

DROUGHT MANAGEMENT IN AGRICULTURE: ISSUES, MEASURES AND EXPERIENCES IN KHORASAN RAZAVI PROVINCE, IRAN

GESTION DE LA SECHERESSE EN AGRICULTURE : PREOCCUPATIONS, MESURES ET EXPERIENCES DE LA PROVINCE DE KHORASAN RAZAVI, IRAN

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ABSTRACT

The Khorasan Razavi (KR), located in the east to north-east of Iran, is a drought prone area and has suffered from recurring droughts especially in the last decade. Besides drought, climate change also had increasing adverse effects on water scarcity and drought impacts. However despite considerable attention and focus on drought management issues in the subjects of water resources management, lesser attention and actions have been carried out on drought management in agriculture. Therefore, the main objective of this study is to identify the problems and hindering factors in regards to drought management in the agriculture, identification of measures, solutions, and strategies for overcoming the problems, identification of threats and opportunities in sustainability of agriculture in the KR province, and finally collection of some locally adapted solutions and experiences in coping with drought and water scarcity in the province. Through brain storming sessions and discussion of the ideas of the experts and resource persons from the water sector and the agricultural sector of the province, the issues, challenges, and measures associated with the management of drought were systematically identified. Based on the identified problems, the main issues and challenges of water scarcity and drought management in the KR province could be categorized in the following: 1) Groundwater resources limitations, 2) Climate change, 3) Lack of information, public awareness, and training of the beneficiaries, 4) Lack of proper policies and plans for the efficient use of water resources, 5) Instability and inconsistency in the plans and lack of proper coordination among different organizations, and 6) The higher scale problems associated with the land use planning in the country and as a consequence in the province.

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Key words: Drought management, Khorasan Razavi, Public awareness, Water scarcity.

RESUME ET CONCLUSIONS

Malgré l'aridité du climat et la rareté de l'eau, le secteur agricole reste l'une des activités économiques les plus importants en Iran. En plus d'être en grande partie aride, l'Iran est un pays sujettes à la sécheresse et de sa vulnérabilité à la sécheresse est en augmentation en raison de la réduction des disponibilités en eau par habitant, résultant de l'augmentation de la population, le changement climatique et la surexploitation et la dégradation de la qualité des ressources en eau.

Une grande partie de l'est et du sud-est de l'Iran a été confronté à une pénurie de précipitations et de sécheresse au cours de la dernière décennie. Le Khorasan Razavi (KR) province, située à l'est au nord-est, a également modifié et subi par les sécheresses fréquentes. La croissance démographique et la demande croissante pour la production agricole dans une main et la pénurie d'eau, changement climatique, et les sécheresses fréquentes dans l'autre main a fait face à cette province à des problèmes critiques et questions. Par conséquent, la viabilité du secteur agricole dans cette province est en menaces critiques

Le but de cette étude était d'identifier les problèmes, questions, mesures et expériences de gestion de la sécheresse dans le secteur agricole de la province en s'appuyant sur les perspectives des intervenants et des opinions dans une méthode participative. Toutefois, il a également tenté de document scientifique des œuvres d'expériences menées pour faire face à la sécheresse et à améliorer ses impacts dangereux dans la région.

Basé sur la méthodologie, les différentes parties prenantes ont été participé à un atelier et les questions suivantes ont répondu par la facilitation des discussions de remue-méninges: 1) Quels sont les principaux problèmes qui entravent la production agricole en ce qui concerne la sécheresse, 2) Quelles sont les principales menaces et opportunités? de l'agriculture durable dans la province en ce qui concerne la pénurie d'eau et la sécheresse?, 3) Quelles sont les mesures et les solutions sont recommandées pour résoudre les problèmes?, et 4) Nomination des expériences locales de faire face à la pénurie d'eau et de gestion de la sécheresse dans le secteur de l'agriculture de l' province.

Dans l'ensemble, 24 cas de problèmes, 18 cas de mesures et de solutions, 16 cas de menaces pour l'agriculture durable, 4 cas d'opportunités, et 8 cas d'expériences réussies dans la gestion de la sécheresse ont été identifiés participative.

Sur la base des problèmes identifiés, les principaux enjeux et défis de la rareté de l'eau et de gestion de la sécheresse dans la province KR pourraient être classées dans les numéros suivants: 1) Les ressources en eaux, en particulier les eaux souterraines, les limites, 2) le changement climatique et ses impacts négatifs sur l'eau production à la demande et de la culture, 3) le manque d'information, la sensibilisation du public, et la formation des bénéficiaires, 4) le manque de politiques adéquates et des plans pour l'utilisation efficace des ressources en eau, notamment par la mise en œuvre d'une bonne répartition des cultures, 5) L'instabilité et l'incohérence dans les plans et le manque d'une bonne coordination entre

les différentes organisations, et 6) Les problèmes plus-échelle pertinente à la planification de l'utilisation des terres dans le pays et, par conséquent, dans la province KR.

Toutefois, en dépit de certaines expériences adaptées aux conditions locales à faire face à la pénurie d'eau, la plupart d'entre eux ne sont pas bien alignées et en conformité avec les problèmes identifiés et les questions. En outre, la plupart d'entre eux sont limités à des cas particuliers et n'ont pas la capacité de la solution généralisée de la gestion de la sécheresse de la province. Globalement, il semble que, malgré la province est située dans une région très aride et sujettes à la sécheresse de l'Iran et la fréquence des sécheresses a de graves répercussions sur la durabilité de l'agriculture, peu d'expérience sont disponibles et / ou peu d'attention est accordée à la lutte contre la sécheresse dans le secteur agricole de la province. La raison peut être, comme la principale source d'eau pour l'agriculture dans la province sont les eaux souterraines, par conséquent, jusqu'à épuisement complet de cette précieuse source d'eau, malheureusement, les décideurs et les experts n'ont pas encore pris crises de l'eau des alarmes dans la province graves.

Mots clés: Gestion de la sécheresse, Khorasan Razavi, sensibilisation du public, pénurie d'eau.

(Traduction française telle que fournie par les auteurs)

1. INTRODUCTION

The Islamic Republic of Iran is situated in one of the most arid regions of the world. The average annual precipitation is 252 mm (one-third of the world average), and this is under conditions in which 179 mm of rainfall is directly evaporated. In other words, 71% of precipitation is lost due to evaporation, while annual evaporation potential of the country is between 1500 to 2000 mm (Fig. 1).

The altitude of the country varies from -40 to 5670 m a.s.l. and has a pronounced influence on the diversity and variation of the climate. Although most parts of the country can be classified as arid to semi-arid, the country, however, enjoys a wide range of climatic conditions. Both latitude and altitude have a major influence on climate in the various regions. This is shown by the spatial variation of annual precipitation (Fig. 2), and a wide range of temperatures up to 100°C (-44°C in Borudjen/Chahar Mahal Bakhtiari province, located in the central Zagros range mountains and 56°C in the south along the Persian Gulf coast) (Keshavarz et al., 2005).

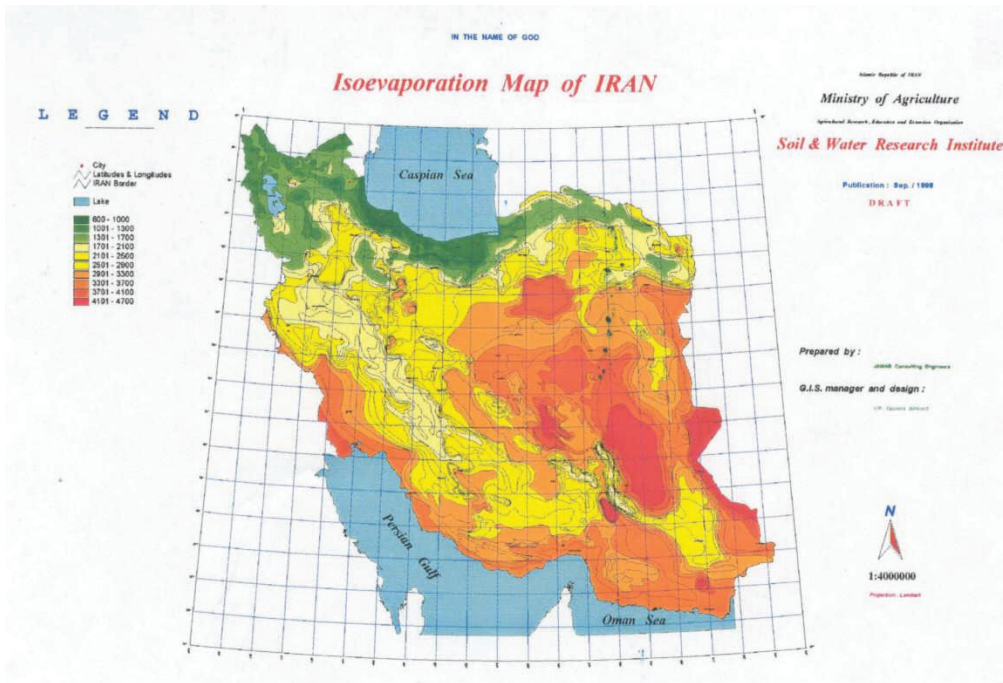


Fig. 1. Average annual evaporation in Iran (Moyenne évaporation annuelle en Iran)

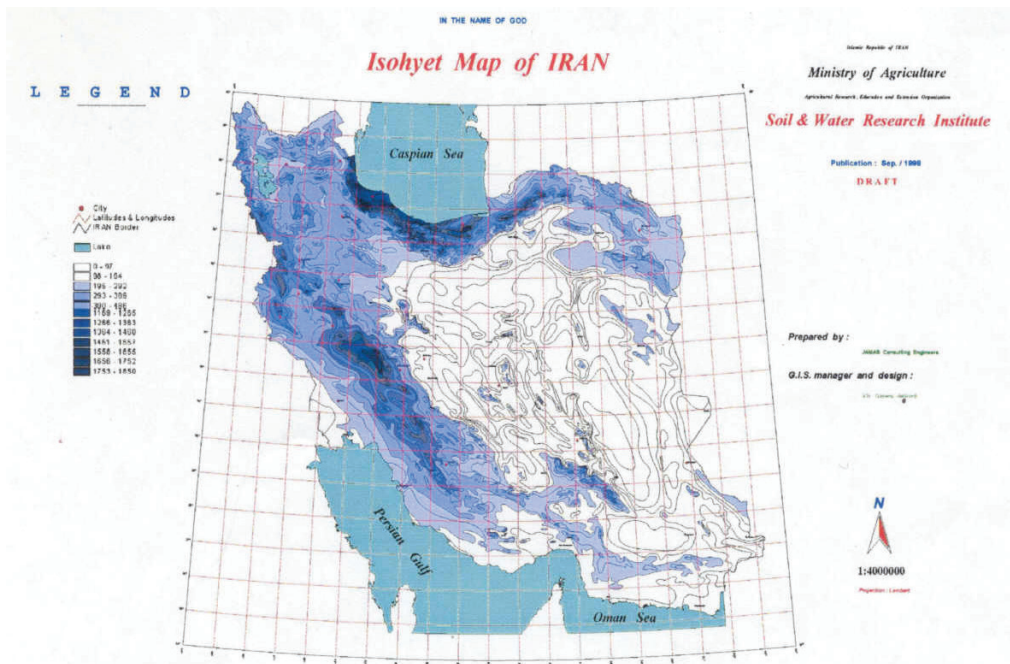


Fig. 2. Average annual precipitation in Iran (Les précipitations annuelles moyennes en Iran)

According to the aridity map (Fig. 3), the climatological situation of the country indicates that more than two thirds of the total area of Iran are within arid and semi arid zones (FAO, 2007).

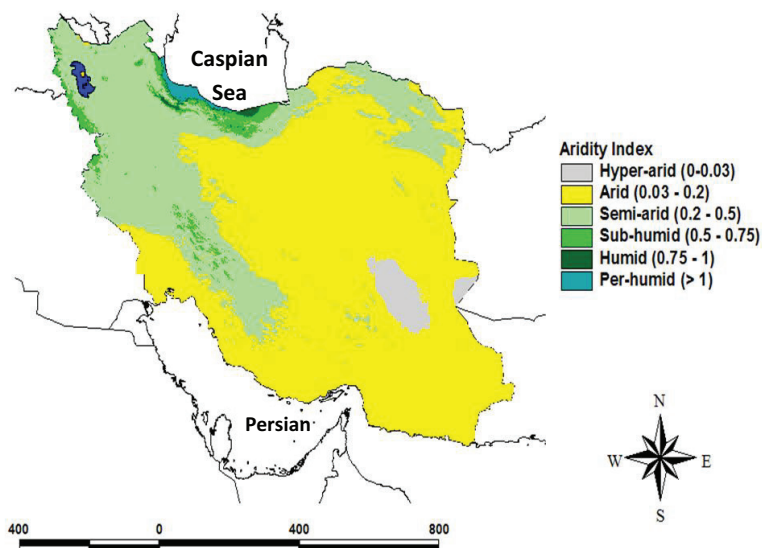


Fig. 3. Aridity Zoning map of Iran (L'aridité de zonage de la carte de l'Iran)

Despite climatic aridity and water scarcity, the agriculture is one of the most important economic activities in Iran. In addition to being mostly arid, Iran is a drought prone country and its vulnerability to drought is increasing because of reduced per capita water availability, resulting from population increase, climate change and overexploitation and quality degradation of the available water resources.

Water scarcity and drought are among the biggest challenges facing the agricultural development in the future. Projections of demographic indicators and food requirements show that the land and water potentials of the country can fulfill the country's needs for domestic food production, but only if measures are taken to promote suitable cropping patterns, improve crop yields and irrigation efficiency, reduce post-harvest losses, improve farm management and, above all, establish an integrated strategy for water management and drought preparedness in the agricultural sector.

According to available estimates, drought damage to agriculture and livestock were about US\$ 2.5 billion in 2001 and US\$ 1.7 billion in 2000. There was substantial loss in rural employment due to shrinkage of agricultural operations and as a result the gross domestic product (GDP) from agriculture and livestock was reduced by about 12% (FAO, 2007). This drought also severely impacted water resources, forests, pastures, and other natural resources.

Frequent occurrence of droughts and its severe impacts on the economy and natural resources have triggered the government to formulate the strategy and action plan for drought management. As a result many relevant organizations/institutes prioritized putting drought management issues in their mandate and as a result, a good number of drought committees,

research centers, and working groups have been established. Out of these drought study centers/working groups is the “Management of Agricultural Water under Aridity and Drought Conditions” working group, which is recently established in the Iranian National Committee on Irrigation and Drainage (IRNCID).

Study and scientific documentation of experiences in coping with drought in the agricultural sector is required for ameliorating its hazardous impacts in the region. This could be done through identification of the problems, issues, measures, and experiences of drought management in the agricultural sector and based on the stakeholders' perspectives and opinions. This is also required for setting the proper policies and plans for the activities related for coping with water scarcity and drought management.

However despite considerable attention and focus on drought management issues, especially on drought monitoring and forecasting, less attention and works have been carried out on managing drought in the field of agriculture. Therefore, the main objective of this paper is to provide a part of results of the IRNCID working group on study and documentation of experiences on locally adapted drought management plans and actions in the agricultural sector of the different provinces of Iran. At the initial step, the Khorasan Razavai (KR), a drought prone area of Iran, was selected and perceptions, ideas, and knowledge of the stakeholders of the region on drought management were gathered through brain storming meetings. The specific objectives and expected outputs from the study were recognition of the problems and hindering factors in regards to drought management in agriculture, identification of measures, solutions, and strategies for overcoming to the problems, identification of threats and opportunities in sustainability of agriculture in the province, and finally collection and documentation of locally adapted solutions and experiences in coping with drought and water scarcity for the purpose of further detailed studies in future.

2. ARIDITY AND DROUGHT IN THE KHORASAN RAZAVI PROVINCE

The Khorasan Razavi (KR) Province is located in the north east of Iran. The Kashaf Roud basin is the main basin of the province (Fig. 4). The basin area is 16787 km² and the average annual rainfall in the basin is 270 mm. The Kashaf Roud River is a branch of Harir Roud River which finally drains into the Gharaghom desert in Turkmenistan (Fig. 4).

The KR province has suffered from trcurring droughts, especially in the last decade. Population growth and greater demand for agricultural and livestock products in one hand and aridity and water resources limitations on the other hand, has made the water scarcity and drought big and challenging issues in the province. For instance, shortages in the rainfall amount in year 2007-08 in comparison to the preceding year and long term average was 18.1 BCM (57%) and 13.2 BCM (50.3%), respectively. This has caused severe decline in surface and groundwater resources of the province. Evaluation of the water flows in the hydrological stations of the province indicates a 78% reduction. Because of continuous drought incidences in the last decade, the water stored in the reservoirs has reduced considerably. Satellite images in the April 2007 indicate that the snow cover was very little and it covered only less than 0.5

percent of the province area and it yielded only less than 30 MCM water. The groundwater tables are in continuous decline and the risk of saline water advance is threatening some important plains of the province. The measurements indicate that the groundwater resources are 1.059 BCM in negative balance yearly.



Figure 4. The Khorasan Razavi province and the Kashaf Roud basin location, including its river branches and the access roads (Sabetraftar, 2008) (La province de Khorasan Razavi et l'emplacement du bassin Kashaf Roud, y compris ses succursales fleuve et les routes d'accès)

Drought damage to the agricultural products in the province is considerable. For example, in the year 2007-08, dryland agriculture was severely affected by the drought. In this agronomic year, 80 to 90 percent (160,000 ha) of dryland farms were damaged and from 260000 ha of irrigated wheat, 60000 ha of which that are only dependent to the river water, also damaged. Damages to the orchards, especially dryland orchards, also was severe in the province.

In addition to the drought, climate change also had increasing adverse effects on water scarcity and drought impacts. Based on reports and long term records of data (Sabetraftar, 2008), climate change, has caused temperature increase in the province. The increase for the southern, central and northern parts has been estimated about 5 and 3 degrees Celsius, respectively. This has caused most of the precipitation to occur as rainfall and little snow falls occur. This has resulted in a reduction of flow duration in the seasonal stream and springs, which are the main source of supplemental irrigation of the farms, especially orchards in the highlands, and less recharge of groundwater. Climate change, however, has also caused crops

net water requirement (evapotranspiration) to increase. Evaluations indicate that for about 2^o C increase in temperature of the province, the increase in crops net water requirement will be by 6% (Alizadeh and Kamali, 2003).

3. MATERIALS AND THE METHODS

Through brain storming meetings and gathering of the ideas of the experts and resource persons from the water and the agricultural sector of the province, the issues, challenges, and measures associated with the management of drought were systematically identified.

The participating stakeholders consisted of the experts representing different organizations relevant to the case, including: Agriculture, Water, Crises Management of Interior, Crop Insurance, Farmer's NGOs, Agricultural Research Centers, Climatology Research Institute, Environment, Consulting Engineering, and the Drought and Aridity Management Working Group of the IRNCID.

Based on methodology, different stakeholders participated actively in a workshop and the following issues were addressed: 1) What are the main problems hindering agricultural productions in regard to drought?, 2) What are the main threats and opportunities of sustainable agriculture in the province in regard to water scarcity and drought?, 3) What measures and solutions are recommend to solve the problems?, and 4) Consideration of the local experiences of coping with water scarcity and drought management in agriculture in the province.

4. RESULTS

In the following results of stakeholders opinions and ideas on the three following targeted questions and issues are as below:

Q1. What are the main problems hindering agricultural productions in the KR province in regard to drought?

- Water resources limitations

Drought causes the problem in supply of water resources. However this problem is more evident in surface water resources than the groundwater resources.

- Extra water losses

Water losses increase due to higher evapotranspiration and temperatures.

- Variation and unfavorable changes in precipitation and temperature

Irregular distribution, shift of precipitation time, and changes in precipitation pattern from snow to mostly rainfall, and reduced total amount of rainfall.

- Non-uniform distribution of water in the field and low irrigation efficiencies

- The problem of water conveyance from the source to the farm.

- Insufficient use of stress (aridity, salinity, and heat) resistant crop varieties in agriculture

- Low organic matter content of the soil

- Increment rate of soil erosion
- Weaknesses in early warning, information (by media), and required capacity buildings
- Small farm sizes and low level of knowledge and training of the farmers
- Weaknesses on continuity and follow ups of the plans and the projects
- Problems associated with the implementation of proper cropping pattern (laws, tools, proper crops, etc.)
- Improper policies and plans on development of pressurized irrigation technologies and failure in real water savings
- Lack of proper plans and incentives in coping with drought and water saving
- Insufficient plans and action on volumetric allocation of irrigation water and oversight on water uses
- Lack of proper mechanism (e.g., local water markets, etc.) creating incentives on saving water and trade surplus waters of the farmers
- Lack of proper coordination among concerned organization, and differences between opinions and perceptions among different sectors
- Lack of monitoring and early warning systems

However, in the monitoring system, the total rain not only should be considered, but other indices, which also consider the time distribution of rainfall, should be used

- Non- seriousness about the water crises, despite its severity
- Lack of conviction of the beneficiaries on the effectiveness of the plans and actions
- The problems associated with the transfer and adaptation of the research and executive findings and the plans
- Not serious actions on over-exploitation or illegal withdraws of ground waters
- Weaknesses in the directions, prescriptions (e.g., permits, license, ...)
- Cultural problems associated with the traditional and religious beliefs about water

Q2. What are the main threats and opportunities of sustainable agriculture in the KR province in regard to water scarcity and drought issues?

The Threats:

- Over-exploitation of ground water and declining water table
- Lack of proper irrigation plan in the fields
- Development of the cultivated areas
- Unplanned and improper use of brackish waters (especially the waste waters)
- Degradation of water quality (salinity, sodicity...)
- Intensive use of agricultural inputs (fertilizers, pesticides, ...)
- Erosion and reduce of soil fertility
- Low levels of farmer's knowledge

- Land subsidies
- Land use changes to villas, country seats, and small gardens (especially into orchards)?!
This is a challenging issue. There was some doubts on whether the case is in favor or in contradiction with the water saving and sustainable agriculture in the province.
- The high costs of deepening or movement of the agricultural wells
- Expansion of the cultivation of high water consuming crops
- Population increase and lack of land use planning
- Low prices of energy?!
This is a challenging issue. There was some doubts on whether the case is in favor or in contradiction with the water saving and sustainable agriculture in the province.
- Slow rate or lack of improvement of water productivity in relation and proper to the needs
- Tourism expansion?!
This is a challenging issue. There was some doubts on whether the case is in favor or in contradiction with the water saving and sustainable agriculture in the province. In the other word it, can be either threat or opportunity, depending on the management measures.

The Opportunities:

- Optimum use of treated waste waters and the urban sewages
- Having of diverse climate and wide range of latitude in the province
This has caused possibility of cultivation of more than 80 kinds of crops in the province.
- Possibility of cultivation of the high economical value exclusive crops, e.g. Saffron and barberry, in the province
- Tourism, good market, and the vicinity of the province to the regional markets?!
This is a challenging issue. There was some doubts on whether the case is in favor or in contradiction with the water saving and sustainable agriculture in the province.

Q3. What measures and solutions are suggested for solving the problems?

- Collection of the basic information required for a designed surface irrigation system, e.g., infiltration rate, soil texture, optimum length of furrow or border, etc.
Such a process and activity has been done for the pressurized irrigation systems. However, this important case for surface irrigation systems, which is a prevail system in more than 90 percent of irrigated areas in the province and the country, is lacking.
- More intense use of the organizations, experts, and the farmers from the weather forecasting available in the Meteorological organization website.
- Sustainable development of water saving irrigation technologies (e.g., pressurized irrigation systems)
- Public awareness on water crises, especially to the organizations and or the individual officials which are not specialized on water issues but are involved in the water crises issues and conflicts, e.g. law courts, members of parliament, disciplinary officers, clerics, etc.

- Removing of subsidies on agricultural inputs
- Specialized trainings of the beneficiaries on subjects e.g. soil and water, deficit irrigation, supplemental or single irrigation, etc.
- Increase in soil fertility and organic matters through conservation tillage, residual management, etc. practices.
- Establishment of surface and ground water user associations (WUA) in the different plains
- Release and introduction of the drought resistance crop varieties, especially for the other crops than only for the cereals
- Establishment of irrigation service companies for water saving practices affairs e.g., doing the first irrigation (germination stage) by pressurized systems, seedling planting than seed planting, etc.
- Development of greenhouse cultivation (Protected agriculture)
- Development and enhancement of groundwater recharge practices
- Establishment of department and or proper administrative structure for coping and dealing with drought in the relevant organizations of the province
- Equipping of the wells with water metering devices
- Land consolidation and a water sources integration and assembling
- Implementation of the laws on cropping pattern and productivity improvement
- Improvement of the engineering system and its orientation toward water scarcity and drought activities
- Study and research on the lawful and legal ways of implementation of policies and the rules

Q4. Identification of some of the locally adapted experiences of coping with water scarcity and drought management in agriculture in the province

- Water harvesting for greenhouse use
- Conjunctive use of surface (conveyance canal) and groundwater resources
- Use of different sources of water for drinking and irrigation water used in the Parks in the Urban areas
- Establishment of WUA and remove of one crop from the cropping pattern
- Use of clay pipe subsurface irrigation systems
- Winter cultivation of sugar beet
- Preparation of manuscripts of appropriate cropping patterns in the different areas of the KR province
- Improvement of irrigation efficiency through changes in the organic matter of the soil

Overall, 24 cases of problems, 18 cases of measures and solutions, 16 cases of threat to sustainable agriculture, 4 cases of opportunities, and 8 cases of successful experiences in drought management were identified.

5. CONCLUSIONS

Based on the identified problems, the main issues and challenges of water scarcity and drought management in the KR province could be categorized in the following issues: 1) Limitation of water resources, especially the groundwater, 2) Climate change and global warming and their adverse impacts on water demand and crop production, 3) Lack of information, public awareness, and training of the beneficiaries, 4) Lack of proper policies and plans for the efficient use of water resources, especially through implementation of proper cropping patterns, 5) Instability and inconsistency in the plans and lack of proper coordination among different organizations, and 6) The large-scale problems relevant to the land use planning in the country and consequently in the province.

However, despite introduction of some locally adapted experiences in coping with water scarcity, most of them are not much inline and in accordance with the identified problems and issues. Moreover, most of them are limited to the special cases and do not have the capability of solving the widespread problem of drought management of the province.

Overall, it seems that despite the fact that the province is located in a very arid and drought prone region of Iran and frequent droughts have severe impacts on sustainability of agriculture, little experience are available and / or little attention is given to cope with drought in the agricultural sector of the province. The reason may be, as the main source of water for agriculture in the province is groundwater, therefore till full depletion of this valuable source of water, no one is mentally ready to foresee the extremely dangerous situation of looming water crisis in the province.

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