FERTILIZER CONSUMPTION IN TUNISIA: Constraints, Perspectives and Extension Methodology

TAREK JARRAHI, Med Annabi and Rim Sakouhi
National Institute of Field Crops, Tunisia

Marrakech (Morocco), September 11-12, 2013
Tunisia

Situation: North Africa / East

Area: 163,610 sq. km

Population: 11 millions

Natural resources: Crude oil, phosphate, iron ore, lead, zinc, salt
Climatic characteristics of Tunisia

- **Mediterranean environment:**
  Hot summers, winter rainfall and mild winters

- **Climatic areas:**
  Humid to arid

- **Rainfall:**
  $100 \text{ mm} < R < 1000 \text{ mm}$

- **Important year-to-year variability**

- **Average temperature:**
  $17°$ to $21°C$

Agricultural production mainly in semi-arid to arid areas

(75 % of total area)
## The importance of Rainfed agriculture
(Data 1993)

<table>
<thead>
<tr>
<th></th>
<th>Irrigated areas (1000ha)</th>
<th>Rainfed areas (1000ha)</th>
<th>Rainfed/Total (1000ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cereals</strong></td>
<td>34</td>
<td>1646</td>
<td>97%</td>
</tr>
<tr>
<td><strong>Trees</strong></td>
<td>130</td>
<td>1835</td>
<td>93%</td>
</tr>
<tr>
<td><strong>Vegetable</strong></td>
<td>108</td>
<td>42</td>
<td>28%</td>
</tr>
<tr>
<td><strong>Fodder</strong></td>
<td>23</td>
<td>285</td>
<td>92%</td>
</tr>
</tbody>
</table>
the soils of Tunisia are classified as podzols, vertisols, red Mediterranean soils, calcic-magnesic soils (dominant soils), brown and isohumic soils, saline and hydromorphic soils and also poorly evolved soils.

<table>
<thead>
<tr>
<th>Nature of soil</th>
<th>Areas (ha)</th>
<th>fertile soils ha</th>
<th>% of fertile soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithosols</td>
<td>2200000</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Poorly developed soils</td>
<td>2180000</td>
<td>1300000</td>
<td>59,6</td>
</tr>
<tr>
<td>calcimagnesic soil</td>
<td>2400000</td>
<td>1050000</td>
<td>43,7</td>
</tr>
<tr>
<td>isohumic soil</td>
<td>3000000</td>
<td>1000000</td>
<td>33</td>
</tr>
<tr>
<td>vertisols</td>
<td>236000</td>
<td>230000</td>
<td>97,4</td>
</tr>
<tr>
<td>Red and chestnut soils</td>
<td>90000</td>
<td>80000</td>
<td>88,8</td>
</tr>
<tr>
<td>Salains and waterlogged soils</td>
<td>1500000</td>
<td>150000</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>12200000</td>
<td>3810000</td>
<td>31,2</td>
</tr>
</tbody>
</table>

Soils nutrient status and agricultural use are related to both the landscape and the climatic area.

60% of agricultural land evolve in an arid zone, where the soil is presented in a precarious condition.
Agriculture plays a key role for the country's economic and social growth.

Growth Domestic Product (GDP): 13%
Exportations: an average of 10%
Employment: 22%
Contribution of 14% in the investments

516,000 farms (87% less than 20 hectares)
Tunisia Agriculture Production

10 M ha agricultural area

- **Arable land**: 5 M ha; 50%
- **Rangeland**: 4 M ha; 40%
- **Forests and scrublands**: 1 M ha; 10%
- **Fallow**: 0.7 M ha; 14%
- **Arboriculture**: 2 M ha; 20%
- **Various crops**: 0.3 M ha; 6%
- **Cereals**: 1.53 M ha (75%)
- **Olives (1.5 M ha)**
Since the 1980s, Tunisia achieved an increase of 50% in agricultural production for most major crops.
Reasons of Yields Increase

The improvement in productivity was essentially a result of:

Government efforts to expand the area of fruit trees and wheat, which declined by about 15% compared to the 1950s

Changes in cultural practices:

Traditional agricultural practices

Improved cultural practices

Fertilizers have played a key role in improving yield production in Tunisia
Fertilizer and Crop Production

Crop Yield and fertilizer consumption relationship

Fertilizers kinds and amounts: An important input contributing 50% towards improvement in crop productivity

The main fertilizers used: ammonium nitrate, super phosphates, ammonium phosphate, potassium Nitrate, potassium sulphate

basically three nutrients are supplied: nitrogen (N), phosphorus (P₂O₅) and potash (K₂O)
During the past 50 years of the history of fertilizer use in Tunisia, we find a considerable increase in the consumption of fertilizers since 1960, by 7 times till 2013. Fluctuation of the fertilizer consumption level is due mainly to the unpredictable climatic conditions.
Tunisia Country a manufacturer of fertilizers

The annual production of phosphate is currently 8 MT/year 5th in the world

Two actors:

Gafsa Phosphate Company (CPG): responsible for phosphate mining

Chemical group in Tunisia (GCT): Production of mineral fertilizers

1952: TSP   1979: DAP   1983; AN

6.6 million tons of phosphate for the national market

1.4 million tons for export
Factors Contributing to Growth in Fertilizer Use in Tunisia

- The initiation of the GOT's wheat project in 1966 and price controls in 1970 increased availability of fertilizer and agricultural extension activities.
- Agricultural Extension Service (include fertilizer demonstration plots), direct subsidies on fertilizer prices, distribution of fertilizer as seasonal credit and privatizing and liberalizing of the market.
Sub humid zone
- Major crops: cereals, citrus, and grape crops, 65%

Semi Arid zone
- The major growing area are cereals, 23%

Irrigated Zone: the major growing area is cereals, vegetables, 7%

semi-arid –irrigated zone
- Garden crops and olive production, 3%

Major crop activities located in the scattered oases, 2%
Crop Fertilizer Use in Tunisia

The cereal sector has absorbed More than 95% of fertilizer used
Climatic conditions and fertilizer use

The amount fertilizer consumption was mainly affected by climatic conditions.

The increase in fertilizers consumption was 53% compared to the unfavorable growing season. Increase in the amount of ammonium nitrate by 73%, while for phosphate fertilizers improvement is about 32%.

Farmers are oriented towards to reduce the level of inputs during the beginning of the crop seasons when the weather conditions are unfavorable.
N/P2O5 ratio evolution in cereal crops in Tunisia
Grain yield and production potentials of cereals

<table>
<thead>
<tr>
<th></th>
<th>AN Kg/ha</th>
<th>N Kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arid</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Sub humid</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Irrigated</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>
Major Constraints

Though the above actions have stimulated fertilizer use and increased the demand for fertilizers, especially nitrogen and phosphate fertilizers, increased fertilizer consumption is still constrained by several conditions as follows:

- Rainfall conditions: Nearly 97% of the cultivated area is under rainfed conditions
- The high price for fertilizer, especially that of locally produced fertilizer;
- Lack of farmer know-how in using fertilizers – specifically nitrogen;
- Degraded & poor soils often subjected to runoff and soil erosion
- Availability of credit in good time
- Poor transport facilities and road network in rural areas
- Small & Marginal holdings– difficulty in use of farm machinery
- Using the manual method in fertilizer application
- Shortage of labour in dry lands – Migration to commands and urban areas
- Inadequate extension reach for technology dissemination
### Nutrient Use Efficiency

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Efficiency (%)</th>
<th>Cause of low efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>30-50</td>
<td>Immobilization, volatilization, denitrification, Leaching</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>15-20</td>
<td>Fixation in soils CaHPO₄</td>
</tr>
</tbody>
</table>
Importance of Integrated Nutrient Management

There is an urgent need to adopt an integrated nutrient supply and management system for promoting efficient and balanced use of plant nutrients.

The main emphasis was given on increasing the proper and balanced used of mineral fertilizers taking into account the production potential.
What is Nutrient Management?

Combine on-farm nutrient sources, with commercial fertilizer, to meet crop need.

- On-farm nutrient sources
- Soil reserves
- Commercial fertilizer
- Minimize nutrient losses
Nitrogen fertilizer

Will be applied based on the supply balance method that takes into account the nitrogen residue from the previous crop, rate of organic matter and target yield.

The total amount of nitrogen will be split into three applications:

- 3 leaf (30%)
- Two Nodes (30%)
- End of tillering (40%)

Phosphates and Potassium

Based on soil analysis
Decision tools

Improving Nitrogen Fertilizer Efficiency

Double density approach

SPAD chlorophyll-meter

www.ingc.com.tn

Cereal Expert System on the web-site of INGC
Integrated fertilizer management for wheat

Objectives:

- Study the effects on crop productivity of the integrated fertilizer management compared with the farmers’ practice
- Assist farmers to adopt an integrated fertilizer management (IFM) approach for wheat production
- Optimize nutrient inputs to wheat production
- Examine the effect of fertilizer inputs on improving the productivity of wheat
- Improve the fertility and productivity of wheat soils in the area.

Sites:

This activity was involved 212 (leaders and satellites fields) at Fernana (Jendouba) and Chebika (Kairouan). These sites have a potential for intensification under rainfed and irrigated conditions, respectively. They are characterized by a very limited use of fertilizers, and these are not always adapted to crop requirements.
Initial soil fertility status of farmers’ fields

Delegation of Fernana

Delegation of Chebika

Frequency of soil samples per available phosphorus ($P_2O_5$), potassium ($K_2O$) and organic matter (MO %) at Fernana and Chebika
The farming practice and crop rotation

Proportions of prevalent previous crop at Fernana and Chebika

<table>
<thead>
<tr>
<th></th>
<th>Frequency (%)</th>
<th>Fernana</th>
<th>Chebika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>40.9</td>
<td>16.7</td>
<td>18.2</td>
</tr>
<tr>
<td>Fallow</td>
<td>31.8</td>
<td>10.6</td>
<td>12.1</td>
</tr>
<tr>
<td>Vegetables</td>
<td>10.6</td>
<td>18.2</td>
<td>68.2</td>
</tr>
<tr>
<td>Legumes</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Fertilizer application (Kg/ha)

<table>
<thead>
<tr>
<th>Farmers Practices (Kg/ha)</th>
<th>IFM (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2O5</td>
<td></td>
</tr>
<tr>
<td>K2O</td>
<td></td>
</tr>
<tr>
<td>AN</td>
<td></td>
</tr>
</tbody>
</table>

- Fernana
- Chebika

↓18 %  ↓38 %  ↑36 %  ↑42 %
Compared grain yield obtained at Chebika and Fernana using integrated fertilizer application (IFM) and common farmers fertiliser applications

Therefore; there is a need to adopt the IFM involving soil test based balanced and judicious use of chemical fertilizers to maintain soil fertility and to increase productivity.

Constraints of adoption of IFM:
Low nutrient content and low efficiency of chemical fertilizer

Improvement of grain yield represents 28 % and 24 % at both sites.
Dissemination Tools to improve farmers’ access to technical knowledge

Field days
Field visits & Traveling Workshops
Field Demonstration

Adoption of the Short Messaging Service (SMS) technologies as a tool to improve farmers’ and extensionist access to technical knowledge and to increase technology adoption

The number of subscribers in the SMS service reached 1840, including 1260 farms. The total number of SMS sent reached 22080
R&D Priorities

Research:
- Development of soil fertility maps (OM, $P_2O_5$ and $K_2O$)
- Remote sensing for Crop Nitrogen Management
- Development of Slow Release Fertilizers
Development:

- Strengthening Soil Testing Service
- Promote farmer capacity to request new technologies and information.
- Promote farmer to farmer extension.
- Push farmers to make their own decisions