Climate change adaptation and technology transfer: the path to disaster risk reduction in the arid and semi-arid zones. The case of Jordan

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Abstract

Climate change is a worldwide phenomenon that does not respect national boundaries nor affects one specific region. Hurricanes, tornadoes, typhoons, drought and floods are just a few of its many disastrous forms. Most world countries, especially in the arid and semi-arid regions, have been seriously devastated by the consequences of climate change at the economic, health, social, and environmental level. Adaptation and mitigation strategies have become the top priority of most international conferences and symposia around the world. The notion "Act locally and think globally" has become the main slogan and the most urgent need for collective action to ease the impacts of climate change. Such efforts like information, education, and technology transfer can make the difference due to their enormous potential to mitigate the implications of climate change. They represent the hope to face negative impacts of climate and the right path to mitigate its various implications, and consequently adapt to its future development.

***Keywords**: climate change, technology transfer, adaptation.*

Résumé

Le changement climatique est un phénomène d'envergure mondiale qui ni tient pas compte des frontières nationales et n'est pas non plus limité à une région spécifique. Les ouragans, les tornades, les typhons, la sécheresse et les inondations ne sont que quelques-unes de ses multiples formes catastrophiques. La plupart des pays du monde, notamment en région aride et semi-aride, ont été sérieusement ravagés par les effets du changement climatique sur le plan économique, sanitaire, social et environnemental. Les stratégies d'atténuation et adaptation sont devenues un thème prioritaire dans les conférences et les symposiums à l'échelle globale. Le concept " agir localement et penser globalement "est devenu le slogan le plus récurrent et il traduit le besoin très urgent d'une action collective pour réduire les effets négatifs du réchauffement planétaire. L'information, la formation et le transfert de technologie peuvent faire la différence vu leur potentiel énorme pour l'atténuation des conséquences du changement climatique. Dans ces efforts résident l'espoir de réussir à faire face aux effets néfastes du climat et la voie à suivre pour atténuer les conséquences de ce phénomène et s'adapter, par conséquent, à son évolution future.

Mots-clés: changement climatique, transfert de technologie, adaptation.

1. Introduction

Climate change is a complex, unpredictable, controversial and global environmental dilemma which affects every single creature on earth. The complexity of this dilemma lies in the absence of proper understanding and/or justification of the reasons behind its development and acceleration of related events. Definitely, agriculture is the sector most affected by the negative implications of climate change, more specifically concerning the products quantity and quality. It represents a major challenge and threat not only to agriculture, but to all sectors as well. The climate change implications include but are not limited to extreme cold or hot temperatures, heavier precipitation, shifting seasons, frost, drought, typhoons, tornadoes, hurricanes, occurrence of new diseases, insects and weeds, combined with shortening of growing seasons and many upshots that we witness every day (Nelson *et al*., 2010). According to Davis (2009), mitigating climate change requires information, education, and technology transfer. Adaptation and mitigation are the strategies most needed by farmers to ease the long-term impacts. This entails massive financial, physical, technical and human resources as well as substantial awareness and attitude change.

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Certainly, enforcement of policies and regulations and reliance on technology transfer are considered to be tangible and appropriate actions to reduce the impact. The great financial support by the Global Environmental Facility (GEF), for example, as a driving force in mitigating the implications, has been focused on technology transfer considered to be the main priority. About $250 million were annually donated to fund renewable energy efficiency projects, $3 billion to support energy generating technologies and $15 billion of indirect funds were granted for the environment. Addressing the issue seriously at all levels has become a pressing need which must be faced through the collective effort of scientists, academia, policy and decision makers, investors, farm owners and ordinary citizens more than ever before.

2. Frightening information and disastrous impact

According to the World Bank (2013), Asia is the most vulnerable continent in the world. Since 1997, 82% of all lives lost in disasters have concerned the poorest Asian countries. In Bangladesh, the expected damage from a single severe cyclone might reach $9 billion by 2050. In Vietnam, the Mekong River Delta will rise 30 cm by 2050, which will lead to increased salinity and reduction of rice cropping by 13 percent. In China and Vietnam, about 130 and 40 million people, respectively, will face unpredictable destiny due to the enormous threat posed by cyclones and

typhoons (World Bank, 2013). According to the Asian Development Bank (2014), around 600 billion to 1.5 trillion USD will be needed annually for climate change adaptation. The bank also stated that by 2025, floods will be threatening over 300 to 410 million people. Globalpost (2014) indicated that each year approximately 150 thousand fatalities are recorded due to climate change consequences.

According to predictions, in the Arab world temperatures will rise by 3-4 degrees Celsius by the end of this century. The year 2010-11, was the warmest year ever since 1800's and five countries set new high records (Kuwait recorded 53.5 degrees). In Syria, dire impact of the recent multi-year drought forced around one million people to migrate toward the main cities (IRIN, 2012). Dorte Verner, Climate Change Coordinator at the World Bank, warns that the whole region will face a 10% water decrease and a 16 to 50% demand increase by 2050. Farajallah (2013), indicated that between 1980 and 2008 over 37 million people were affected and about $20 billion were lost due to natural disasters. Certainly, agriculture, fisheries and forestry are the most affected sectors by climate related disasters.

According to Karas (2006), and as shown by the global map, North Africa and the Eastern Mediterranean region (Arab countries) are the most vulnerable areas concerning climate change impacts, and annual rainfall is expected to decline there by 10-40%. As maintained by Abdel Hamid (2009), most Arab states will face threats like desertification, water scarcity, biodiversity loss, pollution of marine coastal areas, etc.

A report prepared on Climate Change Index (CCI) by Maplecroft, a British risk analytics and forecasting company, indicated that the region is home to 5 of the top 10 countries (Djibouti, Egypt, Iraq, Morocco, and Somalia) most affected by global warming. Saudi Arabia, Oman, United Arab Emirates, Bahrain, Kuwait, and Qatar will suffer significant ramifications, due to inland flooding as sea levels rise. Yemen, Jordan, Lebanon, Libya and Tunisia are ranked among "extremely" vulnerable countries on the CCI index (Abdel Hamid, 2009).

3. Dire predictions for Jordan

Jordan is listed among the most vulnerable countries in the world concerning climate change impacts. It ranks among the top four poorest countries in the world as regards water scarcity (Mayrhauser, 2012). Per capita water consumption/year is the lowest in the world. It dropped to 145 cubic meters, the lowest in the world, if we consider that the UN classified countries with less than 500 cubic meters per person per year as having an "absolute scarcity" of water (Aljazeera, 2013). Water shortage as well as damaged infrastructures would increase the risk of cholera, malaria and dysentery, while the combination of heat and pollution would increase the risk of respiratory diseases, the spread of infectious diseases and dengue fever.

Ninety-three percent of the country's land is classified as arid and semi-arid areas. Rainfall in these areas does not exceed 50 mm, and since they are used for growing forage crops, they suffer the most from climate change impacts.

According to a report, which includes various maps, produced by the "Drought Monitoring Unit (DMU)" at the National Center for Agricultural Research and Extension (NCARE), published by ICARDA in 2014, precipitation in Jordan is expected to decrease dramatically and the maximum decline will be obvious in rainfed areas in the spring season.

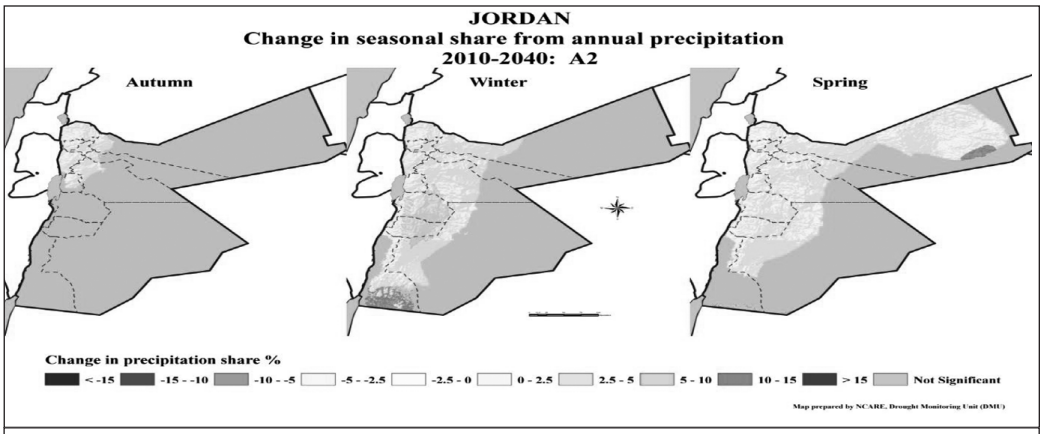
Since the country has a very short rainy season which lasts less than 3 months, the impact will be disastrous as shown in the maps. The grey area in the maps usually receives less than 50 mm/year, and in most cases it receives no rain at all. The dire implication will be recorded in the yellow area that receives periodic amounts of rain. Indeed, all the areas receiving rainfall will be subject to huge changes. On the other hand, the maximum, minimum as well as the mean temperatures, are expected to rise throughout the year in all areas in the country.

Definitely, the frightening prediction concerns the impact on plant growth and growth stages that will be the result of the minimum and maximum temperature increase in the winter and spring seasons.Unquestionably, intense and frequent periods of drought combined with erratic rainfall, extreme temperatures on both sides - hot and cold, shifting climatic zones, resulting in shorter growing seasons and prevalence of new pests and diseases in areas where they were not considered a serious threat before, are just a few examples of the impact (ICARDA, 2012).

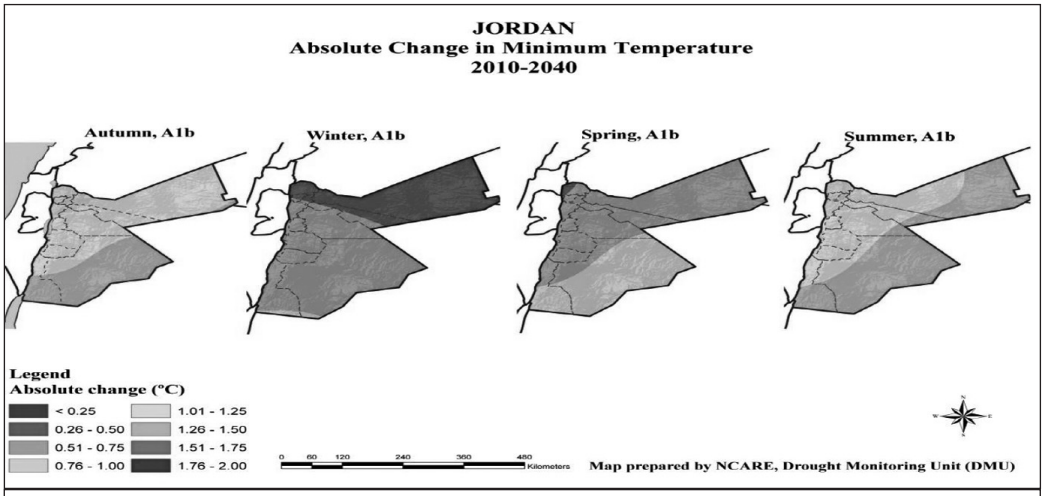
As for the Potential Evapotranspiration (PET), the report summarized its predictions according to which the PET will show an overall increase during the growing seasons - January to March till May (Spring Season). It also indicated that most Jordan areas will record an increase in total annual PET (40-60 mm), of which up to 23 mm in the growing season period, that usually starts in November and lasts until May.

Based on the above predictions, there is considerable evidence that farmers will face dryer seasons and herders will have difficulties to produce more food or meet their basic needs, especially if we take into consideration the length of the growing period in cultivated areas. The report stated also that most areas in Jordan are likely to experience moderate reductions of up to 15 days, but in some areas the decline will be between 15 to 30 days. In both cases, the reduction will have a huge impact on the nutritional content of agricultural products, and as a result, it will have a serious negative impact on people health and state of livelihood. Only one area – the Southern mountains of Shoubak, i.e. the coldest area in the country, will witness an increase in the length of the growing period due to the expected decrease of low temperatures.

As indicted earlier, climate change affects not only selected ecosystem components, but also their functional cycles. It goes without saying that the high population growth rate, in addition to the influx of millions of Syrian and Iraqi refugees, will exert more pressure on natural resources causing disastrous situations.



Maps prepared by DMU and published by ICARDA 2014.



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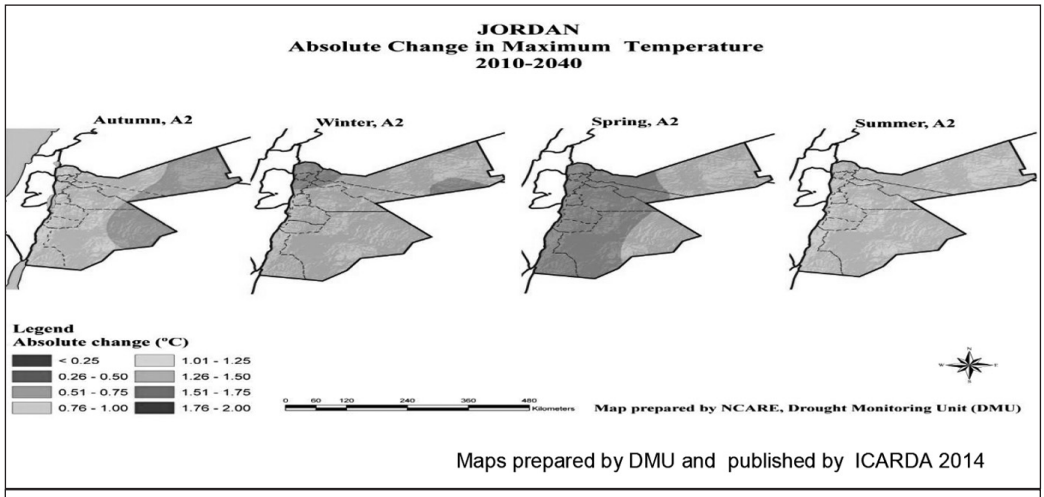


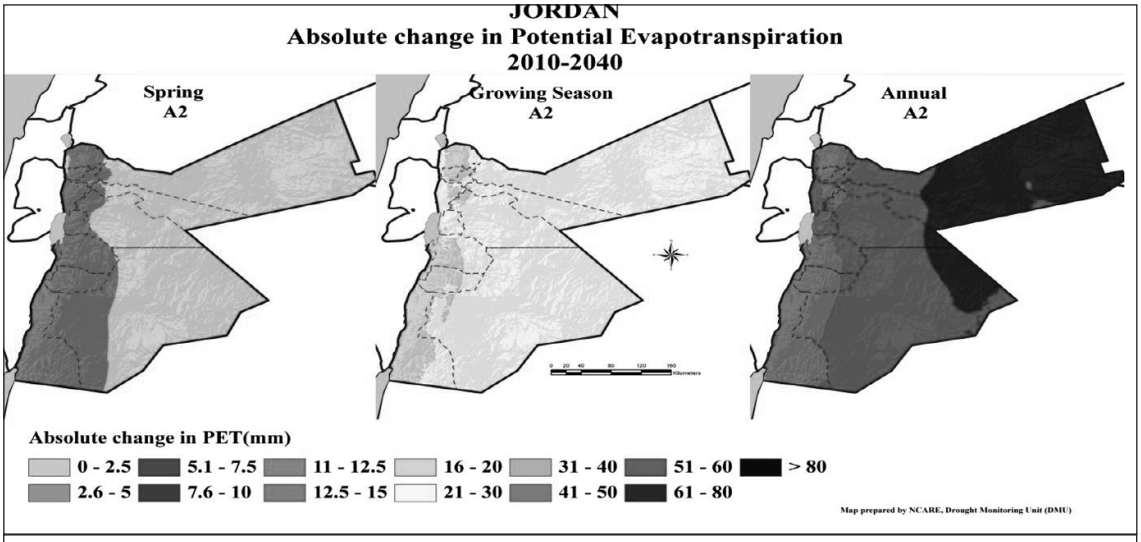
Maps prepared by DMU and published by ICARDA 2014.

Given the complexity of the challenges ahead, partnership between all parties concerned is a need and a critical success factor. Undoubtedly, strong agricultural adaptation measures in Jordan are crucial steps towards mitigating climate change impacts, but they rely upon policies, regulations and financial support.

As shown in the drought maps, during twenty years, most areas of the country were subject to frequent periods of drought, the most severe being over 14 times in twenty years. The least frequent time was between 3-4. This map shows how serious climate change has become in Jordan. From a technical point of view, there is no area that was not hit by a series of drought periods. If this trend continues and population keeps growing, with the continuous influx of millions of refugees, the agricultural sector will face chronic problems in terms of water availability.

Recognizing the complexity of these issues, decision makers, scientists, technology transfer specialists, academics as well as ordinary people realize that no silver bullet can do the job at once. Among the solutions to address these problems, there are a number of key approaches and tactics that can be applied. Technology transfer was recognized as the most effective method to mitigate the effects. Conservation agriculture or Zero tillage, which farmers started to apply several years ago, allows to save soil misture and gives an advantage over conventional farming as shown in the figures below. In many cases in Syria, Tunisia and Jordan, these techniques proved to be very effective compared with conventional farming.

To mitigate these impacts, research facilities must stress the importance of adopting practical methods, such as favouring integrated agro-ecosystems, applying sustainable natural resource management, supporting genetic improvement and enabling environments. Hence, the development of targeted policies and the use of improved crop varieties must go hand in hand



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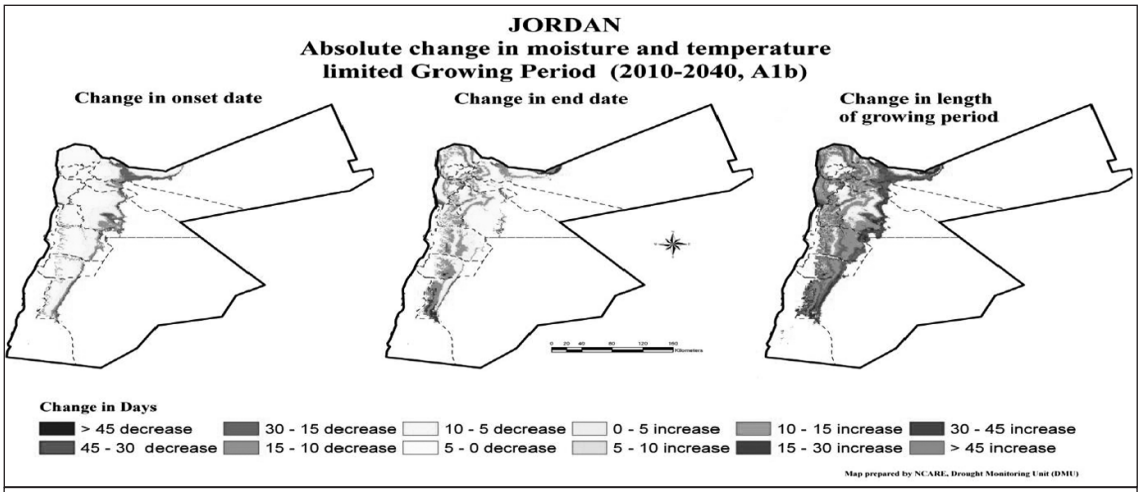
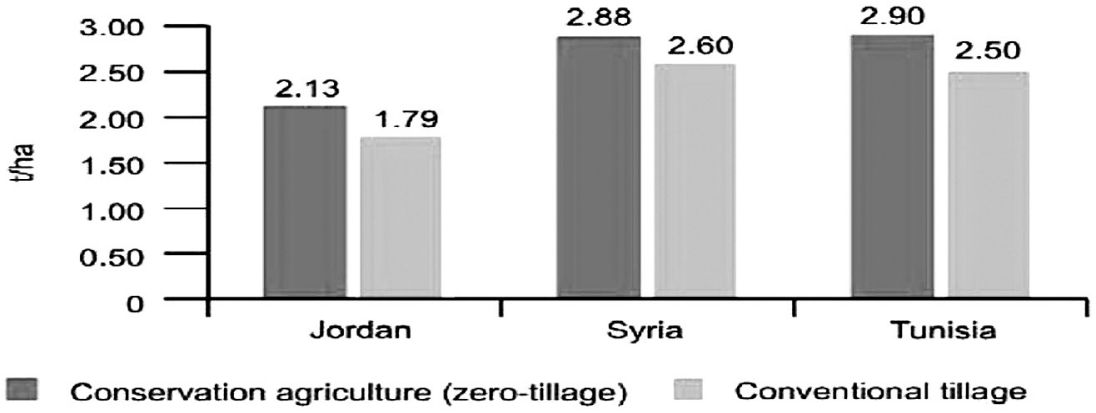


Maps prepared by DMU and published by ICARDA 2014.

Figure 1 - *Wheat yields: conservation agriculture vs. conventional tillage.*



Source: ICARDA Auunal Report. 2012.

with technology transfer. NCARE has produced several wheat and barley varieties which combine high yield and drought resistance and were propagated and distributed to farmers. The diversification of food production systems and the integration of crop-livestock systems are very effective and have proved to be successful. The indigenous knowledge and methods have become the source of information for many farmers. The use of sequential cropping, intercropping, etc. has a positive effect on climate change mitigation.

4. Concluding remarks

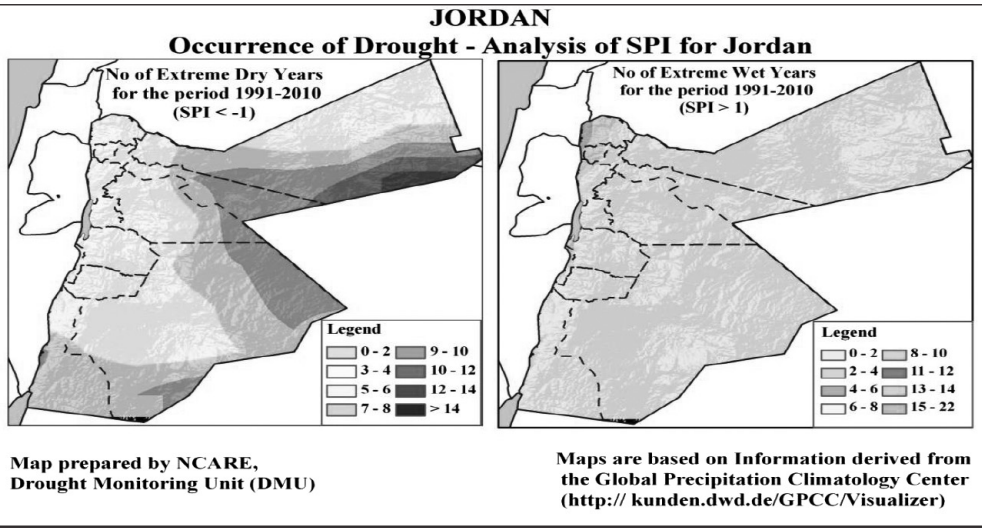
Improving disaster risk reduction requires greater awareness, huge financial support, social interaction and political commitment.

Effective partnership between research centres and technology seekers is a must and a major strategic element in supporting the role of agriculture.

Public and private cooperation can play a significant role in providing farmers with the necessary information, education and technologies.

Extension systems can help farmers deal with climate change by means of adaptation and contingency measures.

Technology transfer can assist farmers and prepare them for greater climate vari-



Source: ICARDA annual report 2012.

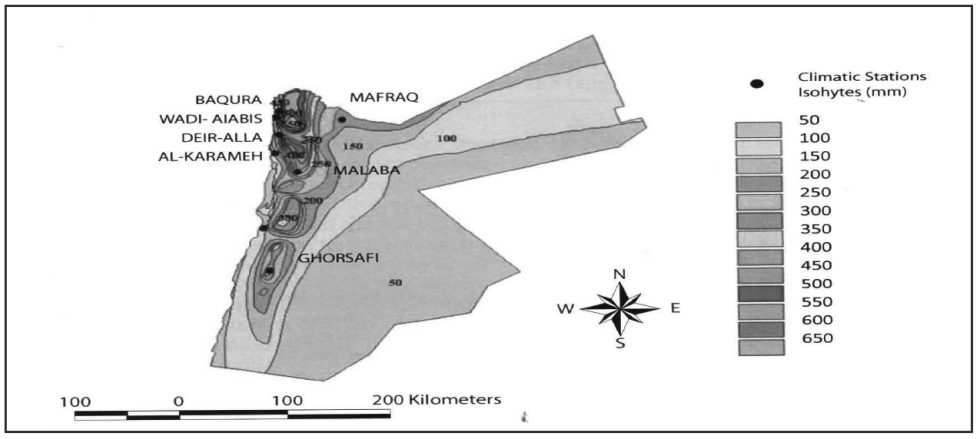


Fig.1: Rainfall Isohyets (26)

Source: ICARDA OSIS Country report 1.

ability and uncertainty. Extension staff can help farmers through knowledge, proper practices and management systems.

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