
Use of Tractors and Productivity of Food Crops
(1990-2010)

Year	Tractors (000'ha)	Yield (tons/ha)
1990	20	2.31
1995	4	1.86
2000	3	1.54
2005	7	1.83
2010	7	1.49

Source: FOASTAT

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)}$$ **ρ=0.125**

It has been found out that there exists positive correlation between the use of tractors by applying Spearman's correlation. As seen from the table that tractors and other machines are the key

material inputs for Turkmenistan's agricultural sector. Turkmenistan was wholly depended on Russia for the supply of machines and tractors during Pre-transition. After acquiring independence Turkmenistan's ability to maintain the volume of imports of tractors dependent on its ability to generate hard currency with which it could pay to Russia or an alternative supplier. With the result of poverty there was continuous decrease of the number of imported machinery as well as the deterioration of their quality. Thus, the country was receiving 7500 new tractors from the USSR before independence. That number dropped to 6600 or 12 percent by the next year while show some improvements after 2000 onwards. It is evident from the table above that the distribution of tractors has shown a wide variation. Large number of tractors was used before independence but the density of tractors has decreased since the independence of Turkmenistan with some improvements after 2000. There is intimate relation between the technology and productivity. The republic should increase the number of tractors per unit area as well as to improve the quality of machinery so that a balance could be achieved. Consequently, productivity of crops could be increased which will play a significant role in declining the food insecurity and improve the economic conditions of the people.

Irrigation and Productivity Potentials

Agriculture growth has remained one of the foremost components of development strategy in the republic particularly in view of the long Soviet agrarian policy and owing to comparatively weak industrial base of the region. With the overall strategy in agriculture growth, irrigation has been accepted as major programme for modernizing Turkmen's agriculture. Irrigation has been assigned such a crucial role because this is a single most important factor which can facilitate the future utilization of the scarce farm land

resources and can facilitate acceptance of improved technology. While examining the performance of irrigation vis-à-vis agricultural development, it has been observed that irrigation has played a significant role in shaping the agriculture of the region and no other factor seem to be so decisive. The impact of other factor, which could had a pronounced influence on agriculture and its pattern of productivity.[1]Here agriculture productivity, the strongest indicator of agriculture development, is positively correlated with irrigation intensity and water-use efficiency. Thus, its productivity and additional production generated an extended cropland which gives shape to the production scenario of the region. **(table 5.9)**

Table 5.9
Irrigation and Productivity of Food Crops
(1990-2010)

Year	Area (000'ha)	Production (000'tons)	Xy	X^2	y^2
1990	176	408	71808	30976	166464
1995	561	1048	587928	314721	1098304
2000	797	1235	984295	635209	1525225
2005	981	1803	1768743	962361	3250809
2010	942	1406	1324452	887364	1976836
	∑x=3457	**∑y=5900**	**∑Xy=4737226**	**$\sum X^2$=5663631**	**$\sum y^2$8017638**

Source: compiled and Computed on the basis of Tables 4.5, 4.7.

r=0.40

After the application of Karl Pearson's correlation, there exists a positive correlation between the irrigated area and level of agriculture production and change in one variable is responded by almost proportionate change in the other variable. Thus, the most important determinant of improved and sustainable agricultural productivity in the republic is irrigation, because irrigation has long

played a key role in feeding expanding population and is expected to play a still greater role in the future. Sustainable and increasing productivity on irrigated lands by means of improving water use efficiency is essential for the overall food security in Turkmenistan.

As per the data and information, it has been observed that the republic is not so water deficit. What has made it so, is the lower irrigation efficiency of water in every sphere of life particularly in irrigation sector. It has been worked out by the formula that field efficiency in the country is 50 percent while the conveyance losses are in excess of 50 percent of water withdrawals and overall irrigation efficiency is about 45 percent. If the maximum benefit is to obtained from a water supply it must be used in the most appropriate manner and after use it must be disposed off or reused satisfactorily. For irrigation to give sustained and satisfactory productivity, it is not enough simply to see that a particular set of subsystems function well, but water supply, use, disposal and or reuse system interacts with other systems. Therefore, the production-marketing system, land management system and so on, also have to be taken care of.

Sustainable management of land and water resources in arid and semi-arid regions like Turkmenistan is of concern as a result of increased population pressure and the need for more food. Irrigation has long played a key role in feeding expanding populations and is expected to play a still greater role in the future. Sustaining and increasing productivity on irrigated lands by means of improving water use efficiency is essential for the overall food security in Turkmenistan. The trend of agricultural productivity vis-vis irrigation efficiency in the region **(table 5.10)**

Table 5.10
Agricultural Productivity at various Stages of Irrigation Efficiency

	Irrigation efficiency (33.26%)		*Irrigation efficiency (35.83%)*		*Irrigation efficiency (75%)*	
	Productivity Index		**Productivity Index**		**Productivity Index**	
	Cereals	*Commercial*	Cereals	*Commercial*	Cereals	*Commercial*
Turkmenistan	***1.124***	***0.964***	***1.550***	***1.774***	***1.645***	***1.995***

Source: Resource Management Regional Cooperation and Sustainable Development in Central Asian States,

Table 5.10 indicates that if we compare the productivity of cereals and commercial crops at two irrigation efficiency levels i.e. 33.26 percent and 35.83 percent, we observe that the republic of Turkmenistan has shown a marked increasing trend in both cereals and commercial crops while improving their efficiency. The irrigation efficiency rate has increased from 33.26 percent during the first phase upto 35.83 percent in second phase, can be raised upto 75 percent which is possible if some measures are taken. It is evident from the table that there exists positive correlation between irrigation efficiency and productivity of crops. It is the better water-use which has improved the productivity from the first to second phase and it will improve at a higher efficiency degree. The logic behind the possibilities for improving the existing irrigation efficiency upto a rate of 75 percent or more is directly or indirectly connected with irrigation management in the region.

So in order to improve the agricultural productivity, dominant economic sector and simultaneously to reduce the salinity menace especially in the provinces of Dashoguz and Lebap, irrigation efficiency has to be improved which is possible through the application of modern irrigation technology and some water

management devices. On the management side, irrigation constitutes of three sub-systems viz. water delivery subsystem, the farm subsystem and water removal subsystem. For a sustained agricultural productivity, all the subsystems must function satisfactorily. With regard to irrigation technology, among the three (surface, subsurface and overhead) irrigation methods, the devices of drip and sprinkler methods which are comparatively recent innovations are recommended for the region.

At the present time the optimal solution for water problems is revision of national water management strategies. Sustainable water management which is pre-condition for food security can be achieved through a number of measures such as:

(i) The Water Delivery Sub-system.

(ii) The Farm Sub-system.

(iii)The Water Removal Sub-system

Water Delivery Sub-systems

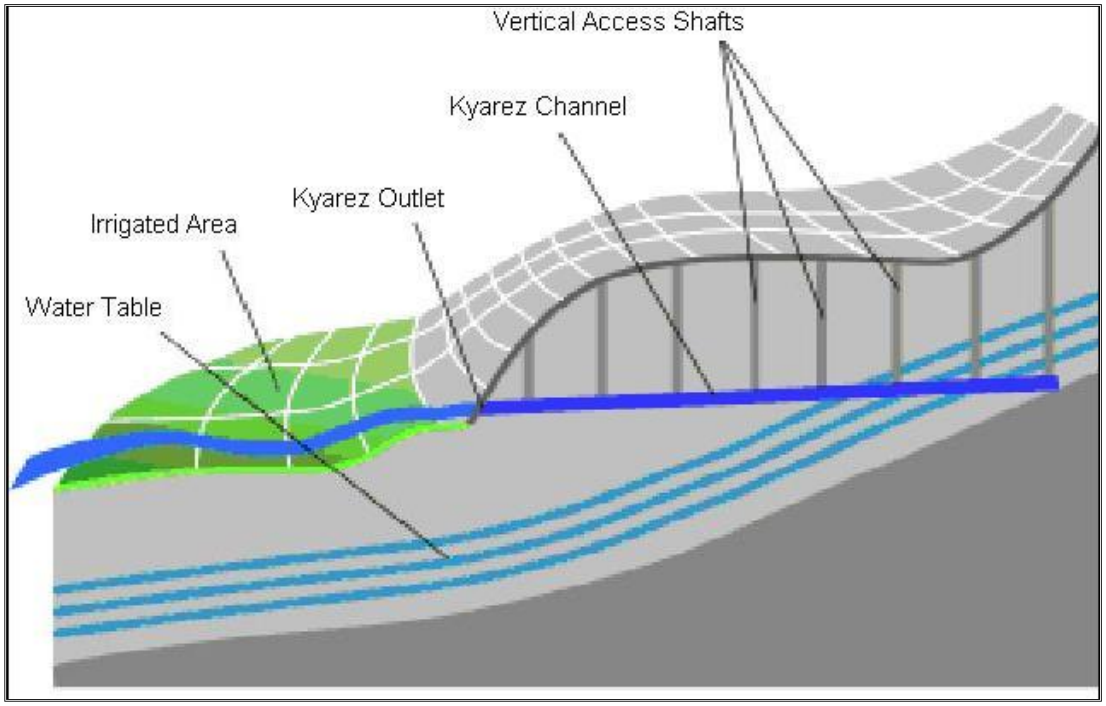
The water delivery sub-system encompasses the source, conveyance, allocation and distribution of water as for as the users turn out is concerned. Conveyance takes place by main canals, pipelines or aqueduct systems. In the desert border regions the amounts of precipitation is very low and are very unevenly distributed. In these regions, agriculture without irrigation is possible only when water is used extensively, and the most obvious way is to reduce conveyance losses from canals supply system is to route canal to take advantage of topography and line any which leak at unacceptable levels. Lining is only worthwhile when the water resources is limited and the water losses exceed the cost of installing and maintaining canal lining if leakage causes environmental problem. Conservation of water by the lining of

canals etc is possible with plastic films. Also, there could be conveyance of water to far flung distance through plastic pipes, leaving least chance of water loss through leakage, evapo-transpiration etc. In this sub-system the technique *Karez* is used.[8]

- ***Karez (Quanats)***

Karez system is important because this system represent one of the most ecologically balanced water recovery methods available for arid and semi-arid regions. *Karez* tap the groundwater potential only up to, and never beyond the limits of natural replenishment and, as a consequence, do not upset the hydrological and ecological equilibrium of the region. As the *Karez* often dug into hard subsoil, there is little seepage, no rising of the water table, no waterlogging, no evaporation during the transit and hence no salinization in the area surrounding the conduits **(Fig. 5.3).** It should be widely used for several reasons. First, unlike other traditional irrigation devices, such as the counterpoised sweep, *karez* require no power source other than gravity to maintain flow of water. Second, water can be moved over substantial distances through these subterranean channels with minimal evaporation losses and little danger of pollution. Finally, the flow in a *karez* is proportionate to the available supply in the aquifer and, if properly maintained, these irrigation canals could provide a reliable supply of water for centuries. Moreover, *Karez* rely entirely on passive tapping of the water table by gravity only, whereas the extractive pumps consume an enormous amount of fuel per year.[9]

Karez Irrigation System



Source:www.wikipedia.org

Fig. 5.3

The Farm Sub-System

This sub-system consists of a network of channels, pipes more often unlined ditches which contribute water from the turn out or where the farmers have access to water (tube well, well, spring, stream etc.) to the point where it is actually applied to crops. The water losses are high in this stage. The amount of water which reaches a plot of land is usually less than 70 percent or less.[12] Farm losses of the region vary from source to source, province to province and year to year, but with a certainty that the losses at this stage are higher, indicating there by, lower field irrigation efficiency.

(i) Water Removal Sub-system

Drainage is one of the most critical aspects of irrigation. Sustained productivity depends almost as much on getting rid of excess water as on getting enough to irrigate with. This sub system pertains to installation of drainage system to control ground water levels and/or to guide surface runoff to where it can be safely disposed of when return flows are badly contaminated with salts or agro-chemicals, a collecting pond or sump may have to be constructed to hold them until they are rendered safe or can be harmlessly released. Central Asian States especially in pre-independence phase, to the extent that the benefits of irrigation are being balanced by the losses rendered by poor drainage system. So far the technology options for drainage are concerned, field or farm drainage involves installation of techniques to remove, excess water.[13] The main problem related to irrigation development within republic care mainly associated with the management faults, techniques.

On the basis of method of water application there are basically two types of irrigation i.e. Surface irrigation and sub-surface irrigation,

but due to the higher efficiency the overhead irrigation method has been added.

Surface Irrigation Method

In this method of irrigation, water is applied directly to the soil surface from a channel located at the upper reach of the field. Water may be distributed to the crops in border strips, check basins or furrows. Two general requirements of prime importance to obtain high efficiency in surface methods of irrigation are properly constructed water distribution systems to provide adequate control of water to the fields and proper land preparation to permit uniform distribution of water over the field.[15] Thus, for all surface irrigation methods there is what is known as minimum unit stream i.e. the ratio of the size of irrigated plot to the rate of water delivery, necessary to achieve uniform water distribution for a given depth of irrigation. The terrain is important in determining the surface method irrigation used. Sprinkler, Drip or Pitcher irrigation is better than any surface technique when an infiltration is rapid. However, current irrigation practices could be made much more water efficient if, for example, excess water flowing off the irrigation plot (return flow) were pumped back to the water distribution system for reuse.

The irrigation methods available today offer the potentials of improving the agricultural productivity, and simultaneously reducing the chance of water losses during conveyance from source to fields, and decreasing the acreages under wasteland, through lesser possibilities of salt built-ups and anaerobiosis, given a better irrigation management policy. Moreover, such techniques have capacity of considerably reducing the crop failure, and have the added ability to offer considerable indirect benefits, like improving

the sustainability of productivity. These techniques include sprinkler irrigation and drip irrigation recent innovation, are probably that which mimics natural rainfall. In this type of irrigation method, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall.

Overhead Irrigation

Over-head techniques have no such costs but require expenditure on piping work, water emitters and pumps. Over head irrigation methods are comparatively recent innovations and in future its costs and disadvantages are likely to decline and have capacity to offer greater water-use efficiency and control over water application by comparing the field irrigation efficiencies of various irrigation methods. The sprinkler or over head irrigation has the highest efficiency (60-80 percent) followed by surface-basin border-furrow corrugation (40-60 percent) and flooded rice 30 percent.[10]

- **Sprinkler Irrigation**

So far as the state of Turkmenistan with respect to Sprinkler irrigation is concerned, no sprinkler irrigation is practized there. Such type of technique is suitable for flat areas, Turkmenistan is the plainest country of Central Asia. This technique is, therefore, suitable so far as the topography and climate of the country is concerned. If this system is designed and operated properly, this is very effective application method, which can be used over wide range of soil conditions. These techniques are very much suitable for the provinces of Lebap and Dashoguz as these two provinces are heavily salinized particularly the province of Dashoguz where most of its cultivable land is rendered unfit for cultivation due to soil salinization and waterlogging. Therefore, the application of Drip and Sprinkler irrigation in these provinces could play a very decisive role

in reducing water consumption per hectare by 30 percent to 50 percent, and promoting agricultural development. These techniques are efficient enough to lower soil salinization and subsequently, improve yield of crops. Although, these techniques require heavy investment in the initial stage but they have the capacity to return the benefits within a shortest period of time.[11]

- **Drip Irrigation**

Drip or trickle is one of the latest methods of irrigation, which is becoming increasingly popular in areas with water scarcity and salt problems. It is method of watering plants frequently and with a volume approaching the consumption use of plants, thereby minimizing such conventional losses as deep percolation, runoff and soil water evaporation. In this method irrigation is accomplished by using small diameter plastic lateral lines with devices called "emitters" or "drippers" at selected spacings to deliver water to the soil surface near the base of the plants. The system applies water slowly to keep the soil moisture within the desired range for plant growth.

In the state of Turkmenistan, drip irrigation covers only 400 hectares of land. Thereby means a small proportion of land under drip irrigation. If drip irrigation is practized on larger areas, irrigation efficiencies can be improved as drip irrigation has the capacity to reach water efficiency of more than 90 percent. This would lead one to conclude that in principle more than half of the water currently used for irrigation could be saved through the use of sprinkler, drip and karez irrigation methods. However, economic use of water is only partly a question of the technique of water deployment and application and the technical, economic and socio-cultural framework conditions. These techniques are also beneficial for reducing the area under wastelands in Turkmenistan because we

know that one of the major reasons for the formation of wastelands in Turkmenistan is infiltration of water due to adequate drainage infrastructure. Therefore, if the irrigation efficiency could be achieved by using modern techniques, wasteland sprawl could be reduced on the one hand and on the other hand wastelands already formed could be rehabilitated. [12]

By comparing the water management policies and levels of irrigation efficiencies between Turkmenistan and other areas having more or less similar geo-ecological setup, one is struck to see large variation both in irrigation inefficiencies, land management and production pattern. For example, take the case of Israel where the management of the water supply system and irrigation network is an example of a successful attempt to establish a modern irrigated agricultural on a national scale, and at the same time, minimize that rate of environmental hazards. Since Israel attained its independence in 1948, the total area under cultivation has increased by a factor of 2.6 to approximately 445,000 hectares, and irrigated area has increased by a factor of 8 to 240,000 hectares. During the same period, agricultural production has expanded 16 times.

At present, over 80 percent of the irrigated area in Israel use micro-irrigation techniques (drip, sprinkler and underground water irrigation), with an irrigation efficiency of 90-95 percent. Gravity irrigation, which has an efficiency of 40 to 50 percent are widely practiced in Turkmenistan, has not been used in Israel since the mid-1960. In Israel in 1995, an average agricultural water use per hectare was 5700 m^3/year (as compared with 12,000 m^3/hectare in Turkmenistan) down from 8,600-9,000 in 1950-1952 while crop productivity per unit of water increased more than two times, from 1.2 to 2.5 kilogram per cubic meter. Water use in the agricultural

sector decreased from over 70 percent to about 50 percent of total use between 1948 and late 1990s. The total annual water consumption decreased from 600 m^3 per capita in 1960 to under 350 m^3 per capita in 1998 (as compared with 4,300 m^3 per capita in Turkmenistan). Experience in Israel has demonstrated how water-use efficiency can be increased by improvement in irrigation efficiency, increased crop productivity, and changes in the types of crops grown. [13]

Institutional Factors

At the moment, agrarian sector reforms serve to guarantee the well-being of Turkmenistan's rural citizens, who make up 58 percent of the republic's population. About 50 percent of manpower is involved in the agricultural sector, and the sector's share represents as much as 20 percent of GDP. Agricultural production and raw materials are very important for the textile industry. However, agricultural production currently faces difficulties due to low yields, inefficient water use, and high water mineralization.

The majority of farmers in Turkmenistan are leaseholders called *arendator* who are assigned land on an annual contract basis in order to grow prescribed crops. There are a small number of private land owners known as *mukldar or daikhans. Mulkdars* are farmers who have shown consistent high farm performance. The main goals of the Turkmenistan agrarian reforms are to increase the role of the private sector and to raise water use efficiency and land productivity. The establishment of *daikhan* communities in 1994 became the starting point for land privatization. A new *daikhan* sector component began to emerge alongside household plots in 1993. These were peasant (private or *daikhan*) farms established by enterprising individuals outside the collectivist framework in

accordance with the presidential decree of February 1993, subsequently formalized in March 1994 in the Law on Peasant (*Daikhan*) Farms. Land was allocated to private farms without payment, as a free grant, but the declared government policy was to give private farms unirrigated, uncultivable land and thus force them to reclaim desert land at their own expense. In effect, the government relinquished the responsibility for what was traditionally regarded as a public good in the Soviet era and relied on private individuals to invest in land reclamation. Yet it seems that the *daikhan* farmers were doing exactly what the government intended, they were actively reclaiming desert land on their farms so that the share of cultivable land in peasant farms steadily increased and by 2004 had reached the same level as in household plots. Despite the physical obstacles and the marginal quality of land allocated to *daikhan* farms, individuals began to apply in increasing numbers for an independent plot of land outside the collective framework. The number of daikhan farms rose from zero in 1992 to 7,000 in 2000-2001. The land allocated to *daikhan* farms "for commercial farming" rose meteorically from zero in 1992 to 100,000 hectares in 1995 and peaked at 116,100 hectares in 1998, the year when the private sector (*daikhan* farms and household plots combined) reached nearly 10 percent of all cultivable land in Turkmenistan. Despite small share in agricultural land, private farms achieved relatively high yields. **(table 5.11).** Since 1998, however, the daikhan farms have lost 80 percent of their holdings as the authorities began to enforce the legal provisions that made land grants conditional on satisfactory farming performance. As a result, the share of the private sector (household plots and *daikhan* farms combined) decreased from 10 percent to 7 percent of cultivable land in 2006 **(Figure 5.4).** It then rebounded to 9 percent

due to a reported increase in the allocation of land to household plots, with hardly any increase in *daikhan* farms. [14]

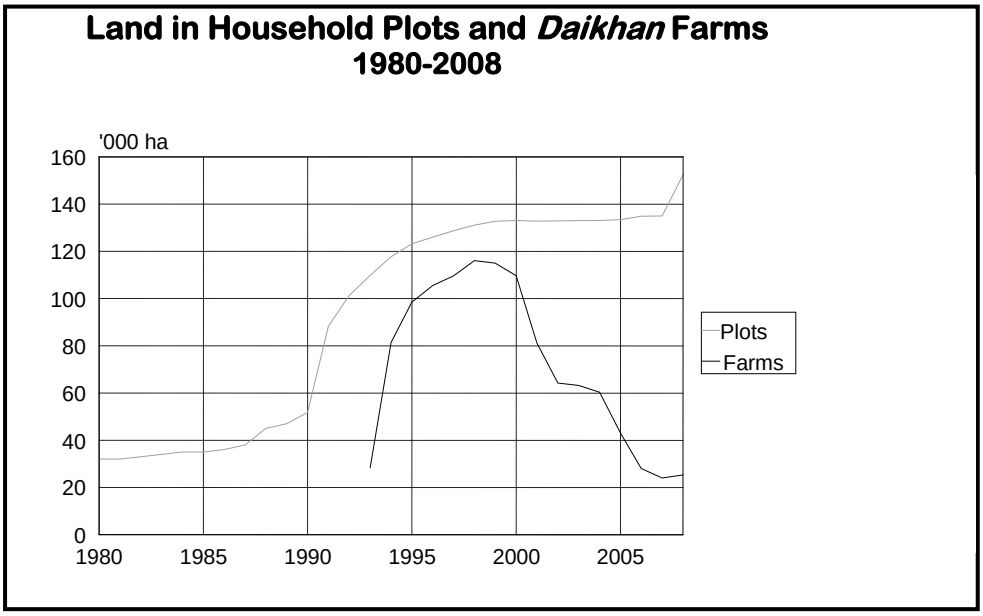


Fig.5.4

The *daikhan* farms achieve substantially higher yields than the peasant associations shows. For grain, melons, and grapes private farms on average achieve yields that are more than double the yields in peasant associations. **(table 5.11)**

Table 5.11
Yields of Main Crop Products: State and Private Sector
(1995-2010)

Year	Land holding 000'ha	Grain		Melons		Grapes	
	Private Farms	State	*Daikhan*	State	*Daikhan*	State	*Daikhan*
1995	98.5	1.30	1.71	6.46	8.04	6.30	5.60
2000	109.7	2.05	3.47	15.33	16.74	7.24	9.76
2005	43.1	2.39	6.55	11.32	32.37	6.98	21.15
2008	25.3	1.01	3.15	8.69	27.25	3.11	26.69

Source: Natsional'nyi institut statistiki i infomatsii Turkmenistan.

It is evident from the table that *daikhan* sector has achieved comparatively much higher yield per unit area than peasant association in grain since 1995 to 2010. Similar results are found in other crops grown in the republic such as melons, grapes, vegetables and cotton. The process of change from state farming to *daikhan* farming has been slow, and farmers continue to rely on governmental control. Nonetheless, the existing mechanisms of governmental control do apply to the development of independent agricultural production. It is necessary to evaluate the impact of privatization on the sustainability and productivity of agricultural production in the short run on transformation of this sector to a market economy in the long run. Increasing the role of daikhan farms will stimulate the economy, which will help in reducing the number of unemployed, increased agricultural production will increase income, which results in lower poverty levels and therefore increase food security.

Development of Oil and Gas Sector

The energy sector which accounts for over 80 percent of Turkmenistan's foreign currency earnings, faces many key challenges. The first is maintaining its gas productive capacity. Second, domestic resources are not sufficient to appraise and develop new gas resources. The oil industry has already proven reserves, but again resources are insufficient to develop them. The Government has concluded that foreign investment is the key to gaining access to financial resources, and to technology as well. The country's capacity to market natural gas should be strengthened as well as its ability to conclude sound long-term commercial contracts which reduce the potential for volatility in gas export revenues due to unpredictable changes in transit transport pricing. Foreign

investment requires an appropriate legal and taxation framework for oil & gas operations. [15]

Turkmenistan ranks fourth in the world to Russia, Iran and the United States in natural gas reserves. The Turkmenistan Natural Gas Company (Turkmengaz), under the auspices of the Ministry of Oil and Gas, controls gas extraction in the republic. Gas production is the youngest and most dynamic and promising sector of the national economy. Turkmenistan's gas reserves are estimated at 8.1-8.7 trillion cubic meters and its prospecting potential at up to 21 trillion cubic meters. Taking the enormous natural gas deposits and the purposes for which the revenue of the natural gas are used. Turkmenistan can be considered as a "gas republic". But Turkmenistan's is heavily dependent on export routes established during the soviet era, namely Russian *Gazprom* pipelines. This monopoly position has been to *Gazprom's* advantage during price negotiations. Alternative export routes are hardly available for Turkmenistan, due to its continental location and high investment costs for opening up alternatives. Despite these difficulties and problems the natural gas sector holds the crucial developmental potential for the country and still guarantees most of the state's revenue. [16]

It emerges from the preceding synthesis that Turkmenistan is one of the most promising regions with regard to oil and gas sector because of her rich reserves, these resources need to be utilized for the strengthening of her economy. The proved reserves of hydro-carbon resources allow an increased production and export that have positive impact on the development in other sectors of the economy such as agricultural and industrial sector. These sectors have potentials to produce food, raw materials for industries which in turn, will result in increasing employment opportunities as well.

So the development of these sectors will help the growth and development of the economy in terms of generating financial resource, increase in food production and generating of employment which in long way protect the sovereignty and integrity of the country.

Solar Energy

The republic has immense potentials of harnessing solar energy through bio-plateau techniques. Solar energy will play an important role in developing agriculture by mitigating the absence of hydro-power needs. Since the country is situated within the grid system dominated by desert relief features where the summer temperatures go upto 40^0 c. This climatic situation is best suited for harnessing the solar strength. The micro as well as macro solar energy projects can help the country to generate heat energy which can, to a large extent, replace the country's energy needs. Since food crops and the related agro-based industries need huge electricity in giving the agricultural technology a practical shape, this sector which has much potential can be developed in the region. In the absence of hydro-power because of shortage and in view of its geo-physical settings, the solar energy sector is the only cheap and viable sector which can play a significant role in making the country self-sufficient in food items. Of course, this initiative will also require huge investment but the country is fortunate enough to facilitate it by way of improving its hydro-carbon sector through internal as well as external resources.

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Conclusion and Suggestions

Conclusion and Suggestions

The preceding analyses of facts and figures regarding the food security situation in Turkmenistan leads to some of the major findings summarized as follows:

Turkmenistan is an agrarian country where agricultural sector plays an important role for regional economy, which is evident from the fact that this sector contributes about 20 percent to regional GDP and provides employment directly or indirectly to about 50 percent of the total population. However, it has been observed that the study region having a meager percentage of (about 4%) of its total cultivable land, suffers owing to its interior location, expansion of Karakum desert and other allied environmental issues. Although, wide variety of crops are grown both food and non-food, in the region which include cotton, wheat, rice, barley, maize, vegetable, fruits etc. but the crop combination analyses has shown that four provinces of the republic are dominated by two crops such as wheat and cotton while Balkan is five crop region.

The republic of Turkmenistan was a mono-crop region before independence period however after independence, Turkmenistan has established a new system to achieve food self-sufficiency. In this regard, the first initiative in agrarian sector was to reduce the intensity of mono-culture in favour of cereals to strengthen the country's ability to provide food products to the population. As per the agricultural census of 2010 is concerned, the area under food crops increased at a very rapid pace. Area sown to cereal crops has increased by 434 percent since independence. Similarly, the area under cereal crops per head also showed positive change which

increased from 0.048 hectares per head in 1990 to 0.16 hectares in 2010. The area under food crops particularly wheat have witnessed sharp increase among all the provinces of Turkmenistan since its independence. All the provinces of the country increased its area sown to cereals, highest percentage of which was experienced in the province of Mary (28.1%) in 2010. Ahal and Lebap provinces occupied second and third position respectively in terms of area sown to it where area under food crops was raised by 27.6 percent and 20.7 percent in 2010 respectively. Dashoguz comes 4th in terms of area devoted to food crops (17.1%) in 2010. The province of Balkan lies to the extreme west of Turkmenistan and experiences the lowest area under food crops (6.3%) and other crops during the period of 2010, the major reasons for the mentioned variations in terms of area under various food crops, are that five provinces vary in agro-climatic setting. Dashoguz experiences very severe winter and Balkan and Dashoguz, have particularly saline soils. In the former, it appears that there has been a significant drop in the amount of land that is strongly saline.

As a result of increase in the area sown to food crops and variations therein, it is obvious that production of cereal crops also recorded increase which increased by 244 percent from 1990 to 2010. Similar results were observed in almost all the provinces of the republic from 1990-2010. The cereal production increased mostly by virtue of more area devoted to it. Due to increase in food crops, the average production of food crops per head has also increased from 0.105 tons in 1990 to 0.240 tons per head in 2010. The highest production of food crops per head was recorded in the province of Mary (0.316 in 2010), it is followed by Ahal, Lebap and Balkan with 0.303 tons, 225 tons and 190 tons per head respectively. The province of Dashoguz has the lowest per capita production of food

crops. So far as the province-wise cereal production is concerned, the largest producer of food crops in the republic is the province of Mary which has recorded an increase from 121 thousand tons in 1990 to 439 thousand tons in 2010. The highest production of food crops in the province is on account of the highest acreage of agricultural land area sown to food crops and due to comparatively better yields than other provinces. The high productivity in the province of Mary is due to comparatively good irrigational facilities through Karakum canal and other small rivers and large number of oases.

It has been observed that cropping pattern of Turkmenistan is dominated by food crops over non-food crops except cotton. Among the food crops the largest share has been occupied by the wheat which alone accounts about 83 percent of food crops followed by rice (8.44%). On the other hand, among non-food crops, cotton accounts about 95 percent. This indicates that food crops in the republic of Turkmenistan have occupied the largest proportion of total cropped area in order to achieve food self-sufficiency. Therefore, there has been lot of change in the cropping pattern and the republic has increased more and more area under food crops particularly wheat. Cotton and wheat are the dominant crops grown in all the provinces of Turkmenistan. However, it is argued that in order to increase future demands for food, the available land and water resources need to be used and managed as efficiently as possible. The main routes for making the Turkmen's agricultural system more productive are through intensification and technological change on currently used agricultural land, land expansion into currently non-agricultural areas.

Enormous increase in terms of both area and production of food crops since independence led the republic self-sufficient in terms of food crops by about 80 percent. However, there are huge disparities

and diversities in terms of food production and consumption within the provinces and among the provinces. There are some provinces which are deficit with regard to cereals crop production while few are surplus in terms of it. The provinces such as Lebap, Dashoguz and Balkan are deficit in terms of food crops while as the provinces of Ahal and Mary are surplus in terms of cereal production. The factors which are responsible for the surplus provinces are that firstly, the provinces got comparatively maximum cultivable land under food crops and better yield. Secondly, these provinces are more urbanized than other provinces. Therefore, the per capita consumption of cereals is lower than other parts of the country.

Though, the country increased irrigated area substantially from 1329 thousand hectares at independence to 1696 thousand hectares in 2010. But at the same time population of the country has simultaneously increased, so it could not keep pace with the increasing population. Therefore, the per capita endowment of irrigated land per capita has decreased from 0.66 hectare per rural person in 1990 to 0.50 hectare in 2010.

In addition to this, poor planning of irrigated land use, lack of proper crop management, inadequate use of mineral fertilizers, pesticides, together with low density drainage networks and inadequate irrigation networks installed resulted decrease in irrigation efficiency (45%) and decline in productivity. As per the estimates 12 km^3 of water is wasted every year through losses in the conveyance and on field system. Due to low irrigation efficiency not only water is wasted but it also reduces soil fertility through waterlogging and soil salinization. More than 68 percent of irrigated land in the country is classified as with medium or high salinity. About 36 percent of this land also has underground water within 2 m of the surface exposing the land to secondary salinization from

evapo-transpiration and waterlogging. This ecological problem is most significant in Dashoguz and Lebap provinces.

It has been observed that these factors led to the poor performance of agriculture sector in Turkmenistan since independence. The productivity of irrigated farming systems in Turkmenistan is under threat from secondary salinization associated with poor irrigation management. Consequently, production of cotton, Turkmenistan's key commercial crop, declined more than a half in real terms. Turkmenistan's cotton yields are not only decreasing over time, but they are also very low compared to other cotton-producing countries. The yields of cotton lint achieved by Middle East countries, Egypt, and Mexico are around 3 times higher than the yields in Turkmenistan; the yields in the United States and Uzbekistan are double the Turkmen yields; yield of cereals have recorded constant decline from 2.32 tons per hectare in 1990 to 1.49 tons per hectare in 2010. Yield of grain continuously remained below those for Tajikistan, the country that suffered the civil war after gaining independence. The comparison with china is even more disappointing. The consequences of inappropriate irrigation management are endemic to rural poverty, household food insecurity, and environmental degradation all of which threaten regional economic development.

Huge variations have been recorded in terms of both production and yield of cereals, fruits and vegetables among provinces. Yang's method has been adapted to find out variations in terms of serial crop productivity, while as Nelson method has been used to find out variations in terms of vegetables and fruits in the republic. It has been found out that there are some provinces which are having yield more than the national average. The province of Mary ranked highest agricultural productivity during the period 2005 and 2010

respectively while as Ahal, Balkan and Lebap ranked medium and the province of Dashoguz has recorded the lowest agricultural productivity. It has been observed that about 60 percent of the total crop production is produced in the provinces of Ahal and Mary due to favourable climatic conditions, comparatively better soils and good irrigation facilities while as 40 percent of crops are produced in other three provinces of Turkmenistan.

Relating to the available land and pressure of population, the demand for foodgrains is very high because the population growth has outstripped the rate of increase in agricultural production. On the other hand, pressure of population and demand for available cultivable land is not corresponding with each other. As it is evident from the facts and figures from the preceding chapters that though food supply has improved enormously since its independence but food security yet to be achieved due to backwardness of agricultural sector and because majority of population (about 50%) are still living below poverty line.

The share of agricultural employment in Turkmenistan is higher than other Central Asian countries. This explains the positive correlation between agricultural labour and rural population. The fact is that, since 1990, the local economies have been unable to generate enough jobs outside agriculture to attract new entrants into non-agricultural labour force. As a result, the economics shrunk thus causing fall off incomes, increase of poverty and a major concern for food security. Gross National Income declined by an average of almost 50 percent between 1991 to 2010 and despite some signs of recovery, shown in the recent five years, the Gross National Income per capita of the region is still less than in many of the low income countries. Poverty remains widespread throughout the region, where some 50 percent of the population is now living

below poverty line. Poverty increased significantly following the dissolution of former Soviet Union that has effected a substantial proportion of population.

There are large disparities in terms of poverty across provinces in the republic of Turkmenistan. There are some provinces which have poverty below national average and few where food poverty is higher than the national average. The gap between regions is clearly more important than the urban/rural difference. The poverty rates in Dasghuz (40.2%) and in Balkan (31.8%) are significantly higher than in Ahal (20.6%), Lebap (25.6%) and Mary (17.5%), and the national average in (27.14%) 2010. However, the provinces of Ahal and Mary have lower incidence of food poverty than the national average. The gap is even more pronounced while looking at the rates of extreme food poverty, it is 4.8 percent in Mary and 5.5 percent in Ahal, 14.5 percent in Dashoguz province followed by Lebap 12.8 percent.

Poverty is clearly one of the most important determinants of food insecurity. There is positive correlation between access to food and the level of income, poverty measures could give an accurate indication of the likelihood of food insufficiency at the household level. Before the transition, the great majority of the Turkmen population did not suffer from food insecurity and absolute poverty, even though Turkmenistan was considered as the poorest republic of the former Soviet Union. The notion of absolute poverty is closely related to food insecurity and undernourishment. Poverty has many dimensions. The most obvious one is hunger. Having enough nutritional intake is considered a necessary condition for being free from poverty. Therefore, poverty lines are developed to ensure that incomes are sufficient to provide minimum nutritional needs –

usually defined in calorific terms and serve to define the cut off between the poor and the non-poor.

Data available suggest a decline in household food security following independence. The decreasing level of consumption in the republic was accompanied by changes in diet composition. In particular, on non-food items fell more than spending on food, and while expenditures on bakery and bakery products changed little, meat and dairy product consumption declined to a large extent. During the period 1990-2010 in Turkmenistan, dairy products declined by 40 percent. Overall protein consumption has also declined sharply. Deteriorating economic conditions and escalating poverty has contributed significant reduction in the mentioned items. There has been a net decrease in the available daily energy supply in Turkmenistan from 2118 in 1990 to 1752 in 2000 calorie/capita/day. However, there was little improvement in terms of calorie intake and poverty following bumper cereal crop production on account of favourable climatic conditions in 2005 in the region. However, since 2008 onwards climatic conditions have become worse, droughts were common which led to the decrease with regard to both irrigated area and productivity and production of crops. The average daily calorie supply per capita amounted to 1990 kcal in 2010, but wide variations exist between urban and rural area.

In Turkmenistan, around 24 per cent of all children below the age of three are too small for their age, 13 per cent are underweight and at least 12 per cent are wasted. Many of these children are severely malnourished. The prevalence of malnutrition varies across provinces, with Dashoguz recording the highest rate (25%) and Ahal among the lowest (17%). Malnutrition in children is not affected by food intake alone; it is also influenced by access to

health services, quality of care for the child and pregnant mother as well as good hygiene practices. Girls are more at risk of malnutrition than boys because of their lower social status.

It has also been observed that food security can be achieved if proper irrigation management alongwith application of farm technology, the production can be increased by converting some semi-desert fringes and surrounding patches of oases into cropland. Furthermore, if through proper water management devices, some water is saved which can be used to irrigate some other wasteland area needing irrigation, so there is hope that the production of cereals can be increased through better irrigation management initiatives, to irrigate some wastelands which need only irrigation to blossom. In addition to that Turkmenistan has a wide scope to improve its yield level of cereals by reducing the inter as well as intra-regional variations. This could go a long way in reducing the gap between food consumption and food need of the people of the country. It has also been observed that huge money needs to be invested to develop agricultural infrastructure. Turkmenistan is bestowed with huge hydro-carbon resources, these resources need to be exploited by attracting foreign investors, so a part of the revenue generated can be invested in developing agricultural infrastructure. In addition to this, the republic has immense potentials of solar energy which will also help in developing agriculture by mitigating the absence of hydro-power needs.

Suggestions

In the republic of Turkmenistan, agricultural sector provides both the opportunities as well as challenges. The sustained growth in the agricultural sector is fundamental for stimulating income growth and demand for industrial and manufactured goods. The region must develop an understanding and consensus on the problems it faces

and the actions need to alleviate poverty, reduce food insecurity and substantially manage natural resource base. Sustainable agricultural development which is a pre-condition for food security, can be achieved through a number of measures which are as under:

At present, the best solution of all water related problems would be the integration of the traditional irrigation technology i.e. *karez,* which is indigenous water saving technique requiring comparatively less investment. This underground irrigation system was used in the southern part of the country for water from Kopetdag but largely abandoned in favour of wells and the use of motor pumps to extract water. But pumping is a short-term solution that creates a long-term problem, the drying up of groundwater due to over-pumping. Integration of old irrigation system would be the decisive solution of the present problems. The intensification of the *Karez* system would some extent alleviate the water consumption through Karakum Canal. *Karez* do not upset the hydrological and ecological equilibrium but in contrary solve many ecological problems and represents sustainable use of water resources. They present one of the most ecologically balanced water recovery methods available for arid and semi-arid regions like Turkmenistan. Thus, *Karez* would play the important role in sustainable water management. An integrated system will facilitate the restoration of natural ecosystems by supporting a participatory process.

Lebap and Dashoguz need different treatment as soils in these two provinces are heavily salinized particularly the province of Dashoguz where most of its cultivable land is rendered unfit for cultivation. Therefore, the application of Drip and Sprinkler irrigation in these provinces could play a very decisive role in reducing water consumption per hectare by 30 percent to 50 percent, and promoting agricultural development. These techniques are efficient

enough to lower soil salinization and subsequently, improve yield of crops. Although, these techniques require heavy investment in the initial stage but they have the capacity to return the benefits within a shortest period of time.

Besides, Turkmenistan should explore more closely the options for deep desalination of its drainage water, taking advantage of the abundance of solar energy in the desert. At this stage, bio-plateau techniques and harnessing of solar energy for desalination is viable solution. If successful, these techniques will produce huge amounts of new water for irrigation and make it possible to double the irrigated area from its current. It will also help in reclaiming lands that have been degraded due to heavy salinization and waterlogging.

Apart from above mentioned-techniques, rehabilitation of existing irrigation system needs to be developed. Ahal, Mary and Balkan are situated on either side of the Karakum canal which are using its water for agricultural purposes. Due to earthen beds of this canal and other inter-farming canals and due to its comparatively lower altitude, excessive irrigation practice, water from all sides get accumulated in the adjacent agricultural land, leads to waterlogging, as there is no proper outlet for the excessive water to drain out. Therefore, it is suggested that the government of the country should construct a drain for the outflow of the accumulated water so that excessive water can easily flow out. It not only reduces the problem of waterlogging but will dramatically improve yields as crops will no longer be stressed by lack of water followed by stress from over-watering, as in present case.

Water has always been considered as treasure in Turkmenistan and an old proverb "A drop of water is like a drop of gold", means that water is important for the agricultural development as agriculture is

the main consumer of water. It is recommended that water pricing for irrigation requires the establishment of an appropriate institution dealing with water charging issues and placing water monitory devices so that excessive use of water could be reduced.

It is often assumed that food shortages can be reduced by increasing agricultural production through the application of modern technology. It is recommended that machines and improved implements need to be used as these have become an integral component of the developed agriculture with increasing rate of environmental degradation, shrinking farm size, the challenges is to grow more and more food for increasing population. The land resources are limited, technology transfer in land use, environmental policy, legal and institutional network for environmental protection is of critical importance.

Desertification, another socio-economic factor responsible for land degradation in the republic has swallowed most of the land resources of the region. It is, therefore, imperative to protect the oases from land degradation from moving sands and shelter belt system need to be designed. It is suggested that there are several herbs belonging to various species, which can be employed for fixation of sand dunes and reclaiming salty areas, plants of such genera are *Agave, Casuarina, Sysgium and Yucca* with scaly, glossy or waxy surfaces are also highly suitable. These are generally most useful in reclamation and afforestation as dried as the dried portions form mulch and part of topsoil and the underground portions hold the soil.

Despite a healthy start of the *daikhan* farming programme in 1994, the state sector still accounts for over 90 percent of agricultural land. The process of *daikhan* farming has been slow, and farmers continue to rely on governmental control, though *daikhan*s achieve

substantially higher yields than the peasant associations (2.5-3.0 tons/ha in private farms compared with 1.5-1.7 tons/ha in peasant associations). It is suggested that the role of the *daikhans* farms should be increased in order to raise water-use efficiency and land productivity and production of crops grown in the region. Increasing the role of private sector will stimulate the economy, which will help in reducing the number of unemployed, increased agricultural production will increase income, which results in lower poverty levels and therefore increase food security.

It is suggested that there should be change in cropping pattern preferably high breed of some less water consuming varieties should be introduced. Less profitable and water efficient crops should be replaced by more remunerative cereals. However, cotton will play a significant role in economic development of the republic for a longer period ahead. So it is suggested that cotton area should be reduced in phased manner in favour of food crops till the republic will be able to make a parallel system for its sustainable growth. For instance, wheat uses 40 percent less water per hectare than cotton. The shift from cotton monoculture to diversified wheat–cotton agriculture may contribute to the stabilization of water use. Scarce water resources should be used for the needs of the country's own population, but not for irrigation of cotton which is being exported to western countries. This will fulfill the regional need and simultaneously improve the fertility status of soil.

Central planning system applied the regions with agricultural inputs such as seeds, fertilizers and pesticides from outside the region. With the help of these modern inputs, region specialized in the production of commodities. The supply of inputs stopped after the break-up. As a result, agricultural production continues to suffer from low level of yield. Thus, one of the major challenges to the

policymakers in this region is to identify the nature and direction of policy incentives that will put the agricultural sector on a dynamic growth path.

So far as the future food need is concerned, the check and measures to stabilize population is to be addressed on priority. Although, the growth of population has recorded some declining trend, through both natural as well as artificial measures, but still the issues needs an urgent attention. The food sufficiency in the republic is not possible in spite the yield growth measures, unless the population growth is checked. Moreover, the social stigma i.e. malnutrition, needs to be addressed.

All the aforementioned suggestions, whether hi-tech or traditional, need money for implementation. Since the republic is energy rich country particularly with respect to hydrocarbons, the republic needs to develop its hydrocarbon sector by improving is internal security situation in order to attract foreign investors. By developing the hydrocarbon sector, the country can be in a position to invest some portion of the revenue generated in agricultural infrastructure. Moreover, the country having a deserty landscape where the summer temperature shoot up about 40^0 C, has the potentials for developing the solar energy which also can play a significant role in the agricultural development.