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Integrating Some of the Ecological Factors in Order Sustainable Canola Production Using GIS in Southwest Iran

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Abstract: Rapeseed or canola (*Brassica napus* L.) is the most important industrial and alternative crops. Rapeseed oil crop has recently been exploited to boost cultivation areas in Iran. The potential of land for agricultural use is determined by an evaluation of agro-ecological. Geographic Information System (GIS) was used to identify suitable areas for rapeseed crop production in Central and West Iran. The study carried out in tow provinces (Isfahan and Chaharmahal va Bakhtyiari), Iran. The study area covers approximately 37659 Km^2 of total area. This area is located between latitude 30° 42' N and 33° 37' N and between longitude 49° 56' W and 51° 57' W. Relevant environment-components such as soil chemical and physical characteristics (texture, gravel percentage, pH, EC, organic matter, soil depth and etc) and topography (DEM) at different spatial and temporal resolutions were considered. The results of stepwise regression indicated that the most important variables of soil and topography affecting the growth and seed yield of rapeseed crop were soil depth, elevation and land slope. The results of maps this study by ILWIS (version academic 3.0) identified that 1113 ha (0.03%), 2307138 ha (61.3%), 128 ha (0.003%), 1418280 ha (37.7%) and 39340 ha (1.04%) of land have currently not suitable (N1) and permanently non 1 suitable (N2), highly suitable (S1), moderately suitable (S2) and marginally suitable (S3) for rapeseed crop production in Central and West Iran, respectively.

Key words: Agro-ecological % GIS % Rapeseed and Suitable area

INTRODUCTION

The increase in the burgeoning population of the world and the shortage of the resources to meet the requirements for food has increased the need for oil and protein sources. The plants are the most important sources of oil and protein for humans and animals nutrition. There are over 350 species oil-producing plants and thousand of sub-species [1]. The world area cultivated by *Brassica* species has been increased rapidly during the last decade due to the intensive work to improve the oil and meal quality of *Brassica* species. Therefore, the winter and spring types of *Brassica napus* L. and *B. compesris* L. as well as the Indian mustard *B. junceae* are provide over 13% of global vegetable oils needs [2]. Rapeseed oil known as rape oil, colza oil and recently canola oil, the recent rapeseed varieties known as a canola contain low levels or free of both erucic acid and glucosinolates. Today rapeseed/canola ranks the second in the world after soybean among oil crops in terms cultivated area, seed and oil production [3].

In Iran, the first record of rapeseed cultivation is from 1997 to 1998 with area of 2893 ha. In 2004-2005 years, this oilseed crop occupies about 119321 ha of agricultural lands of Iran with on average yield 2035 kg ha^{-1}. The cultivating area of winter rapeseed in Isfahan and Chahar Mahal and Chaharmahal va Bakhtyairi are 1626 and 347 ha and average yield 2196 and 2035 kg ha^{-1} on 2004-2005, respectively.

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The potential of land for agricultural use is determined by an evaluation of the climate, soil and topographical environmental components and the understanding of local biophysical restraints [4]. This evaluation is an essential step for the development of agriculture. It is necessary to assess the land suitability for rapeseed cultivation in the area by integrating various kinds of information with spatial analysis technique. The result of land suitability assessment presented in the form of map and report are meaningful to a local user [5].

Geographic Information System (GIS) has the ability to perform numerous tasks utilizing both spatial and attribute data. One of the most useful features of GIS is the ability to overlay different layers or maps [4-6].

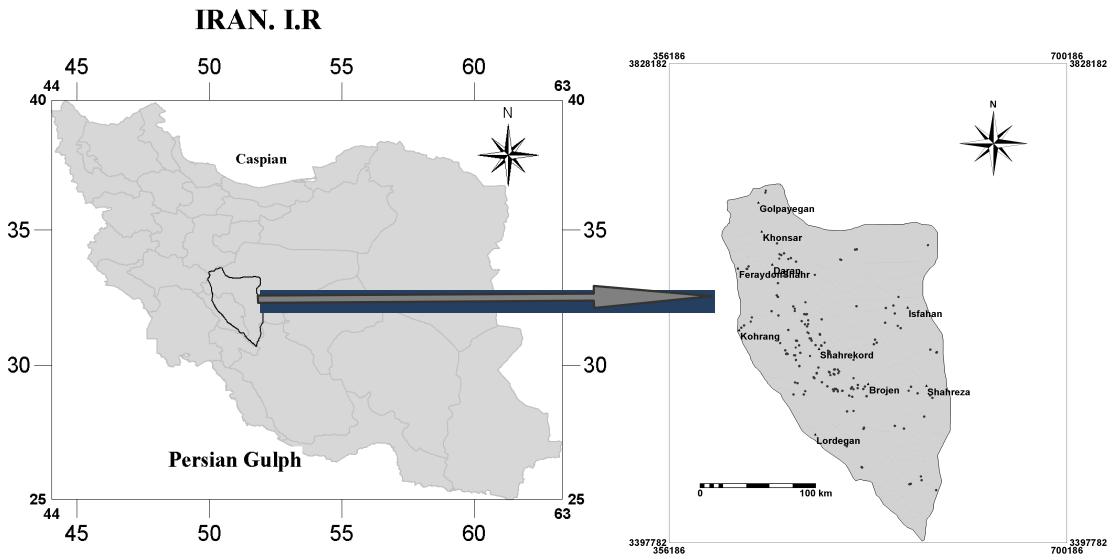
Subjects of study: GIS can be effectively applied to handle such kinds of work and to complete study objectives, these are (1) to construct the geographical databases of land suitability for rapeseed (*Brassica napus* L.) sowing, (2) to assess land suitability for rapeseed using Geographic Information System and (3) to select the possible lands for new rapeseed sowing in Central and West South Iran.

MATERIALS AND METHODS

This study was carried out in Isfahan and Chaharmahal va Bakhtyiari Provinces, Central and West Iran, which is one of the most important areas for rapeseed (*Brassica napus* L.) production in Iran. The study area covers approximately 3,765,999 hectares of total area of Isfahan and Chaharmahal va Bakhtyiari Provinces (Map. 1). This area is located between latitude 30º 42' N and 33º 37' N and between longitude 49º 56' W and 51º 57' W. The elevations range between 1009 and 3889 masl. The natural vegetation is rangeland and oak forest; most of the areas are used for agriculture. The rapeseed crop was chosen in this investigation because has recently been exploited to boost cultivation areas in Isfahan and Chaharmahal va Bakhtyiari Provinces.

Meteorological information was obtained from 51 variation weather stations located within the study area and the surrounding zone. The climate of study area is very variation, for example mean annual rainfall is between 128 and 1433 mm and the average annual temperature is between 16.5 to 9.4°C. Physical and chemical soil characteristics (texture, gravel percentage, pH, EC, organic matter, soil depth and etc) were taken from a soil-sampling in 180 rapeseed farms on the study area. The slope and elevation information were obtained from the Digital Elevation Model (DEM) using two well-known GIS software packages ILWIS (version academic 3.0). The DEM used in the study has a spatial resolution of 3 arc-secs in geographical coordinates. This corresponds to a pixel size of approximately 80 m at the latitude of Isfahan and Chaharmahal va Bakhtyiari Provinces. This array was geo-referenced using a metric UTM coordinate system and the geometric correction was carried out in the GIS ILWIS [7].

Geographic Information System (GIS) was used to build the geographic and ecological database for rapeseed cultivation as well as for land suitability assessment and rapeseed sustainable cultivation using multifactor spatial



Map 1: Location of the study site, Chahar Mahal va Bakhtyari and Isfahan Provinces, I.R. Iran

analysis (Table 1). Using Global Positioning System (GPS)[1] during field in 2005-2006 collected the location of rapeseed farms. The importance of each variable in comparison with the other variables was determined using stepwise regression model by SPSS (version 11.5). Rapeseed seed yield in 2005-2006 year and seventeen variables into 3 environmental factors (soil property, topographic and agronomic) were response and predicator variables, respectively. Study on spatial distribution pattern in importance variables provide information about current environmental situation in geographic. All scored variables, which resorted in vector-based geo-database, were converted into the raster -based datasets with 100-meters grid cell size. The restricted area was overlaid with the classed current environmental suitability datasets using the multiple overlay operation to assess land suitability for rapeseed cultivation.

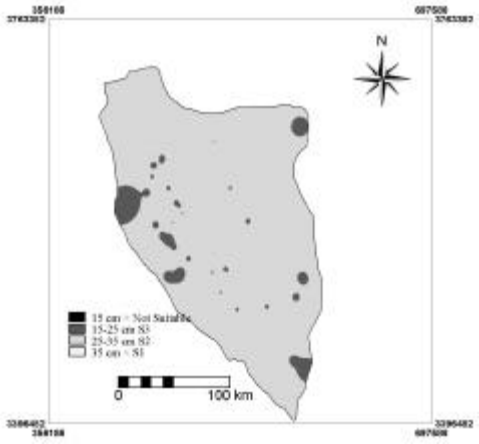
RESULTS AND DISCUSSION

Considering current environmental conditions, it is essential to use information for physical assessment of land suitability at first. Climate, soil, agronomy factors and DEM data layers were prepared and suitability classes were determined, using FAO method, were matched against specific rapeseed requirements derived from agricultural experiments and literature review. The results of analysis of regression by stepwise indicated that the most important variables of soil and topography (DEM) affecting rapeseed seed yield were soil depth, elevation and land slope.

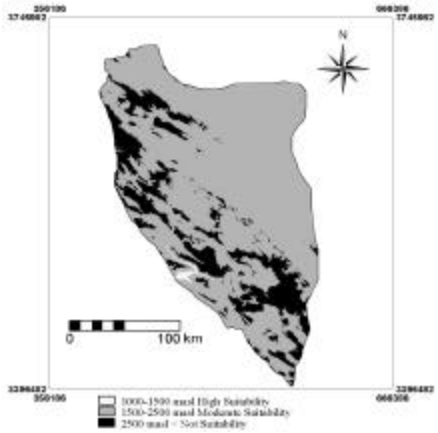
In the first stage, suitability was assessed in terms of topography. Elevation alone did not affect land suitability, because this factor affected on climatic, soil and agronomic management variables [8]. The raster map for elevation indicated that 79.7% and 19.8% of study area is placed in suitable (1500-2500 masl) and not suitable (2500 masl<) categories, respectively (Map. 3). Only 0.4% of the study area was high suitable (1000-1500 masl) category.

The suitability land for soil depth identified that 54 ha (0.001%), 192894 ha (5.1%), 3572937 ha (94.8%) and 146 ha (0.004%) study land have currently not suitable (N), marginally suitable (S_3), moderately suitable (S_2) and highly suitable (S_1) for rapeseed crop production in central and west Iran, respectively (Map. 2).

The result of raster map of slope in study lands identified that 54 (0.001%), of land have currently not suitable (N) and suitable (S_2) for rapeseed crop production in central and west Iran, respectively (Map. 3). Slope, an important element of landform, plays an important



Map 2: Raster map of suitability level for soil depth (cm)

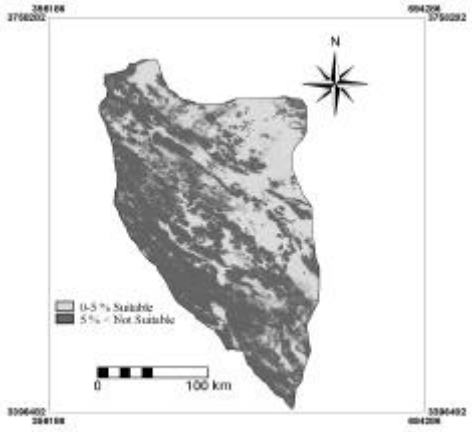


Map 3: Raster map of suitability level for elevation (masl)

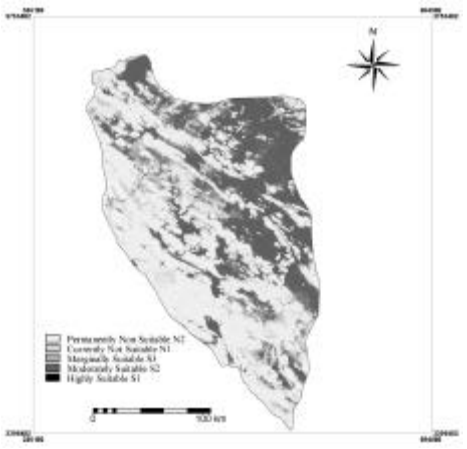
role where mechanization and irrigation is concerned [8]. Sys *et al.*, [5] believed that, on slopes than 20%, mechanization become impossible and for slope less than 20 percent there are still important there are still important variations in productivity according to variation in slope. Also, Bagli *et al.* [1] reported that on slopes less than 5%, irrigation of rapeseed crop become possible.

The suitability map for rapeseed crop under water unlimited (irrigation conditions) was created by overlaying accumulated slope, soil depth and elevation land maps. The results of overall map this study by ILWIS $_{ver3.0}$ identified that 1113 ha (0.03%), 2307138 ha (61.3%), 128 ha (0.003%), 1418280 ha (37.7%) and 39340 ha (1.04%) hectares of land have currently not suitable (N_1) and permanently non suitable (N_2), highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3) for rapeseed crop production in central and west Iran, respectively (Map. 4)

[1]Garmin Etrex Vista Model



Map 4: Raster map of suitability level for slope (%)



Map 5: Raster map (overlaid map) of suitable area for the rapeseed crop in Isfahan and Chahar Mahal and Bakhtyiari Provinces, central and west Iran

This research confirmed that the methodology used was adequate to integrate database of soil and topography with different spatial and temporal resolutions. Soil and topography environment-components proved to be useful in the identification of suitable areas for rapeseed oil crop production, within a GIS environment [9]. This investigation is a physical evaluation that provides information at a regional level that could be used by farmers to select their crop pattern. As well, decision-making regarding adequate crop patterns could be based not only on the information provided by this approach, but also on other aspects such as: production supports (by local and federal governments), marketing, technological level, economic evaluation, in addition to local customs, which are also highly important [4-6]. The method applied is an interesting contribution for the specialists of those countries or counties with similar economy to Central and West Iran, as an alternative and reliable approach to evaluate the biophysical environment for agricultural use.

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