Soil Fertility and Agricultural Sustainability Strategies in the Desertified Area of Binh Thuan, Vietnam

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Introduction

Land degradation caused by human impacts and climatic factors leads to desertification and results in a loss of soil fertility, wind and water erosion as well as a reduction of the vegetation cover followed by socioeconomic problems. Especially land use practices such as **non-adjusted agricultural methods**, overgrazing and deforestation are the main driving forces for desertification. The present study examines how **sustainability strategies** under dragon fruit and peanut cultivation in Binh Thuan, Vietnam influence soil fertility in a region that is characterised by **sandy soils** (Arenosols) and a semi-arid climate. The coastal area is prone to desertification which complicates agricultural production.

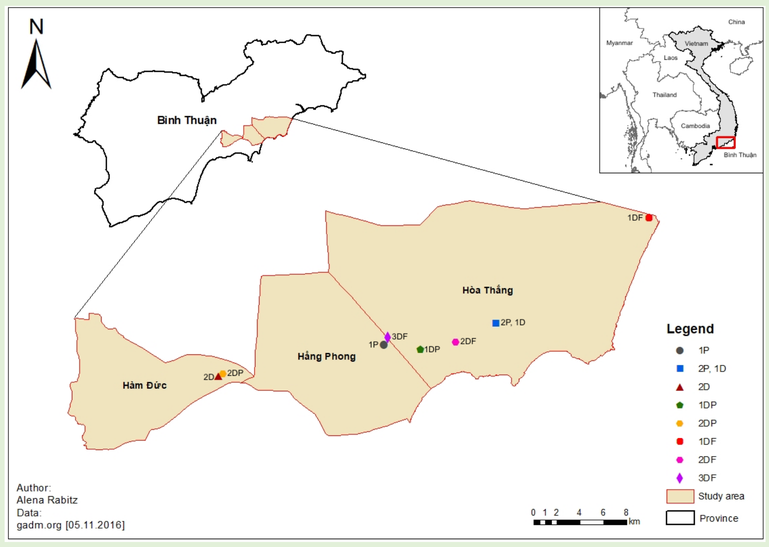

Fig. 1: Research area located in Bình Thuận province, South Central Vietnam
P - peanut, D - dragon fruit, DP - dragon fruit intercropped with peanut, DF - degraded field

Study area

The study area is situated in Binh Thuan province in South Central Coastal Vietnam in the communes Ham Duc, Hang Phong and Hoa Thang, which are part of the districts Bac Binh and Ham Thuan Bac, between the coordinates 108°8'20.4'' – 108°30'10.8''E and 11°0'28.8'' – 11°7'37.2''N bordering the South China Sea in the East (Fig. 1).
The main soil type in the study area can be defined as red or white sandy soil.

Materials and Methods

Soil analyses on different farms (Fig. 2), including **peanut** (1P, 2P), **dragon fruit** (1D, 2D) and **dragon fruit intercropped with peanut** (1DP, 2DP) as well as on **degraded fields** (1DF, 2DF, 3DF) were combined with a socio-scientific survey based on **quantitative interviews**. For evaluating the extent of applied sustainable practices on the farms in the research area, an indicator system was created providing the base for a SWOT analysis which was conducted with four farms. Soil samples on these farms were taken two times on each field – **next to the plant and in between the plants** – at a depth of 0 – 100 cm for analysing total organic carbon (TOC), total nitrogen (TN), dissolved organic carbon (DOC) and salt content as well as other soil parameters to determine soil fertility. Statistical analyses comprised analyses of variances between groups, correlation and regression.
For the purpose of this study, dragon fruit and peanut were chosen since they are popular crops in the area and the main cultivars listed by famers in the conducted interviews. This is especially due to their drought resistance and growth on sandy soils.

Fig. 2: Top: peanut (left), dragon fruit (right); bottom: dragon fruit with peanut (left), degraded field (right)

References

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Results and Discussion

In the research area, most farms **combine conventional farming with different sustainable agricultural practices** i.e crop rotation, use of organic fertilisers, composting of crop residues and choice of resistant plants. Problematic is that tractors are mainly used for cultivation which enhances soil compaction. There is an **average awareness** of land degradation combined with good perceptions of organic farming. Unfortunately, most farms are **threatened by local environmental conditions** (Fig. 4).
Results indicate that **no effects of sustainability strategies** on soil fertility exist. Furthermore, constantly **higher soil fertility occurred in samples taken next to the plants than in between the plants**. This fact is also illustrated in Fig. 3 where the soil profile next to the plant shows a humic Ah horizon in contrast to the one in between the plants with a sole C horizon.

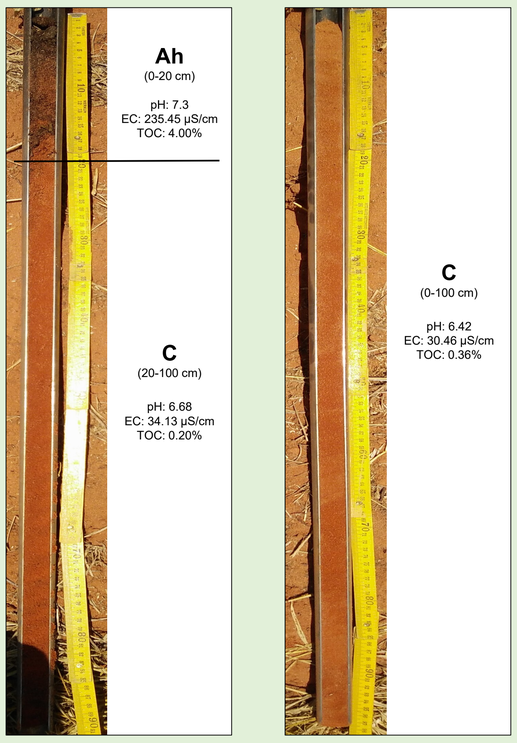

Fig. 3: Soil profile next to the dragon fruit and in between the plants

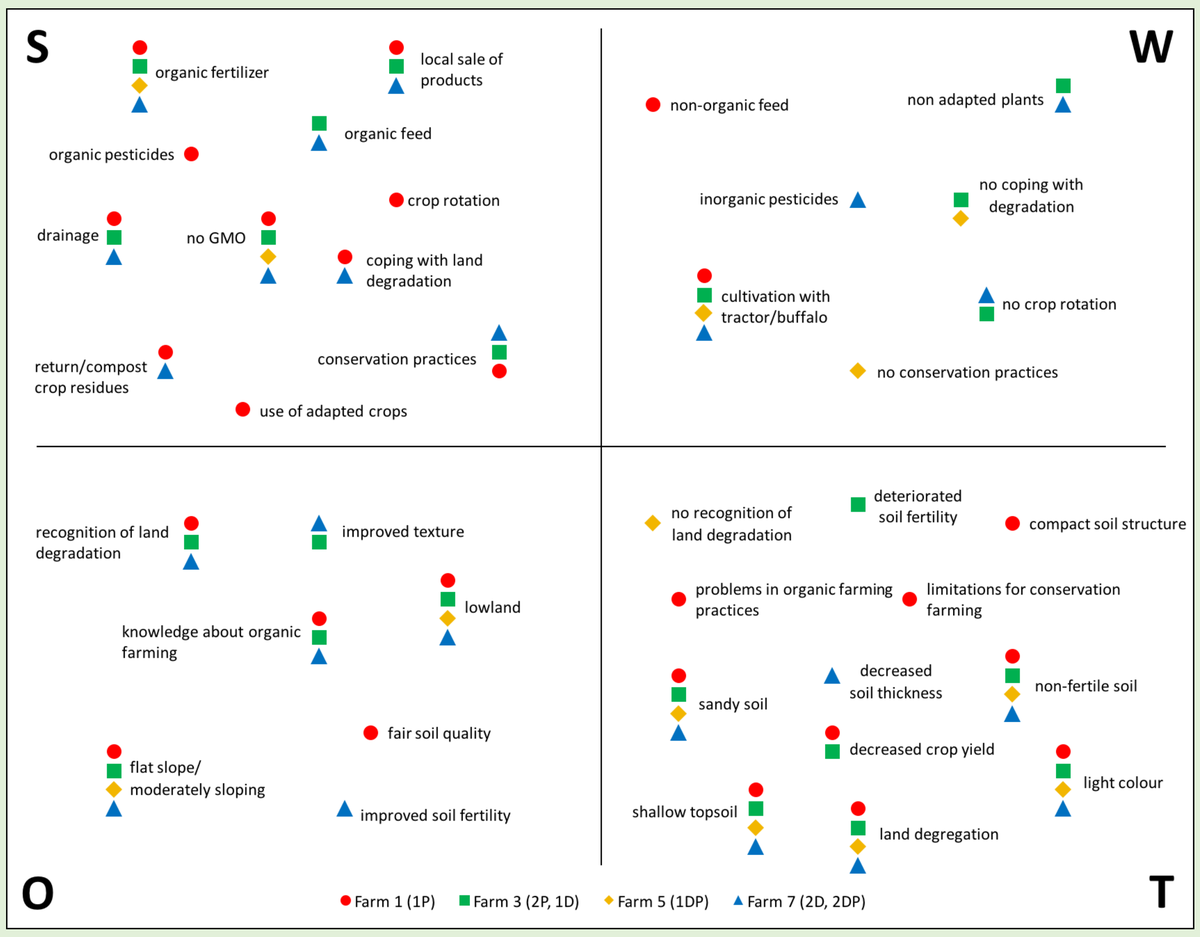

Fig. 4: S(trengths) W(eaknesses) O(pportunities) T(hreats)-analysis

Furthermore, a higher TN and TOC content directly next to the dragon fruit reveals that **dragon fruit cultivation contributes more to soil fertility than peanut cultivation** (Fig. 5). This might be especially through the application of **mulch** around the dragon fruit plant which increases the humus content and keeps the nutrients from leaching. However, the non-cultivated area in between the dragon fruit is more exposed to **soil erosion** and differences in values next to and in between the plants are higher under dragon fruit. Therefore, it can be assumed that under **peanut** plants nutrient concentrations are **more balanced** over the whole field. **No evidence was found that intercropping enhances soil fertility** since soil parameters were not higher under dragon fruit intercropped with peanut than under monoculture.

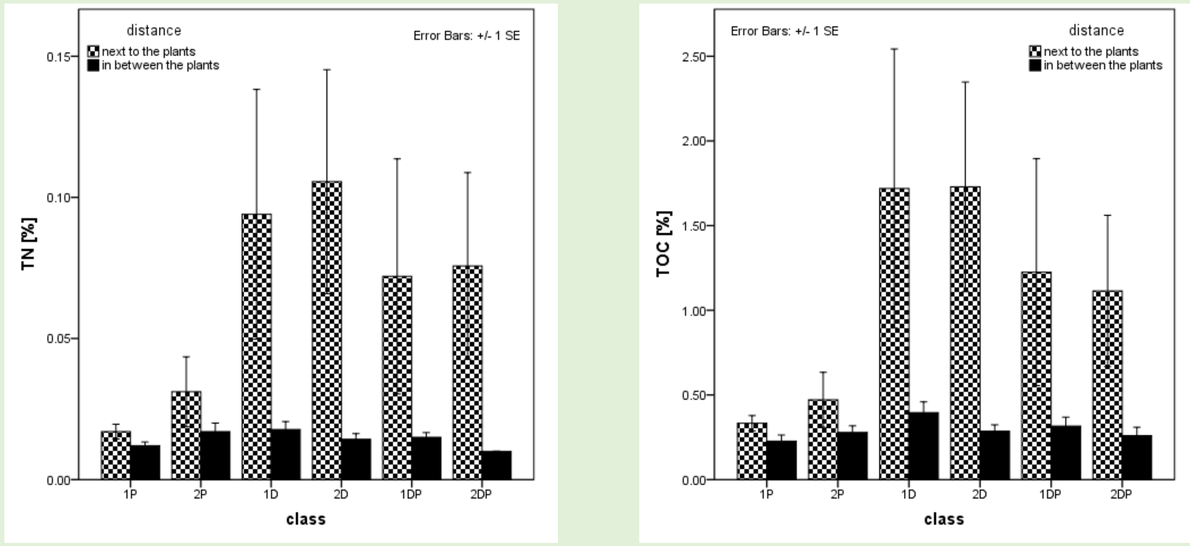

Fig. 5: Total nitrogen (TN) and total organic carbon (TOC) next to the plant and in between the plants

Conclusion

In this study, no effects of sustainability strategies on soil fertility were detected. However, applied sustainability practices, including intercropping, might have positive effects on other parameters such as erosion and additional yields, which were not measured in this study.
Due to a rising demand for food and consequently a pressure on agricultural land, further research on sandy soils concerning the best cultivation methods, i.e. the selection of **appropriate crops,** will become increasingly important – especially for the **realisation of the SDGs** (Sustainable Development Goals).