Evaluation of physical land suitability for the “Thanh Tra” pomelo crop in Hue, Vietnam

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Abstract

“Thanh Tra” pomelo (Citrus Grandis L. Osbeck) is one of the major fruit crops in Hue, Central Vietnam. Its commercial production is an important source of income for many farmers. The production of “Thanh Tra” pomelo is being rapidly developed both in terms of quality and quantity. However, productivity and production of “Thanh Tra” pomelo are low when compared to those in south and north of Vietnam and other countries. There are some considerable constraints facing “Thanh Tra” pomelo development, including socio-economic factors and physical conditions. Evaluation of physical land suitability for “Thanh Tra” pomelo is a prerequisite for sustainable agricultural production and it involves of the multi-criteria evaluation.

Aim of this study is to determine physical land suitability areas for the “Thanh Tra” pomelo production and sustainable agriculture development of a representative village Thuy Bang, Hue, Vietnam.

The methodology used for the physical land suitability analysis for “Thanh Tra” pomelo is a multi-criteria evaluation approach within GIS context, based on FAO land evaluation framework (1976, 1983), modified for Vietnamese conditions. The methodology consists in matching soil/land qualities against ecological requirements of “Thanh Tra” pomelo. Thuy Bang was selected as a representative village for this study with an area of 2298 hectares with 16 soil units (FAO/UNESCO/WRB). Slope varies from 3°-25°, soil depth is 30 cm to more than 100 cm, scared water resource, soil fertility is poor to moderate. The study was carried out by overlapping all individual maps (soil map, soil depth map, slope map, texture soil map, soil fertility map) with GIS techniques for land evaluation mapping of units and physical land suitability classification. Results showed that there are 32 land evaluation mapping units in the study village. A total of 1322.27 ha were suitable for “Thanh Tra” pomelo production, of which 10 % was moderately suitable (S2), and 90 % was marginally suitable (S3). Lack of irrigation, erratic rainfall and poor soil fertility are the most serious problems influencing yield and quality of “Thanh Tra” pomelo.

1. Introduction

“Thanh Tra” pomelo (Citrus Grandis L. Osbeck) is one of the major special fruit crops in Hue, Central Vietnam. Its commercial production is an important source of income for many farmers. The production of “Thanh Tra” pomelo is being rapidly developed both in terms of quality and quantity. A number of organizations and local people are interested in the suitability area for “Thanh Tra” pomelo in order to estimate the production. Systematic and interdisciplinary approach to produce information on the land suitability is needed. The information can be divided into layers to model suitable area as a set condition. FAO guidelines on the land evaluation system (1976, 1983) were widely used. This system was based on matching between
land qualities/characteristics and crop requirements. Physical land evaluation methods are crucial for evaluating potentials and constraints of land for intended land use. Physical resources, such as soil, climate, hydrology, and topography are evaluated. Different technical procedures were used for physical land evaluation ranging from simple methods based on expert knowledge to more complex methods based on simulation models.

A case study of Thuy Bang village, Hue, central Vietnam has been selected to be stimulated for this research. Main aim of this study is to assess physical land suitability for the “Thanh Tra” pomelo crop according to the local priority list through an approach within GIS context, based on FAO land evaluation framework (1976, 1983), modified for Vietnamese conditions. Outputs produced from this database can provide local policy makers, researchers and farmers with important information for land use planning, strategic planning and investment. These outputs could also be used as a typical study in village level so as to expand to further research for other villages in Central Vietnam.

2. Study area, materials used

2.1 Study area

The study area chosen is a hill village Thuy Bang, Hue, central Vietnam at approximately 16°25’S and 107°27’E and at an altitude of 100 m, and covers an area of 2106.27 hectares with 5 major soil groups, Acrisols, Cambisols, Fluvisols, Gleysols, Leptosols and divided into 16 soil units (FAO/UNESCO/WRB). Climate data has been recorded since 1934-1998 at Hue climate and meteorological station showed that monthly mean temperature is about 25.1°C, mean annual rainfall is about 2600 mm, but erratic rainfall distribution, mainly in rainy season from September to Jannuary.

2.2 Materials used

Basically, various forms of originally collected and derived data were used in the study. The crucial data sources are (a) topographic maps, (b) soil maps, (c) hydrological maps, (d) infrastructure accessibility maps, (e) fertility soil map, (f) ecological requirements of the “Thanh Tra” pomelo obtains through research results from literature review, expert opinions, local farmers, and (g) other published and unpublished information, such as agricultural statistics, and soil reports, population reports, horticultural crops reports.

For implementation of research method, several softwares were used as follows:
- Microsoft Excel software is used to create an attribute database
- Mapinfo 7.5 software is used to get some local information maps which are recording in Mapinfo.
- ArcView 3.2 software is used to digitize and scan the thematical maps as well as create of the region GIS and production of suitable site prorprty map for this area

3. Methodology

The methodology used for the physical land suitability analysis for “Thanh Tra” pomelo is a multi-criteria evaluation approach within GIS context, based on FAO land evaluation framework (1976, 1983), modified for Vietnamese conditions. The methodology consists in matching soil/land qualities against “Thanh Tra” pomelo needs and assigning a suitability rating to each land characteristic.

In order to develop a set of themes for evaluation and ultimately to produce a suitability map for “Thanh Tra” pomelo, the crop requirement in terms of land qualities was reviewed (Sys et al 1993, Vietnamese fruit literatures and FAO 1983).
The land qualities used in this evaluation include a number of land characteristics: water availability, fertility availability, rooting conditions, and water and nutrition retention. Each land characteristic is considered as a thematic layer in the GIS. Determinations of the various factors and values assigned are summarized in the Table 1

4. Result and discussion

4.1 Description of the selected “Thanh Tra” pomelo crop.

“Thanh Tra” pomelo is one of the most important smallholder and commercial crops in Hue, Vietnam. At present about 200 hectares are under “Thanh Tra” pomelo cultivation in Hue, and it is expected to expand up to 1000 hectares by 2010. Scale of “Thanh Tra” pomelo production is in smallholders at low management and investment level. Water resource used for “Thanh Tra” pomelo is mainly rainfed and a small part by a well equipped with a pump. Labor force is mainly from family and hired.

4.2 Land evaluation units map

In this step, the 6 important factors were mapped and classified, namely; soil units type map (G1-G13), slope gradient map (SL1-SL4), topsoil texture map (T1-T3), soil effective depth map (D1-D3), organic carbon map (C1-C3), soil fertility map (F1-F3). Land Evaluation Units (LEUs) map was gathered by overlapping all thematic maps above. Result shows that there are 32 LEUs in the research area.
Table 1. Factor rating of land quality for the “Thanh Tra” pomelo

<table>
<thead>
<tr>
<th>Land quality</th>
<th>Diagnostic factor</th>
<th>Unit</th>
<th>Factor rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean temperature in growing period</td>
<td>°C</td>
<td>S1</td>
</tr>
<tr>
<td></td>
<td>Average annual rainfall (R)</td>
<td>Mm</td>
<td>1500-2000</td>
</tr>
<tr>
<td></td>
<td>Organic Carbon (C)</td>
<td>%</td>
<td>&gt;2.5</td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen (N)</td>
<td>%</td>
<td>&gt;0.2</td>
</tr>
<tr>
<td></td>
<td>Available Phosphorus (P₂O)</td>
<td>Ppm</td>
<td>&gt;15</td>
</tr>
<tr>
<td></td>
<td>Available Potassium (K₂O)</td>
<td>Mmg</td>
<td>&gt;15</td>
</tr>
<tr>
<td></td>
<td>Soil reaction (pH)</td>
<td>-</td>
<td>5.5-6.5</td>
</tr>
<tr>
<td></td>
<td>Soil depth (D)</td>
<td>Cm</td>
<td>&gt;100</td>
</tr>
<tr>
<td></td>
<td>Slope gradient (SL)</td>
<td>degree</td>
<td>0-3°</td>
</tr>
<tr>
<td></td>
<td>Soil texture (T)</td>
<td>-</td>
<td>L, LS</td>
</tr>
</tbody>
</table>

Remark: L= Loam; LS = Loam Sand; Si = Silt; SiL = Silty Loam; S = Sand; SL = Sandy Loam; C = Clay; CL = Clay Loam. S1= Highly Suitable; S2= Moderately Suitable; S3= Marginally Suitable; N= Non Suitable

4.3 Physical land suitability for the “Thanh Tra” pomelo

Finally, the “Thanh Tra” pomelo suitability map was superimposed, then all polygons were union together to get a model for the area selection of this crop. The resulting crop suitability model (Fig. 3) shows 3 land suitability classes resulting from the combination of moderately (S2), marginally suitable (S3) and not suitable (N) areas for “Thanh Tra” pomelo planting. A total of 1322.27 ha was suitable for “Thanh Tra” pomelo production, of which 10 % was moderately suitable (S2), and 90 % was marginally suitable (S3). Lack of irrigation, erratic rainfall and poor soil fertility are the most serious problems influencing yield and quality of “Thanh Tra” pomelo

5. Conclusion

5.1 Land resources and agricultural ecological conditions.
There are five major soil groups with 32 land evaluation units of 2106.27 ha in research village Thuy Bang, after overlaying thematic maps of scale 1:10000. Current soil fertility of hilly research region is poor and very poor, namely, limiting factors: pH>K>C>N>P. Climate condition is generally suitable for fruit development, however, rainfall distribution is erratic, to be seriously short of water in dry season for “Thanh Tra” pomelo growth.

5.2 Infrastructures and crop production.
Rural road and irrigation systems are quite poor and unsatisfied for agricultural production and fruit production. Crop systems are quite plentiful but cultivated area per household is too small,
Figure 2: Map for land evaluation units of Thuy Bang village

Figure 3. Map of physical land suitability for “Thanh Tra” pomelo planting
scattered and low economic effect; rice monoculture is still major. Home and hilly garden for fruit cultivation are mixed crops and undesigned and uninvested appropriately yet.

5.3 Physical land suitability for “Thanh Tra” pomelo in research village.
1322.27 ha of 2106.27 ha is current marginally suitable (S3) for “Thanh Tra” pomelo (63%); if improved, 556.44 ha (26%) and 765.83 ha (37%) of 2106.27 ha are potentially moderately suitable and marginally suitable, respectively. Non suitable (N) is 784.00 ha (37%).

5.4 The land evaluation methodology for village administration level in central Vietnam.
The results obtained from this study indicate that the application of GIS and multi-factor evaluation could provide a superior database and guide map for decision makers considering to replace non-suitable crops by the suitable crops in central Vietnam.

References