Prospects of Trace Gas Emission Measurement/Nutrient (NPK) Balance in Urban Agriculture of Kabul

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Outlines

- Introduction
- Afghanistan’s five major Natural Landscapes, population density, pattern of land use types, soil regions, mean annual rainfall and temperature.
- Monitored dominant farming system sites in Kabul city for:
  - Nutrient N, P, K, and C removal via outputs
  - Nutrient N, P, K, and C horizontal balances
  - Nutrient N, P and K use efficiency
  - Nitrate nitrogen (NO$_3$-N), ammonium nitrogen (NH$_4$-N) and phosphate phosphorus (PO$_4$-P) leaching in two urban vegetable gardens (kg ha$^{-1}$ year$^{-1}$).
  - Nutrient (NPKC) losses via surface runoff under the two farms’ conditions.
- Conclusion and Recommendations
Background

- Total Population (27.5 millions).
- Population Engaged in Agri. (75 - 80%).
- Agri. Contribution in GDP. 28 - 53% (77-9-14%)*.
- Climate (Arid to Semi – Arid).
- Rainfall (Ranging from <100 –>1000 mm year⁻¹).

- Total surface (652, 089 km², 80 % mountain).
- Total Agricultural Land (80, 450 km²), 12.3 %.
- Total Arable Land (7.7%)
- Area under Annual Crops (2.3 - 3.2 millions ha).

Five Major Natural Landscapes

1. The high mountain of Hidu Kush ( >4,500 m, Rainfall >700 mm).

2. The mountainous region of Central-Afghanistan (2,150-4,500 m, Rainfall 200 – 700 mm)

3. The semi-desert and steppe regions of the south-west and those of north Afghanistan (<500 – 1,250 m, Rainfall 100-200 mm).

4. The arid dessert-lowlands of south-west Afghanistan (<500 - 1,000 m, Rainfall <100 mm).

5. A narrow strip at the east part of country (500 - >1,000 mm).

Source; field guide Afghanistan 2010
Human Footprint: density, land transformation, human access and settlements
Pattern of Land Use Types

**Source:** Field guide Afghanistan 2010
Soil Regions
Classification of USDA

- Soils are formed under arid and semi-arid climatic conditions.
- Textural classes are mostly clay loam to sandy loam. High soil pH and calcium carbonate contents.
- Soil organic matter content ranges from 0.2 to 2.5%.
- Low water holding capacity, high permeability and infiltration rates.
- Soil salinity is generally not a problem.
- Low levels of nitrogen, variable levels for phosphorus, and adequate levels of potassium.
- Micronutrients deficiencies for iron, zinc, copper, and boron are common.

* Adequate soil moisture retention year-round, STR, Soil Temperature Regime, SMR, Soil Moisture regime
Prospects of Trace Gas Emission

Mean Annual Rainfall

A fundamental characteristic of the hygric climate is the small amount of precipitation throughout the country/ highly variable

- Kabul has a rainy season of about 5-6 months with only about 70 rainy days in this period.
- In the S and SW 20 to 30 days. Strong thunder storms in the rainy season can yield within 24h the total rainfall of a month.

- Central mountain region 60%
- In the desert and semi-deserts in SW and N Afghanistan. Moqor, Gazni, Bamyan basins, Kabul and Jalalabad, 40%
- Hidukush > 60 %

Source; Rafiqpoor (1972-1974), 1979.

This shows a clear altitudinal zonation resolution of rainfall with a significant *hypsometric increase of rainfall amounts from the lowlands to the mountains.*
The temperatures, its annual variability and altitudinal zonation for a country with high-continental climate and high-mountain nature, determine living condition of the people, the rhythm in land use, the life cycle of natural vegetation and the atmospheric composition.

The climate of Afg. is highly seasonal and continental by

- The highest absolute max. tem. +51 °C in Zaranj.
- The lowest absolute tem. -52.2 °C in Panjao, Bamyan.*
- +10 °C can be considered as a robust global threshold. /+6 °C**

*Source: Breckle et al., 2004; ** Rafiqpoor, 2002
The thermal component of the eco-climate classification

The duration of the thermal growing season in the outer tropics as the frost free period of the year that surpasses certain temperature thresholds.

1. Megatherm 11 - 12 months (<1000 m, mean monthly temp. Exceed 6 °C)
2. Macrotherm 9 - 10 months (1,250 - 2,500 m)
3. Mesotherm 7 - 8 months
4. Microtherm 5 - 6 months
5. Oligotherm 1 - 4 months
6. Hekistotherm 0 months

The hygric component of the eco-climate classification

The growth conditions of the natural vegetation and crops do not decide the length of the thermal growing season alone.

Optimal *Hygro-thermal on a monthly basis for Afghanistan

*pertaining to both humidity and temperature
Prospects of Measuring Trace Gas Emission

1 - Nitrogen/Oxygen:

2 - Argon (Ar): is a noble gas

3 - Water Vapor: Due to dry climate, water vapors are scarce only in small eastern belt

4 - Carbon dioxide (CO₂): This increases in Afghanistan seems to be primarily due to human induced burning from fossil fuels, deforestation, and other forms of land-use change.

5 - Methane: Due to Neglected sources (rice cultivation; domestic grazing animals; termites; landfills; coal mining; and, oil and gas extraction) for the additional methane added to the atmosphere is not a problem.

6 - Nitrous Oxide (N₂O): Due to abundant sources for the increase of N₂O in the atmosphere the average concentration of the greenhouse gas N₂O may increase.

7 - Ozone: Under the guidance of the UN Environment, a National Ozone Unit set up with the National Environmental Protection Agency of Afghanistan (NEPA) is already paying dividends.
The most abundant of the trace gases is the noble gas argon (approximately 1% by volume). Noble gases, which also include neon, helium, krypton and xenon, are very inert and do not generally engage in any chemical transformation within the atmosphere.
Measurement and calculations

Matter fluxes:

\[ F = \sum_{i=1}^{n} Q_i C_i \]

- Horizontal nutrient (N, P, K) and C balances:
  \[ \Delta \text{Soil}_{E} = I_E - O_E \]

- Apparent nutrient (N, P, K) use efficiency:
  \[ \text{NUE} = \frac{\sum O}{\sum I} \times 100 \]

Leaching losses of (\( \text{NO}_3^-\text{N}, \text{NH}_4^-\text{N}, \text{PO}_4^-\text{P} \))

- Twice/year, following the procedure described by Lang and Kaupenjohann (2004) and Predotova et al. (2010).

Nutrient (NPKC) losses by surface runoff:

- Monitor for two years (2012-14)
Nutrient N, P, K, and C removal via outputs in three farming systems

Bars show one standard error of the mean and different letters indicate significant differences between farming systems.
Nutrient N, P, K, and C horizontal balances in three farming systems

Bars show one standard error of the mean and different letters indicate significant differences between farming systems.
Nutrient N, P and K use efficiency in three farming systems

Bars show one standard error of the mean and different letters indicate significant differences between farming systems.
Nitrate nitrogen (NO$_3$-N), ammonium nitrogen (NH$_4$-N) and phosphate phosphorus (PO$_4$-P) leaching in two urban vegetable gardens (kg ha$^{-1}$ year$^{-1}$)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>V1</th>
<th>V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO$_3$-N</td>
<td>69</td>
<td>207</td>
</tr>
<tr>
<td>NH$_4$-N</td>
<td>3.4</td>
<td>0.5</td>
</tr>
<tr>
<td>PO$_4$-P</td>
<td>4.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Data show means ± standard error (SE) over one year period.

V1: Vegetable garden 1
V2: Vegetable garden 2
Table 2: Nutrient (N, P, K, C) losses (n=75, 60) via surface run-off on (2012-2014) in College of Agriculture and Guzargah research Station.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
<th>Research Station</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>N kg ha(^{-1})</td>
<td>Total</td>
<td>College Farm</td>
<td>0.04</td>
<td>0.05</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guzargha Farm</td>
<td>0.14</td>
<td>0.09</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>0.09</td>
<td>0.08</td>
<td>135</td>
</tr>
<tr>
<td>P kg ha(^{-1})</td>
<td>Total</td>
<td>College Farm</td>
<td>0.00</td>
<td>0.00</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guzargha Farm</td>
<td>0.01</td>
<td>0.01</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
<td>135</td>
</tr>
<tr>
<td>K kg ha(^{-1})</td>
<td>Total</td>
<td>College Farm</td>
<td>0.01</td>
<td>0.01</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guzargha Farm</td>
<td>0.02</td>
<td>0.01</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
<td>135</td>
</tr>
<tr>
<td>C kg ha(^{-1})</td>
<td>Total</td>
<td>College Farm</td>
<td>1.29</td>
<td>1.22</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guzargha Farm</td>
<td>1.79</td>
<td>1.33</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>1.51</td>
<td>1.29</td>
<td>135</td>
</tr>
</tbody>
</table>

\[P < 0.05\]
Conclusion and Recommendations

- Management practices of Manure application should be evolved.
- Due to natural constraints, gas emission measurement and crop production needs agro-specific interference.
- Contradicted hygro-thermal and *hygric-growing agro-ecological zones lead to divers atmosphere composition.
- Integrated efforts on nutrient losses per unit of area by introducing technologies and management systems.
- Needs to initiate agro-climatic zone specific management testing and to reach out to farmers with zone-specific inputs management Knowledge.
- Imperfect irrigation infrastructures/less investment.
- Monitoring gas emission should be practiced.
- Ozone layer should be protected.
- Desertification should be controlled.

*Water removed slowly enough to keep soil wet for most of growing season.
THANKS