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Assessment of Climate change impacts on wheat and Barley production quality and quantity in Palestine

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Abstract
The wheat and Barley cultivation in the West Bank-Palestine show a distinct Mediterranean climate with most of the rainfall occurring in the winter months. The main detrimental factor limiting plant production in this region is rainfall. Due to clearing of native vegetation, dryland salinity is a major problem in Hebron and east Jenin districts. Since the 1970s years the West bank has experienced a significant decrease in winter rainfall. Across Fifteen sites, growing season rainfall (September to May) decreased by an average of 11% and the sum of rainfall in September and October decreased by 45%. Despite the large decline in rainfall, yields based on the actual weather data did not fall. These results were due to the rainfall changes mainly occurring in September and October, a period when rainfall often is less than crop demand. The findings will have significant implications for estimates of future climate change impacts in the West Bank with changes in rainfall causing proportional impacts on production, where proportionality is often presumed.

Keywords: climate change; barely; wheat; Palestine

1. Introduction: Background

The importance of the agricultural sector in Palestine stalks from its contribution to the national food security of Palestinian households, in addition to the creation of job opportunities in the Palestinian labor market. According to the agricultural census published by the Palestinian Central Bureau of Statistics (PCBS) for 2010/2011; there were 85,885 agricultural holdings in the West Bank, of which 68.2% are plant holdings, 10% are livestock holdings, and 21.8% are mixed holdings. It has been noted that the number of agricultural holdings is continuously increasing due to the inheritance system that divides agricultural land between heirs. The latest agricultural census published by the Ministry of Agriculture and PCBS in 2010 estimated that the total area of agricultural land was 1,207,061 dunum (91.6% or 1,694,554 in the West Bank, and 8.4% in Gaza Strip) [2].

The PCBS reports estimated that the value of Palestinian agricultural production was $1,295 million (70% in the West Bank, and 30% in the Gaza Strip) [3]. But, the agricultural sector's contribution to the Palestinian gross domestic product (GDP) was only 4.1% in the year 2013, and 3.4% of the GDP of the West Bank [4]. Accordingly, the agricultural sector's contribution to GDP has been declining over the years, due to growth in other sectors.

The analysis of the agricultural sector and its activities shows that the sector is facing many challenges and obstacles. The political conflict in Palestine is the most critical. The Climate change has also been a major issue challenging the agricultural sector in Palestine, and directly affecting agricultural production, mainly due to changes and fluctuations in rainfall quantities, and the disintegration of agricultural holdings reducing their productivity, efficiency and profitability.

In Palestine, about 143,326 dunum of agricultural land has been utilized for the cultivation of wheat (*Triticum aestivum* L.) in the West Bank in the year 2012/2013. Wheat is mainly grown in areas with an average annual rainfall ranging between 280 and 550 mm/year. The planted areas show a distinct Mediterranean climate with cool, wet winters and hot, dry summers. Over 75% of the rain falls between October -March months [5]. The main producer governorates are as follow Jenin governorate is the highest producer of wheat, constituting 54% of total production, followed by Hebron governorate (16%), and Nablus governorate (11%) [1].

In Palestine, about 8568 dunum of agricultural land has been utilized for the cultivation of Barley (*Hordeum vulgare* L) in the West Bank in the year 2013/2014. Barley is mainly grown in areas with an average yearly rainfall of between 250 and 500 mm/year. The planted areas show a distinct Mediterranean climate with cool, wet winters and hot, dry summers. Over 75% of the rain falls between October -March months 5. The main producer governorates are as follow Jenin governorate is the highest producer of wheat, constituting 46% of total production, followed by Hebron governorate (21%), and Nablus governorate (16%) [5].

2. Material and methods

2.1 Study area

The West Bank covers an area of about 5,655 km². The area is located within the following geographical coordinates 31.9466° N, 35.3027° E.

2.2 Survey

A Combination of literature survey and multiple interviews with officials from the Palestinian Governmental agriculture related agencies and active NGOs were used for gathering information on Wheat and Barley production in Palestine. We designed semi-structured interviews. We interviewed 18 key informants during a field survey between March and May 2017. We interviewed at least two key informants regarding each of the main topics of Wheat and Barley production of Palestine.

3. Results & Discussion

The analysis of temperature and rainfall changes in the last 36 years (1980–2016) in the studied area showed that over time the annual mean temperature has been increased, and the annual mean of rainfall decreased, In a way that about 0.046 degree centigrade has been added to the mean temperature of the West Bank annually, and the annual mean of rainfall decreased about (11%) mm.

These results confirm the climate change phenomena for this part of the World.

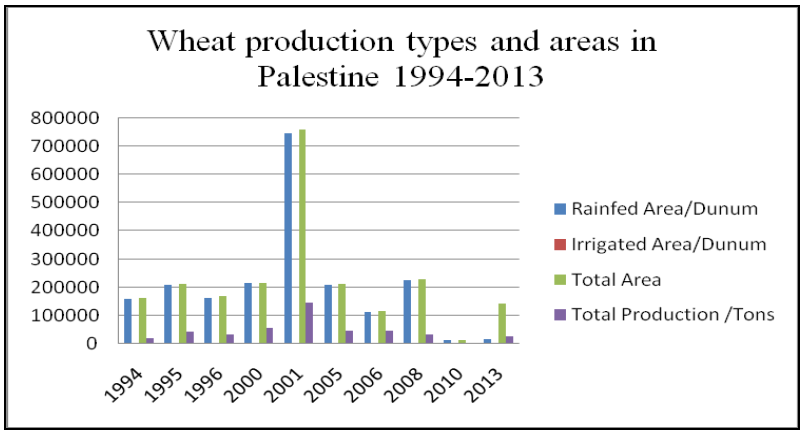
3.1 Climate change impact on wheat production quality and quantity in Palestine

3.1.1 The Growing period (The number of the days from planting to flowering).

The growing period of wheat in all studied sites was less in almost 24% than the normal situation (230-240 days), and thus reduces the wheat growth season. Though it has been reported that in the areas where the crop's growth season encounters limitation, climate change and earth warming can lead to the improvement of crops' yield by increasing the growth season period and the improvement of the plant flowering strength [5]. The rise in temperature will increase the growth and development speed of the crops, though experimental evidence has showed that under this condition, the length of maturity of the seed in the grains and seedy plants will be reduced [6]. Another study by (Menzel, 2003), stated that the rise in temperature leads to the shorter length period of grain filling in the grains and thus will decrease the quality of these products, Since achieving optimal quality depends on the solid material accumulation during the growth season on one hand and also on the existence of enough time to transfer the material to the grain on the other hand [7].

3.1.2 The wheat production quantity.

The data analysis results of wheat yield showed that a decrease will occurs under the influence of future climate changes in the West Bank governorates. The reduction rate of wheat yield was variable between 1.37% and 71.51% for the years 2004-2015. Mitchell *et al*. (1995) observed that the plant yield showed reduction between 16% and 35% under the impact of temperature rise [8]. Saarikko and Carter (1996) also stated that the wheat yield was reduced in southern areas of Finland, as a result of of global warming impact on the wheat production. Change in temperature and rainfall level, affects the plant photosynthesis, growth and absorption rate and water and nutrient distribution and as a result the leaf area index [9].



3.2 Climate change impact on Barley production quality and quantity in Palestine.

3.2.1 The Growing period (The number of the days from planting to flowering).

The growing period of barley in all observed sites was less in almost 19% than the normal situation (210-220 days), and thus reduces the barley growth season. The rise in temperature will increase the growth and development speed of the crops, though experimental evidence has showed that under this condition, the length of maturity of the seed in the grains and seedy plants will be reduced (Parry *et al*., 2004). (Menzel, 2003), (N.M. Holdena, A.J. Breretona, R. Fealyb, J. Sweeneyb, 2003) and (Matthew Gammans, Pierre Mérel, and Ariel Ortiz - Bobea, 2016); (Asseng *et al*. 2015) was also reported in the studies of climate change., stated that the rise in temperature leads to the shorter length period of grain filling in the grains and thus will decrease the quality of these products, Since achieving optimal quality depends on the solid material accumulation during the growth season on one hand and also on the existence of enough time to transfer the material to the grain on the other hand [6, 7, 10, 11, 12].

Barley yield trend

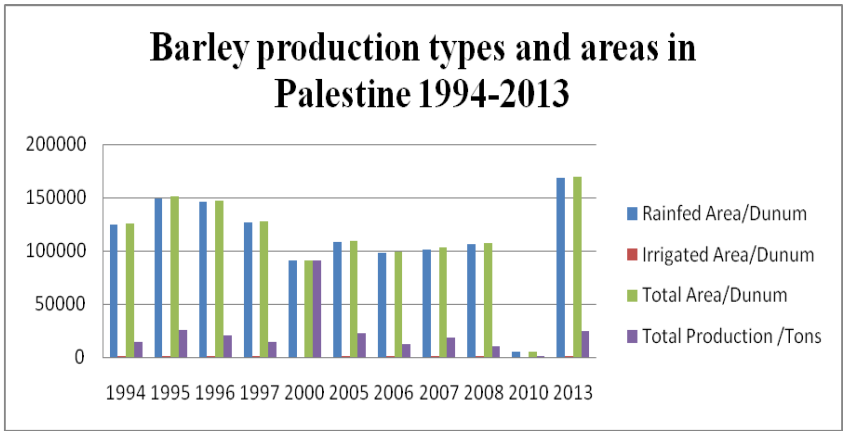
The yield trend of wheat crop showed that the yield has changed significantly over time ($p < 0.05$). However, the yield has fluctuated over time. Wheat had the highest regression coefficient versus time. The yield of wheat decreased 176.31 kg/dunum in the year 2000 and 4.74 kg/dunum in the year 2005, and in other years but not contrast.

3.2.2 The barley production quantity

Our results indicated a very large decrease in crop area (minus 67% and minus 62% for barley, relative to the average of 1994, and 2014).A number of existing yield studies on barley also confirm such finding, like (Asseng *et al*. 2015),and (Teresa Tuttolomondo, Salvatore La Bella, Giusep pe Lecardane, Claudio Leto,) Available evidence shows that the decrease in the grain filling period due to the rise in temperature is the main factor in the yield decrease of the crops in the climate change condition (Challinor *et al*., 2007) [13].

3.2.3 Barley yield trend

Barley decreased (4.74 kg/dunum) every year. But these changes were not significant ($p > 0.05$) with respect to the time variable.



4. Conclusion

The study results show that climate change variables have differential impacts on the yield growth of wheat and barley. However, both rainfed dependant crops are adversely affected by the current climate trends. The yield of barley and wheat, are decreasing due to increased temperatures and decreased precipitation.

Thus, it is recommended that any programs that are working to minimize the adverse impact of climate change on wheat and barley production should first consider these crops, are being most affected by the higher temperatures and are also exposed to higher degrees of vulnerability to climate change.

Therefore, further studies/surveys are highly recommended to better understand the patterns and consequences of climate change affecting wheat and barley productions in Palestine.

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