Study land potential for orientation of agricultural land use in Ham Thuan Bac district, Binh Thuan province

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Abstract
The land potential of Ham Thuan Bac district is classified based on some land quality characteristics and land use requirements of the common land use types of Ham Thuan Bac district for these properties: soil types, soil texture, fine soil thickness, slope and irrigation regime. The whole district has 107 LMU, on which exist 11 types of land use: Rice; Corn; Cassava and sweet potato; Cane; Grass breeding; Other vegetables; Green Dragon fruit; Thing; Rubber; Coffee and Other Fruit Trees. The land area with land suitability levels S1 and S2 for most LUTs is small. Unsuitable land area is quite large. More than 50% of the LUT areas of Rice, Rubber, Coffee, Other Fruit Trees are unsuitable; The remaining LUTs have unsuitable land areas ranging from 10.76% to 25.16% of the district's agricultural land. Actual cultivated area is less than the area under the approved land use plan. Proposal to stabilize 8550 hectares of rice land covering all areas with suitale levels S1, S2 and a part of the area with S3 level to be irrigated. The land area of the remaining S3 and N level of paddy land and the the area of S2 and the S3 levels of Green dragon fruit LUT with active and semi-active irrigation regimes are proposed to change annual crops, other fruit trees and grass for livestock.

Keywords: *Land potential, land suitability, agricultural land use in Ham Thuan Bac*

1. Introduction
Ham Thuan Bac is a mountainous district of Binh Thuan province with an agricultural land area of more than 124 thousand hectares, playing an important role in the district's economic development. Therefore, to increase the source of income for the district budget, it is necessary to use it reasonably, effectively and maximally land resources.

The biggest advantage of the district's natural conditions for agricultural production is the diversity of soil types (8 groups including 17 land units) and topography; Great total heat accumulation, long lighting time.

The biggest constraint on the natural conditions of Ham Thuan Bac district is also the common limitation of the region: semi-arid climate regime of the south pole central region, the dry season lacking water. Drought of the dry season reduces the planted area, especially the area of winter-spring rice is sharply reduced. During the rainy season, the plants may be inundated and partially flooded. Most of the soil types of the district have not high fertility.

Therefore, in order to maximize the effectiveness of land resources, it is necessary to assess land suitability for land resources planned for agricultural production. This is a necessary step for the orientation of agricultural land use, one of the scientific bases to improve the efficiency of agricultural land use of the district.

2. Research method
2.1. Investigate and collect secondary data

Collect documents and reports related to natural conditions; Meteorological data from 1980 to the present, the situation of drought; current status of agricultural land use, agricultural production situation in Ham Thuan Bac district; soil map of Binh Thuan province; ... at Department of Natural Resources and Environment, Department of Agriculture and Rural Development of Binh Thuan Province, hydro-meteorological stations in the South Central Coast region, Division of Resources and Environment, Division of Agriculture and Rural Development of Ham Thuan Bac District, Central sub Institute of Agricultural Planning and Design.

2.2. Field surveys

Investigate, survey the status of crops, identify types of land use for agricultural production and irrigation systems in Ham Thuan Bac district; Survey, take soil samples to check properties of soil types according to land classification of Ham Thuan Bac district.

2.3. Method of building maps

- Digitizing maps: Using MicroStation and Mapinfo software to digitize maps.
- Map overlaying in GIS: overlay vector component maps to have maps containing aggregated information layers.
- Interpolation method: interpolation (Krigging; IDW) to determine the continuous values of rainfall, sunshine, temperature, and humidity distribution for the whole surveyed area (for building drought map).
- Methods of conducting the construction of specific maps are as follows:

+ Soil map: The soil map of Ham Thuan Bac district was compiled from the soil map data of Binh Thuan province at the scale of 1 / 100,000 built in 2005 (Central Agricultural Planning Sub-Institute, 2005) combined with additional surveys and analysis in 2017 using GIS technology (using MicroStation, ArcGis software).

+ Map of soil texture: The information for the soil texture map was compiled from the soil map of Binh Thuan province at the scale of 1/100,000 (2005), combined with the results of additional surveys and analysis in 2017. The information was delineate directly on the base map and then edited into the soil texture map.

+ Fine layer thickness map of soils: The information for the soil thickness map is synthesized from Binh Thuan province's soil map of 1/100,000 scale (2005), combined with the results of investigation, excavation, soil profile description and sampling supplemented in 2017. The information is mapped directly to the base map and then edited into a fine layer thickness map of soils.

+ Map of slope: The slope map is synthesized from the soil map of Binh Thuan province at the scale of 1/100,000 (in 2005), combined with the use of the digital elevation model (DEM), the resolution of 50m x 50m

+ Map of irrigation regime: Irrigation regime map was created by inheriting secondary documents and data on the irrigation system in Ham Thuan Bac district, combining with results of field observation. The above contents, after being done, transfer the different areas of the irrigation regime to the base map and then edit such as making the irrigation map.

+ Map of land units: The land unit map was created by overlaying the above land character maps. Lots with the same land properties are arranged in a land map unit called land unit for short.

+ Map of appropriate land classification: The land suitability classification map was built based on the results of assessment and classification of land units based on land use requirements of land use types in the study area. Suitability levels are identified and delineated on a base map and then edited into a land suitability map.

3. Results and discussion

3.1. Natural conditions of Ham Thuan Bac District

Ham Thuan Bac is a semi-mountainous district, adjacent to coastal areas, Phan Thiet city and Di Linh plateau.

- Topography: In general, the topography of the district is quite diverse, lower in the direction of Northwest - Southeast; including semi-mountainous terrain, alluvial plain and coastal sand dunes.

+ The semi-mountainous area extends from Ham Hiep commune to Ham Tri, Ham Phu and Thuan Hoa communes and highland communes of Dong Giang, Dong Tien, Thuan Minh, La Da and Da Mi with a total area of 92,257.96 ha, accounting for 68.62% of the district's natural area. This is a land with great potential for exploitation. The land use status is mainly forest, perennial fruit trees, sugarcane and some short-term industrial crops.

+ Riverine alluvial plain: including Ma Lam and Phu Long towns and Ham Thang, Ham Liem and Ham Chinh communes, with an area of 17437.36 ha, accounting for 12.97% of the total natural area

of the district. This land has relatively flat terrain and the best soil fertility of the district. Current land use status is mainly rice, and high value commodity fruit trees such as green dragon fruit...

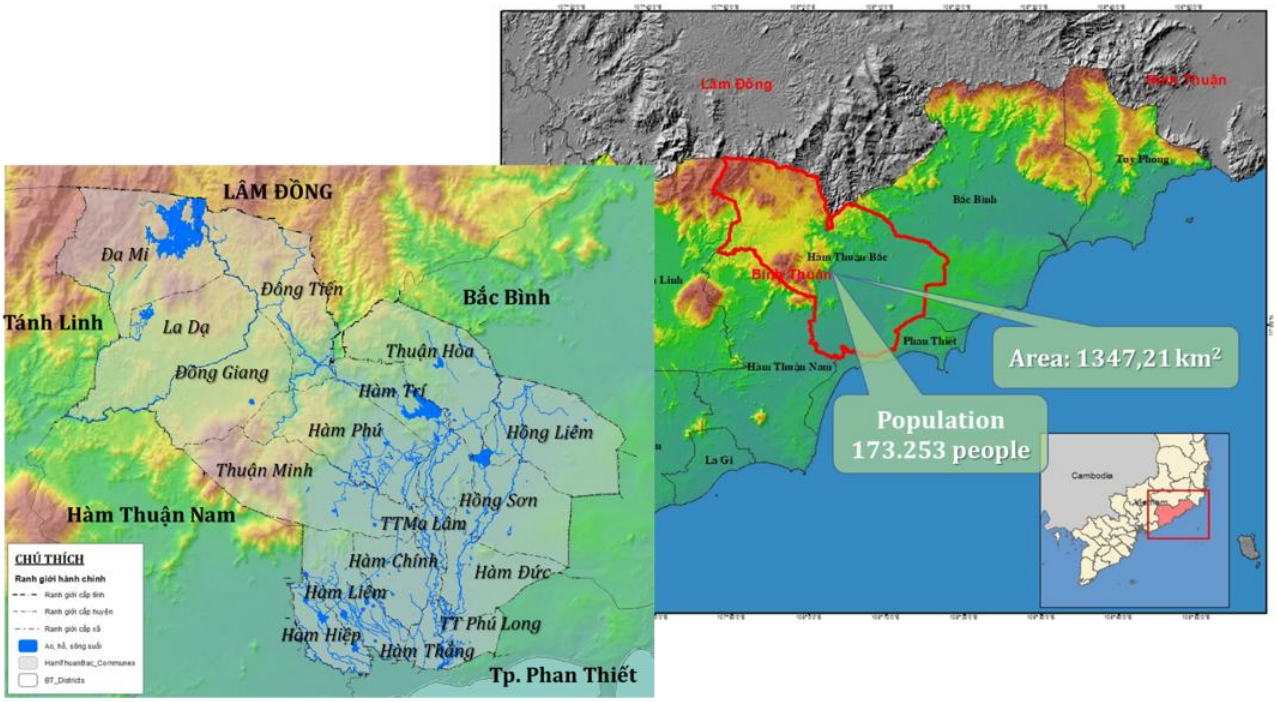

Figure 1. Location of Ham Thuan Bac district, Binh Thuan province

+ Sea sand dunes: extends from Ham Duc commune to Hong Liem commune with an area of 24,755.90 hectares, accounting for 18.41% of the district's natural area. This is the region with the driest white and yellow sand dunes in the district. Current status of land use mainly for protection forests to prevent the encroachment of sand into agricultural land, residential areas, in addition to planting watermelon for seeds and some other crops.

- Climate: Ham Thuan Bac is located in the tropical monsoon region, but the district's climate is characterized by semi-arid climate regime in the southpole central region. During the year, the climate is divided into 2 distinct seasons: the rainy season from May to October, and the dry season from November to April of the following year. In general, the district's heat and humidity regime is suitable for many crops and livestock; However, due to the low rainfall and uneven distribution of the year, the dry season often causes serious shortage of water for production and people's daily life.

- Hydrological regime of the district is influenced by 2 main rivers: Cai Phan Thiet and La Nga rivers. In addition, the district also has a system of other small rivers and streams.

+ Surface water: quite plentiful and provided by the district's main river and stream system, Cai Phan Thiet river, originating from Di Linh plateau with a basin area of 1,050 km2 (the length flowing through the district 433.42 km), the total annual average flow reaches 389 million m3 of water. However, due to sparse river and stream density of 0.33 km / km2; the rivers are short, steep and narrow, so the rainy season often causes flash floods and the dry season causes droughts, in which the flood flow (Quao river) varies from 2.65 - 13.53 m3 / s (reaching maximum in October), while the dry season varies from 0.48 to 2.95 m3 / s (the lowest is in March). Therefore, to effectively exploit surface water, it is necessary to strengthen irrigation systems, build reservoirs in combination with hydroelectricity to serve production and daily life, at the same time regulate microclimate and improve groundwater level in the region.

+ Ground water source: with a total dynamic reserve estimated at 31,300 m3 / well / day, but the ability to exploit and use water is poor and unevenly distributed among the sub-regions in the district.

3.2. Land unit map

- The land unit map of Ham Thuan Bac district, Binh Thuan province is built on the whole area of agricultural land and unused land by the method of superposition of single map layers including: soil type, slope, thickness, soil texture, and irrigation regime.

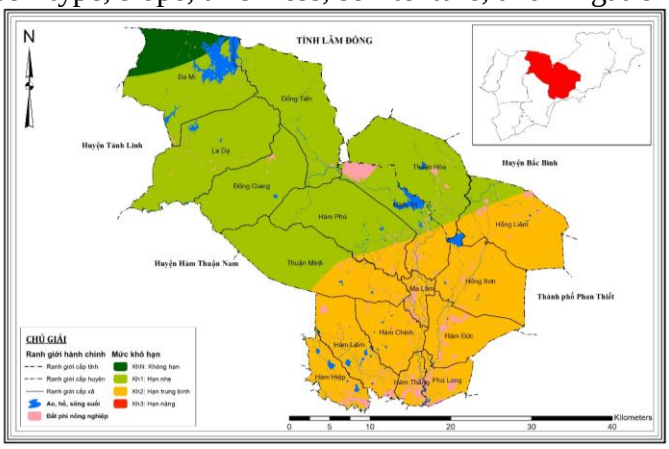

Figure 2. Drought zoning map of Ham Thuan Bac district in the period of 2006-2016

Drought is a common limiting factor for district agricultural production; 35.86% of the natural land area is moderately drought (concentrated in the south of the district), 54.37% of the area is slightly drought and only 2.95% of the remaining natural land area is not drought (concentrated in the north of the district). Therefore, it is not necessary to use the drought indicator to develop a land unit map.

+ Soil map: The soil of Ham Thuan Bac district consists of 8 groups with 17 types of land, in which the largest area of yellow red and gray soils is respectively 30559.35 ha and 23023.78 ha, accounting for 22.73% and 17.12% of the natural land area (134451.22 ha) of the district); followed by reddish brown soil on basalt rock (13711.69 ha, sand dune soil (11917.53 ha), yellow brown soil on ancient alluvial (10481.13 ha) and yellow red soil on clay rock (8117.20 ha); soil types (no deposited alluvial soil, alluvial soil with variegated horizon, stream alluvial soil, lowland soil caused by deluvi products, purple brown soil on basalt, reddish yellow humus soil in mountains and eroded and exposed gravel soil) with less area; their respective areas are 6636.41 ha, 5120.35 ha, 3744.44 ha, 4680.59 ha, 2039.92 ha, 2103.07 ha and 1621.12 ha. Soils with the smallest areas include high saline soils (31.31 ha), gley gray soil (160.38 ha), yellow red soil changed by wet rice cultivation (528.73 ha) and gley sand soil (793.79 ha), respectively accounting for from 0.02 to 0.59% of the district's natural land area.

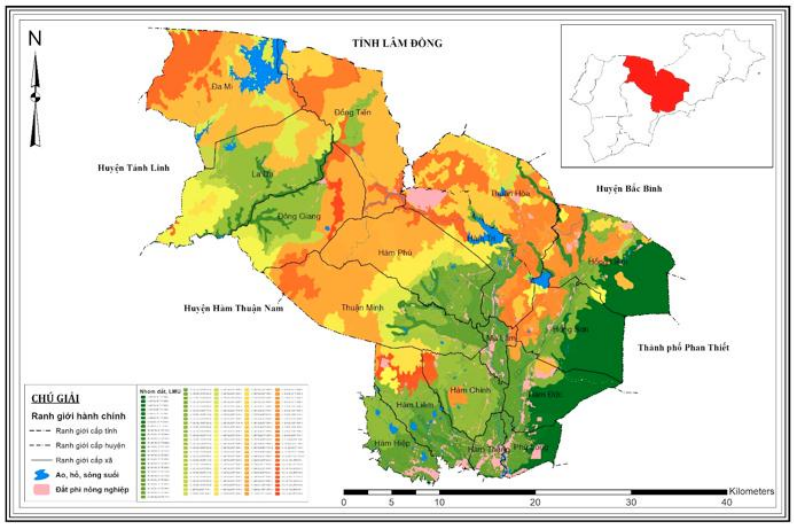

Figure 3. Land unit map of Ham Thuan Bac district

In general, the potential fertility of soil types in Ham Thuan Bac district is not high. To achieve high and stable crop yields, it is necessary to fertilize the plants appropriately.

+ Slope map: About 50% of the natural land area of Ham Thuan Bac has a relatively flat terrain (the alluvial plain and sea sand dunes), in which the slope is from 0 to 3^o, accounting for 54043.51 ha (40.20%) and the slope of 3 - 8^o accounts for 13459.75 ha (10.01%). The semi mountainous area of the district has a rather large slope, in which the slope with > 25^o has the largest area (31598.28 ha, accounting for 23.50%). The soil with slopes of 3 - 8^o, 15 - 20^o, 20 - 25^o has less area, respectively, their slope is 10468.92 ha, 4032.87 ha and 11667.48 ha.

+ Soil thickness map: The soil thickness of Ham Thuan Bac soil is also very different. Approximately 70% of the district's natural land has soil thickness > 70 cm, in which, soil thickness > 100 cm has 41864.80 ha (31.14%) and soil thickness from 70 - 100 cm has 49668.55. ha (36.94%). The remaining soil has the thickness of 50 - 70 cm (17249.08 ha), the thickness of 30-50 cm (55.09 ha) and the thickness of less than 30 cm (14812.18 ha).

+ Map of soil texture: Most of Ham Thuan Bac soil has light texture (sand, loamy sand, sandy loam) with the area of 82924.30 ha, accounting for 61.67% of the natural land area. Soils with heavy texture (clay loam, silty clay, clay) has the large area (34342.36 ha, accounting for 25.54%). The area of the soil with medium texture (sandy clay loam, loam, silty loam, silty, silty clay loam, sandy clay) is least (6383.36 ha, accounting for 4.75%).

+ Irrigation regime map: built on the basis of irrigation map and irrigation zoning map of Binh Thuan province in 2015 (1 / 100,000 scale) in combination with survey results, field zoning of the research team. The study results show that up to 65.95% of the district's natural land (88676.01 ha) is not irrigated. About 13998.99 ha (17.85% of the agricultural land is actively irrigated and 12595.81 ha (9.37%) of the remaining land has a semi-active irrigation regime (near water sources, which can be pumped by itself).

- The land unit map of Ham Thuan Bac district has 107 land mapping units (LMU), abbreviated as the land units, in which: 6 LMU belongs to sandy soil, 2 LMU belongs to saline soils, 18 LMU belongs to alluvial soils, 17 LMU belongs to the gray group, 53 The LMU belongs to the yellow red soil group, 1 LMU belongs to the reddish yellow humus soils in the mountains, 2 LMU belongs to the lowland soils, and 8 LMU belong to the eroded soils.

3.3. Land suitability classification

Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvements. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for defined uses.

3.3.1. Land use type in Ham Thuan Bac district

Based on the current land use data (Division of Natural Resources and Environment of Ham Thuan Bac district, 2017), the results of the survey on the distribution of crops, 11 LUTs have been identified on agricultural land of Ham Thuan Bac district (Table 1).

Table 1. Area of LUTs in Ham Thuan Bac district according to land utilisation plan in 2017

No	LUT	Notation	Area (ha)	Proportion (%)
1	Rice	LUC	12,588.97	9.363
2	Maize	CHN	2,372.07	1.764
3	Cassava and sweet potato	CHN	3,070.56	2.284
4	Sugar cane	CHN	497.91	0.370
5	Grass for livestock	CHN	3.69	0.003
6	Other cash crops (Peanuts, Beans,…)	CHN	5,696.45	4.237
7	Green dragon fruit	CLN	19,352.71	14.394
8	Cashew	CLN	3,507.57	2.609
9	Rubber	CLN	1,887.19	1.404
10	Coffee	CLN	152.86	0.114
11	Coffee and Other fruit trees (Custard-apple, Avocado, Mango …)	CLN	11,996.11	8.922
Total area of agricultural land			**61,126.09**	**45.463**
Total area of natural land			**134,451.22**	**100.000**

LUTof The fruit tree area has the largest area (31348.82 ha), of which Green Dragon fruit accounts for 61.73% of the district's fruit tree area (19352.71 ha). Other fruit trees include: Custard-apple,

Avocado, Jackfruit, banana, Mangosteen, Mango, with less area (11996.11 ha, accounting for 38.27% of LUT of fruit tree). The annual crop is mainly wet rice (12588.97 ha). Depending on rain and irrigation conditions, rice can be transplanted for 2 to 3 crops. Other annual crops with significant areas (over 11,000 ha) include: Peanuts, Beans (5696.45 ha), Cassava and Sweet potato (3070.56 ha), Maize (2372.07 ha). Rice is mainly grown in drought-prone areas in the medium level. Therefore, in the winter-spring season, rice and other crops are often strongly affected by drought due to lack of water.

Unlike other LUTs, LUT of Grass for livestock are not allocated land in the land use plan of the district. People often grow grass on annual crop land or in family gardens, so the land area of this LUT is negligible. According to the survey results, only about 3.7 ha.

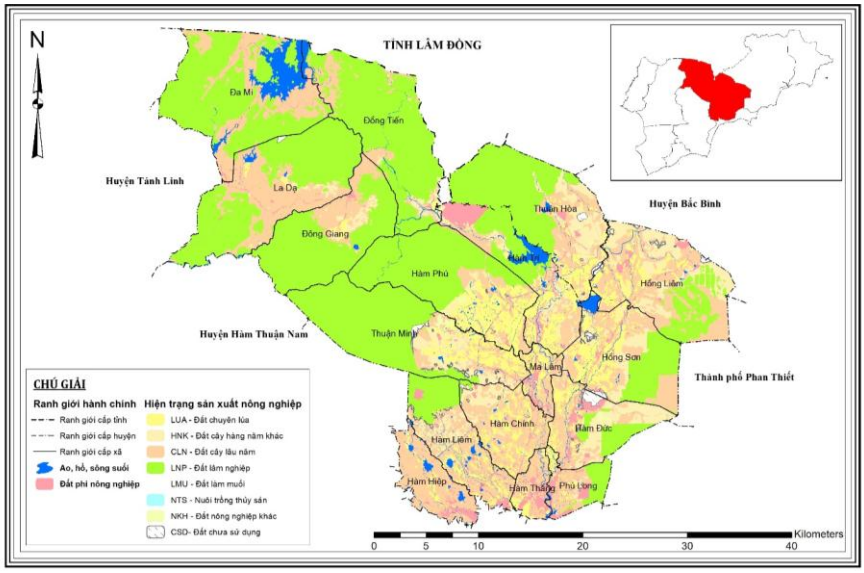

Figure 4. Current status map of agricultural land use of Ham Thuan Bac district in 2017

3.3.2. Land use requirements of LUTs

Land use requirements are land character requirements with varying degrees of suitability for each selected land use type. The determination of land use requirements and the suitability classification for land use types is conducted on the basis of crop growth, land management and protection requirements applied to specific conditions of the study area.

Land use requirements are graded according to four levels: S1 - highly suitable, with the lowest restriction; S2 - moderate suitable, with a restriction from less to moderate; S3 - low suitable, with a large limitation; N - not suitable, with such a large limit that the possibility of LUT application in practice must be eliminated.

Land use requirements of Ham Thuan Bac district LUTs (Table 2) include 6 properties: soil type, slope, soil thickness, soil texture and irrigation ability (regime).

Table 2. Land use requirements of LUTs

Land properties		Notation	LUT										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Soil types													
1	Cc	G01	N	N	N	N	3	2	3	N	N	N	N
2	Cg	G02	3	N	N	N	N	2	N	N	N	N	N
3	Mn	G03	N	N	N	N	N	N	N	N	N	N	N
4	P	G04	1	1	2	1	1	1	1	N	N	N	1
5	Pf	G05	2	2	3	2	2	3	1	N	N	N	1
6	Py	G06	1	1	2	2	2	1	1	N	N	N	1
7	Xa	G07	3	2	3	3	1	3	1	2	3	3	N
8	Xg	G08	2	N	N	N	3	N	3	3	N	N	2
9	Fa	G09	N	3	2	3	1	3	1	2	3	3	3
10	Fk	G10	N	1	1	1	1	1	2	1	1	1	1

	Land properties	Notation	LUT										
			1	2	3	4	5	6	7	8	9	10	11
11	Fl	G11	3	2	N	N	2	3	N	N	N	3	N
12	Fp	G12	N	3	2	3	1	2	1	1	2	3	2
13	Fs	G13	N	3	1	2	2	3	2	3	2	2	2
14	Ft	G14	N	1	1	1	1	1	2	1	1	1	1
15	Ha	G15	N	3	3	N	2	2	N	N	N	3	N
16	D	G16	3	2	N	N	1	3	2	N	N	N	N
17	E	G17	N	N	N	N	N	N	N	N	N	N	N
Slope													
I	$< 3^0$	SL1	1	1	2	1	1	1	1	1	1	1	1
II	$3 - 8^0$	SL2	N	1	1	2	1	2	2	1	1	2	1
III	$8 - 15^0$	SL3	N	2	2	3	2	3	3	2	2	3	2
IV	$15 - 20^0$	SL4	N	3	3	N	3	N	N	2	2	N	2
V	$20 - 25^0$	SL5	N	3	3	N	N	N	N	3	3	N	3
VI	$> 25^0$	SL6	N	N	N	N	N	N	N	N	N	N	N
Soil thickness													
1	> 100 cm	D1	1	1	1	1	1	1	1	1	1	1	1
2	100 - 70 cm	D2	1	1	1	2	1	1	2	3	3	3	3
3	70 - 50 cm	D3	2	2	2	3	2	2	3	N	N	N	N
4	50 - 30 cm	D4	3	3	3	N	3	3	N	N	N	N	N
5	< 30 cm	D5	N	N	N	N	N	N	N	N	N	N	N
	Eroded and exposed gravel soil	E	N	N	N	N	N	N	N	N	N	N	N
Soil texture													
	Eroded and exposed gravel soil	E	N	N	N	N	N	N	N	N	N	N	N
1	Light soil texture	T1	2	2	1	1	2	1	2	2	2	3	2
2	Medium soil texture	T2	1	1	2	2	1	2	1	1	1	2	1
3	Heavy soil texture	T3	3	3	3	3	2	3	2	2	2	1	2
Irrigation ability (regime)													
1	Rainfed	I1	3	3	3	3	3	3	3	3	3	3	3
2	Semi active	I2	2	2	2	2	2	2	2	2	2	2	2
3	Active	I3	1	1	1	1	1	1	1	1	1	1	1

where: 1: S1 (highly suitable), 2: S2 (medium suitable), 3: S3 (low suitable) and N (not suitable).

3.3.3. Classification of land suitability

Based on the land characteristics and land use requirements of the LUTs of Ham Thuan Bac district (Table 2), the land suitability classification for 11 land use types on the whole area of 61126.09 ha of agricultural production land of Ham Thuan Bac district. The results of land suitability classification (Table 3) show that: more than 50% of the land area of LUTs of Rice, Rubber, Coffee, and other fruit trees is unsuitable land (52.03%, 58.18%, 58.44%, 57.22% and 63.15% of agricultural land, respectively). The remaining LUTs have unsuitable land area varying from 6579.72 ha to 15377.54 ha, accounting for 10.76% to 25.16% of the district's agricultural land area. The area of land with a high level of suitability (S1) for all LUTs is not much, even some types of land use (Cassava and Sweet potato, Cashew, Rubber tree, Coffee) do not have this type of land.

Table 3. Land suitability potential of agricultural land of Ham Thuan Bac district

No	LUT	Area (ha)				Total (ha)
		S1	S2	S3	N	
1	Rice	1487.49	1075.24	26757.20	31806.17	61126.09

2	Maize	1487.49	14143.29	34165.17	11330.15	61126.09
3	Cassava and sweet potato	-	9399.02	39872.98	11854.09	61126.09
4	Sugar cane	8.58	2,419.33	43320.63	15377.54	61126.09
5	Grass for livestock	152.81	33540.54	20752.83	6679.91	61126.09
6	Other cash crops (Peanuts, Beans,…)	419.93	9385.49	44740.94	6579.72	61126.09
7	Green dragon fruit	1579.53	28266.76	22200.08	9079.72	61126.09
8	Cashew	-	6299.06	19265.92	35561.12	61126.09
9	Rubber	-	2557.13	22849.49	35719.47	61126.09
10	Coffee	-	-	26146.86	34979.23	61126.09
11	Coffee and Other fruit trees (Custard-apple, Avocado, Mango …)	1579.53	14324.95	6621.59	38600.02	61126.09

The area of land with S2 suitability level of the LUTs is higher than that of S1. For most LUTs, it only accounts for 1.76% to 15.38% of agricultural land (land of LUT of Coffee does not have the suitable level S2); except for land of LUTs of Grass for livestock and Green dragon fruit has the largest area of S2, accounting for 54.87% (33540.54 ha) and 46.24% (28266.76 ha) and land of LUT of Other fruit trees and LUT of Maize has a quite large area of suitable S2, accounting for 23.44% and 23.14% of the district's agricultural land respectively.

With S3 land suitability level, excluding LUT of Other fruit trees have 6621.59 ha (accounting for 10.83%), land with S3 suitable level of other LUTs is quite large ranging from 19265.92 ha (Cashew) to 44740.94 ha (Other colors).

From the results of land suitability classification of agricultural land according to the land use plan in 2017 for each LUT (Table 4), it is found that: the land area of LUTs of annual crops is mainly at the suitable level S3. The percentage of land area with S3 suitable level of these LUTs ranges from 67.75 to 100.00% of the current area of the LUTs. For perennial trees, except Green dragon fruit LUT with most of the current land area having S2 suitble level (15150.11 ha, accounting for 78.28%), the land of other perennial LUTs is mostly at an inappropriate level and low stuitable level S3; especially for LUTs of Cashew, Rubber, Coffee and Other fruit trees, their proportion of unsuitable land area is very high, 65.13%, 44.47%, 85.61% and 75.42% according to the approved land use plan, respectively.

Table 4. Land suitability classification of existing agricultural land of Ham Thuan Bac district (according to the land use plan in 2017)

No	LUT	Area (ha)				Total (ha)
		S1	S2	S3	N	
1	Rice	700.19	427.49	8529.07	2932.22	12588.97
2	Maize	74.55	325.95	1848.85	122.71	2372.07
3	Cassava and sweet potato		102.41	2455.73	512.42	3070.56
4	Sugar cane		7.04	486.09	4.78	497.91
5	Grass for livestock			3.69		3.69
6	Other cash crops (Peanuts, Beans,…)	31.00	1389.46	4166.07	109.91	5696.45
7	Green dragon fruit	694.67	15150.11	2455.06	1052.88	19352.71
8	Cashew			1222.95	2284.61	3507.57

9	Rubber		1048.06	839.14	1887.19
10	Coffee		22.00	130.86	152.86
11	Coffee and Other fruit trees (Custard-apple, Avocado, Mango …)	112.94	2835.29	9047.87	11996.11
Total area of agricultural land					**61126.09**

4. Orientation of agricultural land use in Ham Thuan Bac district

According to the survey results and statistics (Department of Agriculture and Rural Development of Ham Thuan Bac district, 2017, 2018), actual cultivated area of LUTs (Table 5) is much different from that of LUTs under the 2017 land use plan (Table 1).

Table 5. Cultivated area in 2017 and 2018 in Ham Thuan Bac district

No	LUT	Area (ha)					
		Winter-spring		Summer-autumn		Autumn	
		2016-2017	2017-2018	2017	2018	2017	2018
1	Rice	8515	8545	9171	9000	9323	9079
2	Maize	75.5	68	528	619	1327	1526
3	Cassava and sweet potato	9.5	10	1086	1148	44	10
4	Sugar cane	269	164	1552	1403	39	41
5	Grass for livestock	3.7	3.7	3.7	3.7	3.7	3.7
6	Other cash crops (Peanuts, Beans,…)	1031	797.5	1247	1410	1134	1438
7	Green dragon fruit	9000	9071.7				
8	Cashew	1365	1728				
9	Rubber	1531	1531				
10	Coffee	1550	1634				
11	Coffee and Other fruit trees (Custard-apple, Avocado, Mango …)	858	1300				

LUT of Rice is actually only cultivated on an area of 8515 to 9232 ha depending on the season, while the rice area under the district's land use plan is 12588.97 ha. The difference in the cultivated area in 2017, 2018 and the area under the approved land use plan of other LUTs is similar. The main cause of this discrepancy is due to unsuitable (N) or low suitable (S3) land area of the district (Table 3). The district has not been able to exploit effectively, maximizing the whole area of agricultural land if not investing to overcome the limiting factors (firstly the irrigation regime) or changing suitable crop structure.

Because the general limitation of the whole region is drought in winter-spring and early summer-autumn seasons, with the district's existing irrigation capacity, the LUT Rice should be stabilized with an area of about 8550 hectares for sure (including 1127.68 hectares of rice land with the appropriate level S1, S2 and 7422.32 are paddy fields with a suitable level S3 (due to the less suitable soil mechanical composition (S3) but active irrigation regime); the remaining area is converted to other annual crops (including land area of LUT of Rice with the remaining S3 level and the area with the suitability level N (mainly due to inappropriate soil - yellow red soil).

Due to the consumption market, the actual cultivated area of LUT of Green dragon fruit is only over 9000 ha, much lower than the approved land use plan (19352.71 ha). Therefore, for this LUT, it should only be cultivated on the land area of LUT of Green dragon fruit with the suitable level of S1 (694.67 ha) and about 8377.03 ha with the suitable level of S2.

Land area of LUT of Green dragon fruit (according to land use plan) with the remaining S2 suitability level (6773.08 ha) is converted to cultivate annual crops, other fruit trees (mango, grapefruit,...) and a part of growing grass for livestock.

For LUTs of Other perennial crops are mostly grown on the land with low suitability level (S3) or are not suitable (N). So, it is advisable to cultivate existing crops only on land with the S3 suitable level (1222.95; 1048.06; 22.00 of the Cashew, Rubber, Coffee LUTs respectively) and 112.94 ha (S2) and 2835.29 ha (S3) of LUT Other fruit trees.

The unsuitable land areas of these LUTs are converted for afforestation or growing soil improvement plants

4. Conclusion

4.1. Agricultural and unused land in Ham Thuan Bac district is distributed on 107 LMU.

4.2. Current status of district agricultural land includes 11 types of land use: Rice; Maize; Cassava and sweet potato; Sugar cane; Grass for livestock; Other cash crops; Green dragon fruit; Cashew; Rubber; Coffee and Other fruit trees.

4.3. The land area with suitable level S1, S2 of most LUTs is not much. Unsuitable land area is quite large. More than 50% of the area of LUTs of Rice, Rubber, Coffee, Other fruit trees is unsuitable; the remaining LUTs have unsuitable land areas ranging from 10.76% to 25.16% of the district's agricultural land.

4.4. Actual cultivated area is less than the area under the approved land use plan. To improve the efficiency of land use, it is proposed to stabilize 8550 hectares of rice land covering all areas with suitale levels S1, S2 and a part of the area with S3 level to be irrigated.

The land area of the remaining S3 and N level of paddy land and the the area of S2 and the S3 levels of Green dragon fruit LUT with active and semi-active irrigation regimes are proposed to change annual crops, other fruit trees and grass for livestock.

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