11.1 Summary

Agriculture is one of the most important economic sectors in Iran. It contributes twenty percent of national income (GDP) involving 23.4 percent of total employment, 80 percent of domestic food requirements and more than one-third of non-oil exports. In recent years some research has been carried out by FAO, Iranian government and non-government agencies at national and regional level to find out natural resources as well as agricultural problems like soil productivity, land capability, watershed management, irrigation development, natural vegetation, soil conservation, desertification, crop disease, problems and prospects of agriculture etc. Whereas regarding crop land use a few researches have been carried out in Iran. For this purpose Jiroft watershed is selected for the research work to find out problems and prospects general as well as agricultural land use patterns, their capability, and solution strategies. On the basis this research, following observations were made for its planning and development of agriculture in Jiroft watershed in Iran.

11.2 Summary

Jiroft watershed is situated in south central part in Kerman province extends from $28^0 5' 9''$ to $29^0 21' 30''$ north latitudes and $56^0 44'32''$ to $58^0 31'5''$ east longitudes covering 132442 square kilometers area. Administratively, this watershed has divided into 21 rural districts and it is consisting of 1236 revenue
villages and two urban settlements. It is one of the most important agricultural regions of Iran having high potentiality for agricultural production and development. It is known as small India in Iran because of variety of climatic conditions, and Agricultural production. The region falls under scarcity rainfall zone and experiences typically mediterranean climate. Seventy two percent of rainfall receives in winter (from December to April). The summer (from June to the end of September) is hot and dry it receives one per cent of total rainfall. Rainfall ranges from 157mm in central and south parts and more than 350 mm in the north parts in study region. Mediterranean cyclone generally commences in December and receives highest rainfall in January (79.3 mm) and lowest in July (less than 1 mm). The rainfall is inadequate, irregular and uneven distributed throughout the year and place to place. The highest temperature is observed in July (43.8°C centigrades) and lowest in January (7°C centigrades) in Jiroft station. Jiroft watershed has varieties landforms by applying Digital Elevation Model (DEM) it has divided into four physiographical zones, namely, highland, moderate highland, piedmont and alluvial fans and alluvial plain which have different physical characteristics such as rainfall, temperature, soil, and land use/land cover patterns. The highland consists of high elevation peaks with 4000 altitude and hills in north and eastern parts. Cliffs in the highland zone on all sides of the watershed are very steep (>30 percent), general direction of slopes is towards central and south. Geological formation of Jiroft watershed is complex in both stratigraphically and structurally. The rocks range in age is probably from Paleozoic to recent time (Holocene). Five major soil types is identified in study
area, namely, lithosols, in highland zone in north and eastern parts, calcareous and sierozem soils in moderate elevation zone, coarse textured colluvial and regosols soils in piedmont and alluvial fans, fine textured alluvial soil and slonchak and solonetz occupying 42.5 percent, 30.2 percent, 22.5 percent, 2.3 percent and 2.5 percent respectively. The Lithosols soil has confined to the north east and southeast parts, calcareous and sierozem soils lying in west part, coarse textured colluvial and regosols soil lie in central and in Esfandagheh plain in western parts, which play a vital role in feeding of groundwater aquifers in Jiroft watershed, fine textured alluvial soils laying in central part and slonchak and solonetz has spreaded in south-central parts in Jiroft watershed. This area has highest productive soil in study region occupied 10 per cent of to total geographical area whereas 63.9 per cent of total net sown area is found here. HalilRud river is perennial river irrigates the vast area of Jiroft’s fertile plain originates from Lalhzar and Hazar range mountains in northwestern part of Jiorft watershed. Second important river in the study area is Shur river, originates from Jabal-e-barez mountains range in northeast part. The general direction of the stream flow is from north to south, northeast, and northwest to central and south-central parts. The drainage patterns can be recognized are dendritic and sub-dendritic, reflecting the homogenous character of the sub-surface lithology of the study area. Jiroft watershed covered by natural vegetation covers mainly in north, east and central parts. The different types of vegetation covers that have been distinguished in study region by using available satellite images (Land sat TM Jaun-2002) and field survey. Forest is classified into two types vis, medium
density (25-50%) in north part (Bahr-e-Asman mountain range) and low density (5-25%) in north and western parts. Total area of forest covers 7.7 per cent of total geographical area. Permanent pastures and other grazing land are classified into three categories: high density (>50%) in north, medium density (25-50%) in eastern and low density pastures (5-25%) on piedmont and alluvial fans in central part. Pasture cover occupied 45 per cent of total area in Jiroft watershed.

Population plays vital role for regional development because it affects both consumption and production of agricultural production. Total population in study area was recorded 217608 persons in 1996. It has increased by 43.3 per cent from 1966 to 1996. Its population density is 16.4 persons per square kilometer (1996). The density and distribution of population is influenced by topography, soil fertility, availability of water resources, transportation network and urbanization in study region. Highest and lowest population density was recorded in Jiroft plain and highland zones respectively. Percentage of total workers to total population with value of 47.5 per cent was recorded for 1966, and percentage of farm workers to total population and to total workers was recorded 48 per cent and 53.4 per cent in 1996 respectively. High percentage for both of farm workers to total population and farm worker to total workers are found in highland zones because agriculture and related activities is only the way of livelihood. It is identified that in highland zones animal husbandry and nomadism is also another
activity of the people in study area. Goats and Sheeps are more than 90 per cent of total animals. The people keep animals for their meat, milk, and wool production at subsistence level. Literacy and population growth are two factors which have brought significant and change in agriculture. 82 per cent of total population are literate (1996). Literacy is varies from place to place and year to year. Low literacy is observed in highland zone whereas highest percent was recorded in lowland area in central and south-central parts in study region. Irrigation is the most important agricultural water supply total cropped lands is irrigated. Agriculture depends mainly on surface water, represented by HalilRud flow and ground water. High ground water potentiality supports agricultural productivity and development. In summer season when HalilRud is dry or with insufficient water cropped land is highly depend on ground water resources which is different place to place in study region. Transportation has influenced on agricultural development of the study area. Developed transportation network is identified in Jiroft plain in central and south-central parts. The study area served by five types of transport routs, namely main road, secondary road, drift road, gravel road and others. The main road runs from south to the north direction connecting all Kerman province cities to Jiroft watershed. Secondary road connects Jiroft and AnbarAbad cities to rural districts. Drift roads links rural districts, villages and farms to Jiroft and AbarAbad cities. There are two central markets to
distribution of local and national level of agricultural products, namely, Jiroft national and Jiroft local markets in Jiroft city. No market centre is established in south, east, and western parts of the study area.

The temporal and spatial variation of general land use are studied for ten years from 1993 to 2002. Five types of landuse is recognized in Jiroft watershed, namely, net sown area, fallow land, pasture land, forest land, barren and land not available for cultivation. Net sown area gently increased from 1993 to 2002 by 1.6 per cent to total area. It was 5 per cent to total area in 1993 whereas it was recorded 6.2 per cent to total geographical area in 2002. Net sown area shows less percentage to total geographical area which is too much variable between highland (27 per cent to net sown area) and lowland zones (73 per cent to net sown area). To compare with Kahnuj district and Kerman province, net sown area in Jiroft watershed is slightly more. This shows less expansion area under cropped land use in study region as well as Kerman province. The result of spatial analysis shows that high percentage of net sown area is located in Jiroft plain along the HalilRud river and its flood plain. The result implies that water availability, soil fertility and smooth ground surface are the main factors that led to the increasing of arable land in Jiroft plain (central and south-central parts) than highland zones. In highland region mostly cropped lands are located in valleys and on gently slopes. The temporal analysis reveals that annual variation of each landuse pattern has its characteristics with small to high fluctuations in ten years duration of this investigation (1993 to 2002) Forest, permanent pastures and fallow lands have declined from 9.4, 53.6, 2.3 per cent to 7.7, 45,
and 1.3 per cent in 1993 and 2002 respectively, whereas barren lands and land not available has increased from 29.6 to 39.7 per cent of total geographical area in 1993 to 2002 respectively. Permanent pastures and other grazing lands is the significant landuse pattern with near fifty per cent of total geographical area, which classified into three classes namely: high density pastures, medium density pastures and low density pastures. Negative volume of change in pasture and forest covers is found during the period of investigation due to the cutting of trees, over grazing, drought and decrease of precipitation (changing of climate). Maximum change of pastures and forests is accrued in Amjaz (-16.8 per cent) and Delfard (5.5 per cent) in north-central and east parts of the study area. Maximum positive volume change (18.6 per cent) was experienced for barren and land not available for cultivation in Amjaz rural district due to decrease of pastures and other grasslands.

The spatio-temporal analysis of the fifteen selected crops have been studied in study area for year 2002-2003. It is found that Jiroft watershed, being the arid and drought prone, it does not show considerable fluctuation as far as the aerial extent of these crops is concerned. Summer and winter seasons are major agricultural seasons. Potato, wheat, onion, walnut, Alfalfa, barley, corn, sre major winter crops and date, cucumber, tomato, lemon, orange, watermelon, and vegetables are the major summer crops in Jiroft watershed. It is observed that the area under different crops have different spatial distribution pattern in area under investigation in 2002. Spatial distribution patterns of different crops are influenced by different environmental factors such as soil characteristics, rainfall,
temperature, terrain features, water accessibility and socio-economic factors, e.g. proximity to the market places and accessibility and transportation. Among fifteen crops, orange, lemon, potato, tomato, cucumber, onion, watermelon, and vegetables show slightly increase, whereas in the area under cultivation some crops such as grape, date, alfalfa, barely shows steadily decrease. Walnut and corn shows slightly stable position with minor fluctuation. Among all crops Orange covers maximum area of 19.05 per cent to total net sown area. The highest per cent of this crop is found in the east due to favoures climatic conditions. Date is a drought resistant crop has the second position in areal extent after orange, covering area of 16.24 per cent to net sown area. The highest per cent of date is seen in the south-central part on solonchak, solonetz, and coarse textured colluvial soils, warm and arid climatic conditions. Wheat as a main food crop occupied 12.53 per cent of net sown area with decreasing trend by -3.12 per cent which is the dominant crop in west part, namely, Esfandageh rural district. Vegetables and summer crops such as potato, tomato, cucumber, onion, watermelon, shows increasing trend. Among these crops potato accounting for 6.26 per cent net sown area is identified in the central part, cucumber with 5.7 per cent to net sown area is identified in central and south parts. Tomato with an area of 4.7 per cent to total net sown area is observed in the southern part in Jiroft watershed. Fodder crops which are used for livestock feeding, namely, barley, alfalfa and corn with covering an area of 9.49 per cent of net sown area is found in west and north parts. The area under cultivation of
vegetables due to market demands is grown in the east part in favourable
environment a conditions and accessibility to the market places.

In order to make agricultural regionalization in Jiroft watershed, rural districts
level has been considered as basic unit for in depth study to highlight crop
combination and crop diversification. A number of quantitative methods have
been used for computing of crop combination regions. Among them the statistical
technique adopted by Rafiullah (1965) is more accurate for delineation of crop
combination regions. Three crop combination regions are found in Jiroft
watershed by applying Rafiullah’s methods. Date, Orange, lemon, walnut and
wheat crops have entered in monoculture in sixteen rural districts covering an
area of 67 per cent of total area. Orange is leading crops occupied 29.2 per cent
of total area under monoculture whereas only 9.9 per cent to total area is found
under wheat. Date is identified on 23.81 per cent total area in south-central part
in warm climate region where soil is sandy whereas walnut is observed in north
part having cold climatic conditions and rugged terrain where coarse shallow soil
is appeared on gently slope. Two-crop combination is identified in three
isolated pockets in west, central-east and east parts covering an area of 31.7 per
cent of total area. Wheat-barley is occupied largest area in western part of the
study region over the 81 per cent of total area where sandy loam soil is identified
whereas orange-date combination is seen in central part covering an area of 6.23
percent to this combination region. Out of 21 rural district Potato-Orange and
date are found as three crop combination in one district, namely, DowlatAbad in
central part covering an area of 1.3 per cent to total geographical area having soil
fertility, developed irrigation and transportation facilities and high population
density. Gibbs Martin index applied to identify crop diversification region.
According to this method three crop-diversification regions have been found
namely, highest diversification, medium diversification and low diversification.
High diversification region is seen in ten districts occupied 60.88 per cent of total
area in central, south-central and southeast parts where low amount of rainfall
and warm climatic conditions is dominant. Whereas low diversification is
observed in two districts with favours conditions namely, Delfard and Maskun in
north-east part covering an area of 3.96 per cent to total area. Moderate
diversification occurred in 35.16 per cent of total area in west, north and east
central parts with rugged terrain, moderate climatic conditions, where
productivity of land is low, thin and coarse shallow soil is dominant on gently
slopes and sub-deep and deep in valleys.

The agricultural productivity of an area is influenced by a number of physico-
socio-economic, institutional and organization. Variation in productivity is well
marked within the one region to another region depending upon characteristics of
relief, slope, climate, drainage and irrigation and transportation facilities,
utilization of fertilizers and pesticides and soil fertility, farm size, level of farming
inputs, market price and access, credit availability, education and extension
service. Although the region suffers from the shortage of rainfall and water
availability as a result of extensive droughts, yet, the productivity of most crops
has increased in central and south-central parts. It is especially so in case of
potato, cucumber, orange, onion, tomato and watermelon in central and south parts study area is due to increase in drip or sprinkler irrigation to make an optimum use of available water resources. Whereas agricultural productivity in north, west and east parts is relatively low. Low productivity is the result of unfavourable condition like, rugged topography, steep slopes, thin soil, low capability of land, scarcity of arable lands, limitation of water resources, low population density, insufficient labour, traditional agricultural activities, lack or undeveloped transportation facilities, poor irrigation facilities, lack of market center. In these regions traditional structures and undulating topography face small and fragmented plots, cultivation is carried on to non-geometric small-scale plots which limit application of farm machinery and mechanization development. According to both Enyedi’s and Bhatia’s methods crop productivity has similar decreased trend towards north, west and east parts for selected leading crops and the study region could be divided into three parts, namely, high productivity area in south-central, medium productivity area in north and low productivity area in west and eastern parts.

The application of correlation co-efficient aims at studying correlation between twentythree selected landuse and environmental variables. Potato shows positive correlation with an area under Fallow land (0.769), population density (0.579) and net sown area (0.420) this indicates area under potato proportionally increases with area under fallow land, population density, and net sown area. whereas it has negative correlation with average slope (-0.290) this is results of very cold climate and uneven topography which is not favours for cultivation of
potato. Tomato display high positive correlation with area under cucumber (0.832) net sown area (0.759) and mean annual temperature (0.636) whereas it shows negative correlation with average slope (-0.689) and mean annual rainfall (-0.632). It is clear that tomato as a summer crop requires warm climate, and doesn’t require cold climate and more rainfall for its maturity. Orange has positive correlation with average slope (0.466) whereas shows negative correlation with area under wheat (-0.466). This is indicates that mountainous area and gently slopes is favours to growing of orange threes. Walnut is a winter crop which require cold climate and more rainfall and labours hence it has strong positive correlation with mean annual rainfall (0.797), agricultural density (0.627) and average slope (0.550) whereas has strong negative correlation with mean annual temperature (-0.771), yield of date (-0.484) and area under date (-0.439) Warm climatic conditions, flat ground and less rainfall favours for growing date as a summer crop hence it has established strong positive correlation with yield of date (0.811), mean annual temperature (0.717 and area under tomato (0.646) it shows moderate positive correlation with population density (0.508), and yield of orange (0.338) whereas display strong negative correlation with mean annual temperature (-0.703) and average slope (-0.662). Net sown area shows stong positive correlationship with population density (0.878), area under tomato (0.759) and area under cucumber (0.714) whereas display strong negative correlation with average slope (-0.658) and mean annual rainfall (-0.625). Area under forest shows strong positive correlation with mean annual rainfall (0.775) and average slope (0.759)
whereas it exhibit strong negative correlation with mean annual temperature (-0.789) and yield of date (-0.655). It is display that cold climatic condition and high rainfall are favours for growing the forest threes. Population density shows strong positive correlation with net sown area (0.878) and fallow land (0.773) whereas display moderate negative correlation with average slope (-0.553), mean annual rainfall (-0.543) and area under forest (-0.518). It is clear that population density is very low in mountainous area with high rainfall, steep slopes, forest cover whereas in low land area in central part high population is identified. Further the results of correlation with net sown area are strengthened by employing multiple regression. The variable net sown area has given high multiple correlation value of 0.9695 for the area under study. Date crop has given high multiple regression value of 0.8148 for the study area. Orange shows multiple correlation value of 0.7733 which is high degree of association for the study area. The variable area under tomato has given high multiple correlation value 0.939 for the study watershed. In this regression set variables like, cucumber, date, net sown area, forest, population density, slope, mean annual temperature, mean annual rainfall and yield of date were included. The variable area under potato has given high multiple correlation value of 0.7848 for the study region. Furthermore, earlier approach has been followed by applying Factor Analysis technique to identify unique variance among selected variables of agricultural landuse in Jiroft watershed in order to search for common variances as a set of new variables. The first four factors were identified as tomato, yield of date, area under wheat, yield of orange and yield of wheat and
mapped and interpreted to show spatial distribution. It helped to unfold the correlation of landuse factors, in the study area. The scores on Factor I and II were used as the base for demarcating agricultural regions into three categories as agricultural backward, developing and developed regions in Jiroft watershed. Problem oriented strategies were formulated for better agricultural land use planning and development for four agro-ecological zones in study area with respect to variations. with respect to variations in landform, climatic conditions, soil type, arable land, availability of water and irrigation systems, transportation network, and population density. South-central region has high potentiality for development in agriculture due to fertile and productive soil and availability of ground water, developed irrigation systems and agricultural implements, but soil salinity in southern part hampers the overall development. Central region because of high potentiality of ground water which is not available now capable land could bring under cultivation, has high potentiality for agriculture development. Western region could be termed as problem-region due to coarse shallow soil, unavailability of irrigation facility and transportation network, market centers with condition and low density of population. Northern part has more rainfall and water but this region face with some problems such as poor transportation network and irrigation facility, migration, small size of farm, and less arable land. Reclamation of new land for cultivation is an expensive process therefore efforts must be made to utilize the available natural resources to obtain maximum output by increasing the yield per hectare and thus solving the problem of land limitation to a great extent. Control of surface water, and transfer of water
for the benefit of consumers. Establishing marketing and storage facilities. Improving farmers income and standard living to reduce migration to cities and providing adequate manpower in different fields for the operation of desired plans. Changing the farming system from monoculture to a multicropping system, and from multicropping systems without a mechanism to keep soil fertility to crop rotation systems that do maintain fertility. The model is proposed for agricultural development in Jiroft watershed for integrated development and different strategies were suggested for better agricultural land use planning and development in Jiroft watershed.

In-depth study of six sample villages in Jiroft watershed by studying aspects, namely, physio-socioeconomic cal conditions, of the village, general as well as agricultural landuse pattern for 2005-2006. The selection of these sample villages was based on crop combination regions of this study area. In-depth study of sample villages have shown diversified characteristics. Village Dosari is an important village of Jiroft watershed it extends in 2962.7 hectares area, having 2580 persons in 1996 with the population density 87.2 persons per square kilometer. Orange, wheat, cucumber, lemon and tomato are leading crops sharing 58.69 per cent of cropped area. Date is predominant crop in this village having highest coverage (22.36 per cent) which followed by orange and wheat occupying 13.16 and 9.73 per cent respectively. SadAbad village lies on Jiroft plain hence has fertile soil on 64.5 per cent of total area. 81.8 per cent of population is engaged with agriculture and related activities. Total net sown area is 1119 hectares (47.75 per cent ) to total geographical area. Orange, onion,
tomato, date and watermelon are the leading crops which occupied 46.92, 12.42 and 10.63, 9.92 and 9.83 per cent of total cropped area respectively. Ground water and surface water are major source of irrigation. The major problem faced by village is insufficient credit facilities, improved seeds and fertilizers, lack of local markets, high cost of electricity, and agricultural labours, uncertain market values and migration. AliAbad has a total area of 449.9 hectares and population of 894 persons with density of 198.6 persons per square kilometer. (1996). Agriculture is major occupation where 80 percent workforce is engaged. The net sown area accounts for 330 hectares. The net sown area in this village accounts for 73.35 percent concentrated in central, north, south and eastern parts. Ground water is the main water resources for agricultural purposes. The net sown area has occupied 73.35 percent to total geographical area. Orange, tomato and cucumber are the leading crops of summer season cultivated over 54 per cent to total geographical area in central, east and southern parts. Orange is the leading crop having highest coverage of 33.93 per cent to net sown area which followed by cucumber 20.30 per cent and tomato, 19.4 per cent. This village has 234 farmers and 80 agricultural labours. The main problems in this village are namely, high cost of agricultural labours, Insufficiency of the credits facilities, and insufficient and high cost of greenhouse implements and high cost of improved seeds and fertilizers. MohammadAbad lying in developing region north part in Jiroft watershed. Agriculture and animal husbandry are the main sources of livelihood for 97 percent of population of this village. It has spreaded on 572.4 hectares. It has 253 person with density of 44.4 persons per square
kilometer (1996). Local relief of this village plays vital role in landuse pattern in MohammadAbad. Walnut and wheat are the leading crops cultivated on 30.28 and 26.76 percent to net sown area respectively. Barley occupied 20.42 per cent to net sown area. Fodder crops concentrated on 14 hectares north part. Potato is also found over 12.67 percent in north portion in the village. Cold climate, lack of arable lands, local market and transportation facilities, unskilled of agricultural labours are the main problems of this village. Ferdows is falls in backward region at 1720 meter above mean sea level in west part of the study area. Population of Ferdows is 335 persons with density of 19 persons per square kilometer. The cropping pattern is mainly influenced by climate conditions, soil fertility, and availability of water. The village seems to be agriculturally backward as only 30.56 percent of total area is under cultivation. Out of total crops wheat, barley and corn are three major crops accounting for 39.56, 33.47 and 22.32 percent to net sown area of this village respectively. Out of total population farmers consists of 33.44 per cent whereas agricultural labours is 13.43 per cent and only 19.7 per cent was recorded for other workers. The region faced with water shortage and soil salinity, lack of local market, transportation facilities and youth migration. Dask is one of the most backward villages in eastern part in Jiroft watershed. Rainfall scarcity and occurrence of frequent drought condition within last 14 yeas affected on this village. Komesh seasonal river and spring are the main water resources of this village. Dask spreads over 333.8 hectares of area having population of 179 (1996). Only three landuse categories is observed in this village, namely, cropped land, forest and land not available for cultivation.
Dask has 114.2 hectares net sown area accounting for 34.22 percent. Orange is the leading crop occupied 65.41 per cent to net sown area in central and south-central parts on sandy soil followed by lemon covering an area of 26.27 per cent to net sown area in north and north-east part. 8.32 per cent of net sown area in southern part is covered by alfalfa. The net sown area is mainly concentrated along the river in central part which totally is irrigated. Poor qualities of soil, lack of arable land, insufficient of water, Poor road facility and non-accessibility to market center are the major problems of this village.

11.3 Conclusion Remarks

Jiroft watershed falls in scares rainfall zone in Kerman province in Iran. This area has encircled by mountain range and this study area receives less rainfall from 157-350 millimeters annually. Even then this region is endowed with water as source taken from under ground. This is a main source for irrigating the land for cultivation of the region. It is surprising that this region has more than 90 per cent land under irrigation and produces orange, date, cucumber, tomato, watermelon, vegetable crops, walnuts, onion, melon barely, wheat and potato. The modern irrigation system using green house in the field the crops through out the year. The production of some crops are taken surplus in the region which are locally consumed and supply to surrounding states in Iran and some time in abroad too. Most of the villages have hundred per cent irrigation for cultivation these crops. Thus, this region has supplemented irrigation for landuse properly. Despite less rainfall receiving through out the year region attracts by the planners agriculturists, farmers to look into the landuse of the region. From this point of
view, the study of landuse planning and its development is top priority in this present study for better agriculture crop and yields. Thus there is a ample scope for its expansion and intensification by introducing modern irrigation system and other inputs in the fields in Jiroft watershed.