Land management planning concerning to workability timing of soil in Souma area, using Aljarafe model

Farzin Shahbazi and Ali Asghar Jafarzadeh

Soil Science Department, Faculty of Agriculture, University of Tabriz, Iran, Email shahbazi@tabrizu.ac.ir
Soil Science Department, Faculty of Agriculture, University of Tabriz, Iran, Email ajafarzadeh@tabrizu.ac.ir

Abstract
Workability timing is related to land management planning at a farm level. Automating and application of procedures using soil resources survey data are used to predict soil moisture and workability timing. Within the new framework of MicroLEIS DSS, the Aljarafe statistical model in terms of particle size distribution, cation exchange capacity, and organic matter content was used to estimate the optimum moisture and workability timing. For this purpose, the Souma area located in the west Azerbaijan; of about 4100 ha was selected. Soil physical and chemical data taken from 35 representative profiles were stored in SDBm plus which is designed to harmonise, store and use large amounts of geo-referenced soil profile data, elaborated in the field and the laboratory, in an efficient and systematic way. The results showed that plasticity indexes were classified as C1, C2 and C4 for 3839 ha, 126 ha and 125 ha, respectively. The number of days when the soil can be worked after rain or workability timing for the whole studied area except 126 ha were classified as moderate optimum moisture for working. Integrating the results with GIS will be useful to create geo-referenced maps to solve problems by looking at the data in a way that is quickly understood and easily shared.

Key Words
Workability timing, MicroLEIS DSS, Aljarafe model, Plasticity index.

Introduction

The soil workability status is considered as the optimum soil water content where the tillage operation has the desired effect of producing the greatest proportion of small aggregates (Dexter and Bird 2004). If the soil is drier that the optimum water content, then tillage requires excessive energy and can also produce large clods (Rounsevell and Jones 1993).The plasticity index is based on the work of Atterberg and is defined as the range of water over which a soil exhibit plastic behavior, being calculated by the liquid limit minus the plastic limit (De la Rosa *et al.* 2003). Several studies (Wagner *et al.*1992; Mueller *et al.* 2003) found the best disaggregating effect of tillage implements to occur at the water content corresponding to maximum proctor test which it is the density of a given soil can be compacted varies with water content and force of compaction. Therefore, the optimum water content for workability is equal to the water content at maximum proctor density. Although these limits can be slightly different for different tillage implements as observed by Bhushan and Ghildyal (1972), they relate to typical tillage operations in the arable layer of the soil. Automating the application of procedures in engineering soil evaluations can be useful to people engaged in planning, construction and maintenance projects, along with agricultural soil management. Finally, an attempt is made to predict soil technological and engineering qualities/vulnerabilities by studying the relationship between these properties and other more readily-available soil characteristics caused to be established Aljarafe statistical model within the new framework of MicroLEIS DSS (De la Rosa *et al.* 2003). According to the Aljarafe model for the Ahar area (Shahbazi 2008; Shahbazi *et al.* 2009a), optimum moisture for working on soils are calculated between 10% - 20% and 20% - 30% in 3422 ha and 5411 ha of the studied area, agricultural sustainability can be achieved with attention to the obtained results. The optimum water content for tillage, by application of the *Aljarafe* (soil plasticity and workability) model, in the 7 agricultural benchmark sites in Seville province, Spain (De la Rosa *et al.* 2009) showed that soils of the Campiña site (SE03: Typic Chromoxerert) and Marismas (SE05: Salorthidic Fluvaquent) present many difficulties for tillage and the lowest period with an optimum workability status because the optimum water content is very low (<15 %).

Methods

Study area and soil characteristics

Study area covers 4100 ha and includes the Havarsin, Khargosh, Aghsaghghal, Johny and Bardouk natural regions in the north-west of Iran, west Azerbaijan province which has located between 44°35' to 44°40' east

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longitude and 37°50' to 37°55' north latitude. According to previous studies in Souma region (Shahbazi *et al.* 2009b; Jafarzadeh *et al.* 2009); nine soil families and mapping units were recognised. Identification of agricultural land according to their limitations and ecological potentialities was the first major objective and the second one was to predict land suitability for a specific crop over a long period of time. In this case, 80.49% of the total area mainly covered by Typic Calcixerepts, Fluventic Haploxerepts was capable for agricultural uses and 19.51% comprising Typic Xerofluvents, Typic Calcixerepts because of high carbonate percentage and erosion risk factors must be reforested by Swamp Pine species and not dedicated to agriculture. Soil physical and chemical necessary data as weight average values used for running the Aljarafe model were calculated for a vertical section from 0 to 50cm (Table 1).

Table 1. Summary of soil physical and chemical characteristics in Souma area

USDA soil family (USDA 2006)	Ext. area (ha)	CEC (Cmol+/Kg)	OM (%)	Clay (%)
Sandy skeletal, Mixed, Mesic Shallow Typic Xerofluvents	403	10	0.8	12
Fine-Loamy,Mixed,active, Mesic Typic Clcixerepts	126	16.2	1.02	24
Fine, Mixed, active, Mesic Typic Clcixerepts	125	32	0.87	53
Fine-Loamy, Carbonatic, active, Mesic Typic Calcixerepts	343	15	1.46	31
Fine, Carbonatic, active, Mesic Typic Calcixerepts	916	24	1.4	41
Coarse-Loamy, Mixed, superactive, Mesic Fluventic Haploxerepts	223	10.5	1.03	15
Fine-Loamy,Mixed,active, Mesic Fluventic Haploxerepts	1132	15.6	1.98	36
Fine, Mixed, active, Mesic Fluventic Haploxerepts	822	18.6	1.61	37
Fine-Loamy,Mixed,active, Mesic Fluventic Endaquepts	66	21.7	1.8	29

Model calibration

Aljarafe model deals with the characteristics of a quantitative system of evaluation of soil engineering qualities, making use of computerized multiple regression techniques (De la Rosa 1979). It is a first approach to predicting plasticity index and optimum moisture based on information of a wide range of Florida (USA) soils. Statistical regression models, with appropriate calibration (De la Rosa 1979) and validation analysis for Mediterranean soils (De la Rosa *et al.* 1983), were developed to establish the relationships between soil plasticity and optimum moisture for workability with other more readily-available soil characteristics provided by standard soil surveys. Also the Aljarafe model equations have been applied under various soil and climate conditions over the World (Ohtsubo *et al.* 1984). As climate conditions are not input data in the presented model, it will be readily used in semi-arid regions (e.g. Iran) if the soil properties are included in the calibrated range of the model (Table 2).

Table 2. Range and mean for selected properties in the soils investigated (De la Rosa *et al.* 2003)

Soil variable	Range	Mean
Independent variables		
Clay content (%)	0.1-93.5	25.3
Cation Exchange Capacity (Cmol+/kg)	0.2-34.9	7.2
Organic matter content (%)	0.1-4.5	0.5
Dependent variables		
Plasticity index	0.1-116	16.6
Optimum moisture (%)	10.2-45.6	17.8

Comparing data in two presented tables shows that clay content, cation exchange capacity and organic matter content as independent variables of study area are exactly fitted in the calibrated range of those variables. Therefore, calculated dependent variables such as plasticity index and optimum moisture for Souma area must be mentioned as high accuracy. Several studies and using Aljarafe model will legalize the obtained results in this semi-arid region.

Model application

After installing the MicroLEIS DSS which is now protected and it needs to be connected with Evenor-Tech Company in Spain or others who have an agreement with that company (e.g. Shahbazi from Iran, Braimo from Japan).The software installation along with the different run options from the main screen are included: Set up, Individual mode, SDBm+ connections, Language change, and Help tabs. Selecting the individual mode option will be open a dialog box, where the required model data as a valid numeric value within the model calibration range can be introduced. Pressing the estimate option, the model will be executed and a window with the output evaluation results will appear on the screen. Example of model application and evaluating the results for the first unit of studied area is shown in (Figure 1).

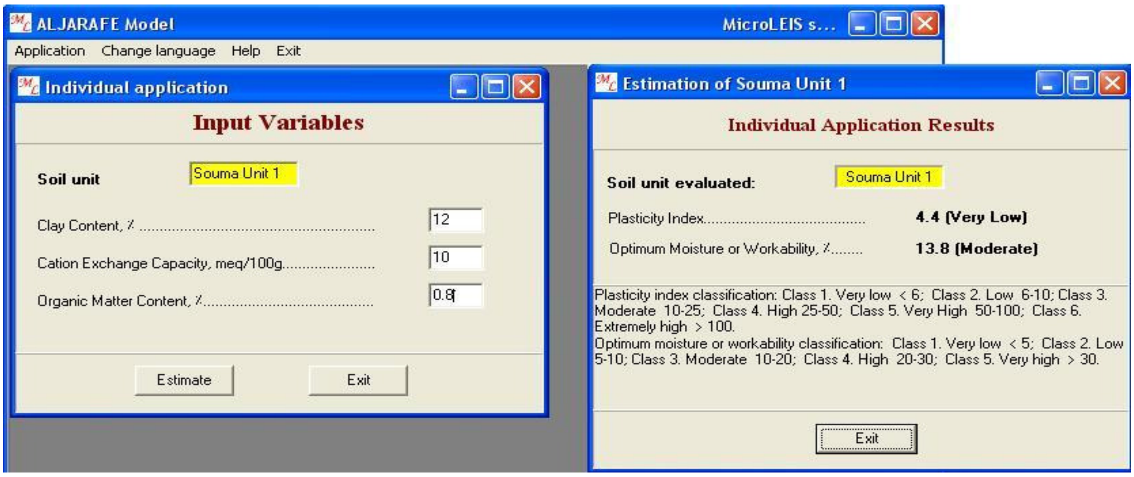

Figure 1. Screens for input data and results in individual mode of Aljarafe model

GIS spatialization

GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. It helps to answer questions and solve problems by looking at the data in a way that is quickly understood and easily shared. In land evaluation procedure, the soil survey maps (Figure 2), which in geographical format are usually polygonal multifactor maps, are the main source of basic information. Additional basic soil plasticity or optimum moisture maps in the whole studied area can be extracted by integrating the model results with GIS tools (e.g. ArcView).

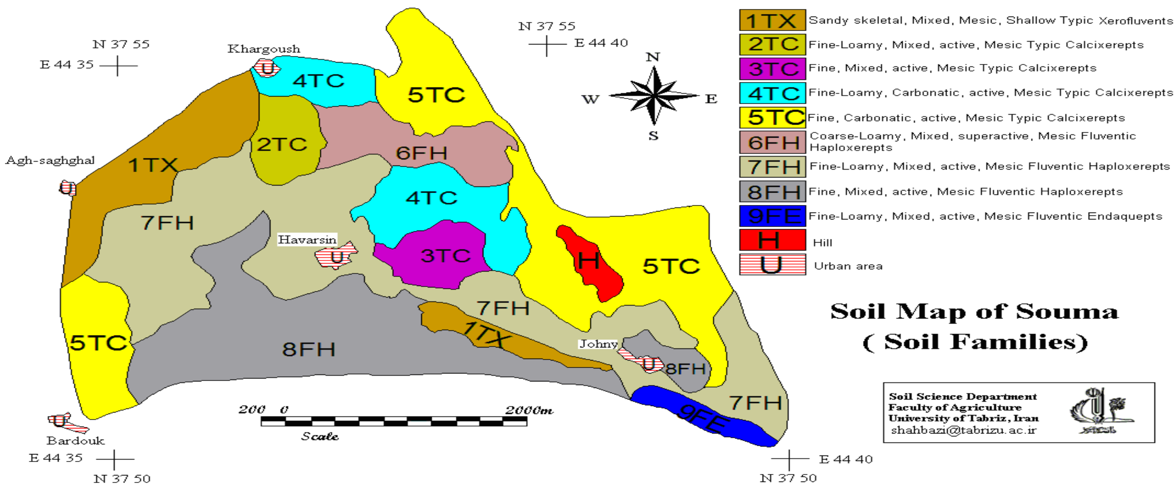

Figure 2. Soil family map of the study area

Results

Classification of the plasticity index and optimum moisture ranges according to the established model and its extension in the studied area is summarised in (Table 3)

Table 3. Summary of model application results and its base establishment

Classification	Plasticity index	Area covered (ha)	Optimum moisture (%)	Area covered (ha)
C1 (very low)	<6	3839	<5	-----
C2 (low)	6-10	126	5-10	-----
C3 (moderate)	10-25	-----	10-20	3975
C4 (high)	25-50	125	20-30	125
C5 (very high)	50-100	-----	>30	-----
C6 (extremely high)	>100	----	-----	-----

Conclusion

According to the obtained results, plasticity indexes vary from 1 to 25.1 in the studied area which is classified into 3 classes: C1, C2 and C4. On the other hand, optimum moisture for workability of studied area divided into 2 classes: C3 and C4. These results showed that there is no limitation due to optimum moisture for tillage. Attention to the results and using decision or planning support tools such as Aljarafe model within the MicroLEIS DSS and geo-referenced provided maps (Figure 3) will ebable sustainable soil management which can maintain and even improve soil quality under local soil conditions.

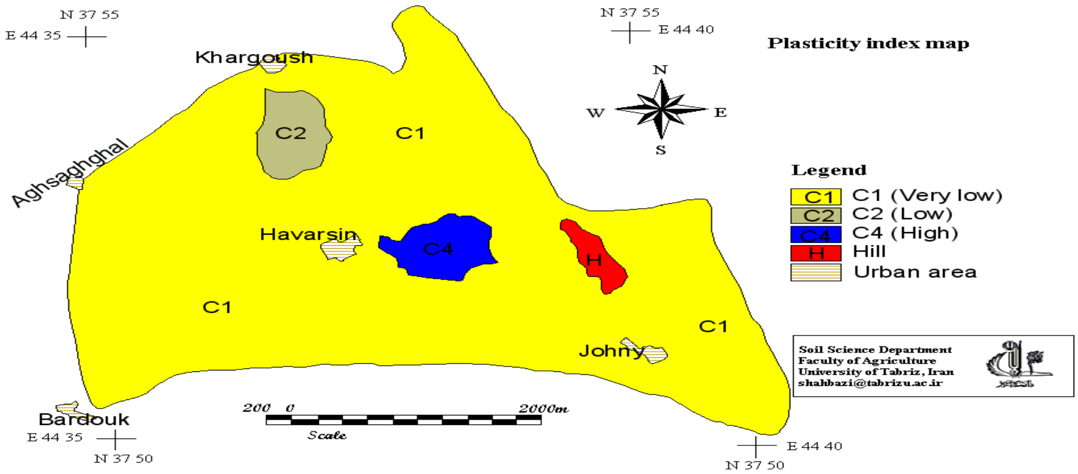

Figure 3. Map of plasticity index provided by GIS

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