

Soil Suitability for Apple (*Malus domestica*) Cultivation within the Borders of the Municipality of Bužim

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Abstract

The consequences of improper land management are long-term, inadequate for agricultural production, and reflected through the loss of land, reduced yields, soil erosion, etc. In order to determine the optimal role or suitability of the land for apple cultivation within the Bužim municipality, a survey was conducted according to the FAO method of AEZ (FAO, 1976), and based on the obtained results, an assessment of the suitability of the land for apple cultivation was carried out. It was found that a significant land portion of the total of 13,026.27 ha agricultural land within the Municipality of Bužim is suitable for fruit production marked from S1 to N suitability class.

Thus, the areas with the best graded class S1 cover only 1.23% or 159.52 ha, the S2 class occupies 5.51% (717.24 ha), the S3 class occupies 2.29% (298.24 ha). However, the largest areas are marked as the unfavourable N-class with 36.68% (4,772.60 ha). It is evident that pre-existing conditions for apple production within the municipality do exist. With the implementation of the necessary measures of soil/ land regulation, education of agricultural producers, and mindfulness of constraint factors hindering intensive production such as terrain slope, depth, rockiness and soil response, progress in production can be made.

Key words: municipality of Bužim, soil suitability, apple, AEZ.

Introduction

The Municipality of Bužim is located in the southern part of the northern temperate climate zone and is influenced by continental air currents. Administratively and geographically, it is a part of the Una-Sana Canton, i.e. Federation of Bosnia and Herzegovina and it covers the total area of 13,026.27 ha (Ičanović M., 2016). There are two repartitions of soils/ land with associated classes and types, namely automorphic/ terrestrial and hydromorphic soils (Ičanović M., 2016). The total of eight types of soils have been identified: regosol, calcomelanosol, calcocambisol, terra rossa, eutriccambisol, districcambisol, luvisol and fluvisol, and six land capability classes including two related land capability subclasses. Currently, the relationship between high-quality land and lower quality categories moved towards fewer quality categories (Ičanović M., 2016). The purpose of research is to assess the suitability of soil in the Municipality of Bužim for apple cultivation. The research resulted in determining of three soil classes suitable for apple cultivation: S1 (1.23%), S2 (5.51%), S3 (2.29%), and an N class of unsuitable soil with 36.38%.

Material and Methods

The soil/ land as the subject of suitability assessment encompasses a wide array of different suitability factors required for the assessment of the intended use of space (FAO, 1976 and Vidaček et. al. (n.d.)). The applied model of agro-ecological zoning is a methodology used for assessing the suitability of soil for agricultural production. The AEZ system is used in order to determine the specific limitations for crop cultivation in certain climate, soil, and terrain conditions.

A detailed description of the AEZ method used in this research can be found in FAO Guidelines on Agro-Ecological Zoning (FAO Soils Bulletin 73, Rome, 1996). The soil map of the Municipality of Bužim at 1:25 000 scale was used as the basis for the development of this research. The data on boundaries of agrozones was obtained from the Federal Agro-Pedological Institute, and the data on climate were obtained from the Federal Hydro-Meteorological Institute. Reconciliation of specific requirements of crops, defined by LUT, with the parameters of soil texture, reaction, contents of organic carbon, and soil depth renders the degrees of soil suitability for cultivation of certain crops. The interaction of these parameters results in the final form for land utilization planning.

Table 1. The levels of suitability of soil/ land per parameters
(Biancalani et al., 2004)

Suitability parameters	Classification	Limit values of parameters
Soil depth	S1	100.0-150.0 cm
	S2	70.0-100.0 cm
	S3	50.0-70.0 cm
	S4	30.0-50.0 cm
	N	<20.0 cm
Soil reaction	S1	6.5-7.0
	S2	5.5-6.5 7.0-7.2
	S3	5.0-5.5 7.2-7.5
	S4	7.5-7.9
	N	<5.0 >7.9
Soil texture	S1	I, PrI, PGI, PI, PrGI
	S2	PrG, GI
	S3	PG, PI
	S4	Pr, P
	N	G
Organic carbon	S1	20.0-50.0 g/kg
	S2	50.0-60.0 g/kg
	S3	10.0-20.0 g/kg
	S4	60.0-100.0 g/kg
	N	<10.0 g/kg >10.0 g/kg

Abbreviations: I – loam, PrI – silty loam, PGI – sandy clay loam,
PI – sandy loam, PrGI – silty clay loam, PrG – silty clay,
GI – clay loam, PG – sandy clay, Pr – silt, P – sand, G – clay.

Table 2. Soil/land suitability classes (Biancalani et al., 2004)

Classification	Suitability class	% suitability
S1	Highly suitable	> 80
S2	Suitable	60-80
S3	Moderately suitable	40-60
S4	Limitedly suitable	20-40
N	Unsuitable	< 20

The levels of suitability of specific soil parameters for successful cultivation (*Malus domestica*)

Table 3. The degree of suitability of specific parameters for *Malus domestica* (Source: Biancalani et al., 2004)

Parameters	S1	S2	S3	N
pH	6.5-7.0	5.5-6.5; 7.0-8.0	5.0-5.5	<5.0; >8.0
Depth in cm	>150.0	100.0-150.0	50.0-100.0	<50.0
Texture	I, IP, PrI, PrGI	GI, PI, PrG, PG, PGI	Pr, P	G
Total C	>30.0	20.0-30.0	20.0-10.0	<10.0

Soil types

There are two soil orders in the Municipality of Bužim: automorphic/terrestrial and hydromorphic soils. Situated out of reach of the flooding or underground waters and characterized by water percolation through solum, automorphic soils are the dominant ones (Ičanović M., 2016). Due to denser net, the quality of data presented and the comprehensiveness of the research probes and profiles, eight soil types were observed in the research area and the soil map was developed at 1:25 000 scale (Fig. 1).

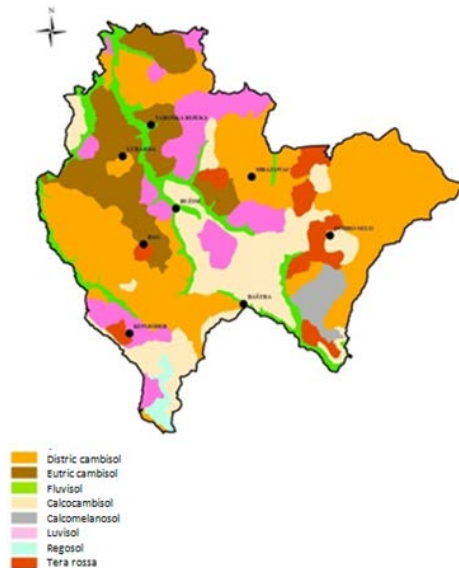


Fig. 1. Soil map of the Municipality of Bužim

Table 4. Soil types in the Municipality of Bužim

Soil Type	Area (ha)	Percentage (%)
Regosol	128.01	0.99
Kalkomelanosol	331.60	2.54
Calcocambisol	2,272.20	17.45
Eutric cambisol	1,867.45	14.33
Distric cambisol	5,266.51	40.42
Rossa	709.16	5.44
Luvisol	1,550.98	11.91
Fluvisol	900.31	6.92
Total	13,026.27	100.00

Results and Discussion

The climate of the research area

The climate characteristics for the Municipality of Bužim were described using the data of the nearest meteorological station in Bihać situated at 246 m altitude. The presented data were based on the observation periods of 1961-1990 and 1999-2009, respectively. According to Šarićet. al. (2010), the length of vegetation period for the area of the Una-Sana Canton is 264 days for cryophile plants (+5C°), and 204 days for termophile plants (+10C°).

Table 5. The mean monthly and annual air temperatures for the area of Bihać, in the periods 1961-1990 and 1999-2009 in °C

Period	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1961-1990	0.3	2.3	6.1	10.7	15.1	18.3	20.1	19.3	15.9	11.3	6.3	1.7	10.6
1999-2009	1.4	3.1	7.3	11.5	16.7	20.0	21.5	20.9	15.6	12.4	7.5	2.9	11.7

(Source: Federal Hydro-Meteorological Institute)

Observing the data of mean monthly temperatures reveals that the values of mean temperatures are higher in the observation period 1999-2009 in all months except September, where minor drop of 0.3C° in mean monthly air temperature was observed. As a result of rise in the sum of monthly temperatures, the mean annual temperature also rose. In the first period from 1961-1990, the mean annual air temperature was 10.6C°, while in the second

period from 1999-2009 the mean annual air temperature was 11.7 C°, which means that it increased by 1.1 C°. According to some estimates, warming in the moderate longitudes and latitudes of the northern hemisphere will increase, exceeding the global average, and ranging between 0.8 and 1.0 C°, for every 10 years (Komljenović et.al., 2014, Žurovec, et.al., 2015).

Table 6. Mean monthly and annual precipitation for the area of Bihać in the periods from 1961-1990 and from 1999-2009 in mm

Period	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1961-1990	86	91	99	115	116	109	106	109	108	110	146	114	1.309
1999-2009	103	96	106	120	112	83	87	97	139	116	132	149	1.342

(Source: Federal Hydro-Meteorological Institute)

More than one third of annual precipitation falls in the autumn. What is characteristic for the period of 1961-1990 is that in the summer period the atmospheric precipitation is higher than in winter. The comparison of the total annual precipitation for the period 1961-1990, which was 1309 mm, with the precipitation for the period of 1999-2009, which was 1 342 mm, shows that the precipitation increased by 33 mm (Table 5). Generally speaking, this increase can be seen as a good sign for agricultural production, however the rainfall distribution is not favourable, since the precipitation is lowest in the summer when water demands are the highest.

Summarizing the results of suitability with respect to texture classes, organic carbon, reaction, and soil depth in the Bužim area, a map of the total suitability of the land for apple cultivation in the territory of Bužim municipality was drawn up. In the whole area there are four classes of suitability of the land for growing apple, namely: S1, S2, S3, and N class of suitability, Fig. 2.

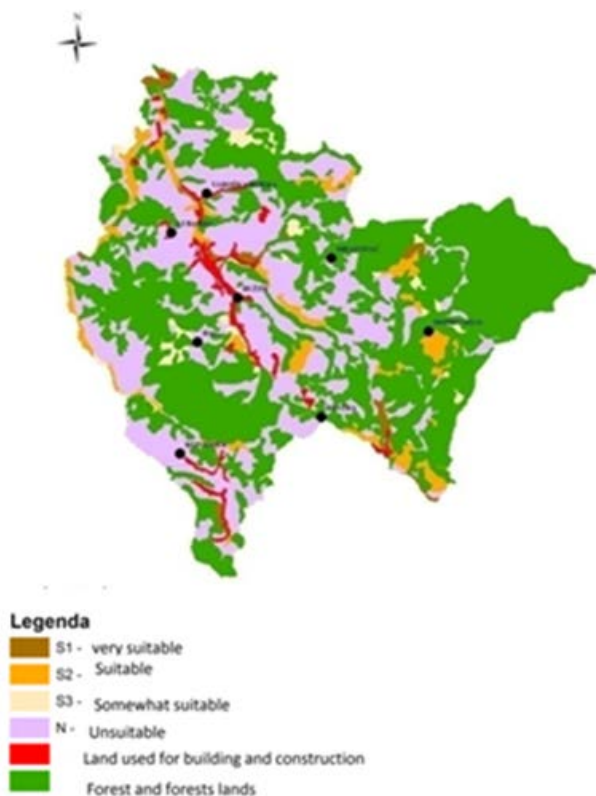


Fig. 2. Representation of the soil suitability for the purpose of apple (*Malus domestica*) cultivation within the Municipality of Bužim

S1 class

The S1 class occupies only 1.23% of the total area of the Municipality or 159.52 ha. Administratively, we find this convenience class at five localities in the Municipality. The first locality of this class is in the local community of Konjodor, to the left of the regional road towards Pajalići. The second S1 area of apple growing convenience in the Bužim municipality is in the local community of Čava, which is from the Čavnik elementary school to the last houses opposite the local sawmill. The third locality of this convenience class is in the local community of Radoč, more specifically the area around the Primary School, the local church. Also, the area of the Zaradostovo local community, from Cinska Dolina to Piskovac, has S1 class suitability for apple cultivation. This is a terrain with a gentle slope of 3-4o,

suitable for the application of heavy agricultural machinery, its infrastructure linked to regional road communication. The last locality of the S1 apple growing class in the Bužim area is located in Čaglica. This is also one of the better quality areas of the Municipality, a lot of flat terrain suitable for intensive agricultural production and for irrigation, near the regional road Bužim - Velika Kladuša.

S2 class

The S2 apple growing class in the municipality occupies predominantly the peripheral parts of the municipality and some small central part. These are also areas with lower altitudes, located in Jusufovići, from the bridge to the intersection for the town of Jušići, and this is an area marked on the pedological map with the fluvisol soil type. This class is also found in the eastern parts of the Municipality of Isaković, the local community of Bućevci, located from Duranovića Glavica and occupying Brezika, Isakovića Glavica and the area around the new mosque. These areas are predominantly close to the S1 class and are found mostly on flat and slightly undulating terrain. The total area occupied by the S2 apple growing class for the Bužim area is 5.51% or 717.24 ha.

S3 class

The S3 cultivation convenience class occupies only 2.29% of the total area. This class is encountered in multiple locations with smaller or larger complexes. One such complex is located in the towns of Urija and Velići, towards Kobiljak and Njivice. This area is to the left of the centre of the Municipality, quite populated and intertwined with road communication. It is important to emphasize that these are areas with a slightly higher slope of the terrain compared to the areas covered by the previous two classes. There is an S3 class of amenities in Mulalići and Pomajden, but with very small areas. This is the area on the east side from the Mulalići burial ground towards the old town and all the way to Mlinčići. The S3 class is also situated to the right of the Bužimnica River and goes through the very centre of Bužim, which is Radostovo from Aličić all the way to Merdžani. This area is very often used as a natural or artificial meadow and partly for grazing. It is important to note that access to one part of this area is difficult. The last area with the S3 suitability class for apple cultivation in Bužim is in the Bajraktarević field in Hakolići. This is a slightly undulating complex that is intensively cultivated and used in agricultural production.

N class

The largest part of the territory of the Municipality is designated N class (unfavourable), with as much as 36.38% of the total territory of the Municipality. The highest concentration of N class occupies mostly the central and southern part of the Municipality, and no eastern areas are excluded, as can be seen on the map of suitability. It is very important to note that the N class of unfavourable land occupies the largest areas of the municipality of Bužim with 36.68 and 4,772.60 ha. The reasons for the extremely high percentage of this class are certainly the depth of the soil, which is mostly not suitable for apple cultivation (N convenience class 30.82% of the total municipality area) and organic carbon content, which is also dominated by the percentage of N class unfavourable land, with 18.21% of the total area of the Municipality. Also, one part of the municipality is built land with an area of 1.77%, as well as forests and forest land with a total area of 52.53%. It is very important to emphasize here that there are no intensive apple orchards in the municipality, just individual trees mostly, which the locals have as part of gardens, and the fruits are used for their own needs mostly in the fresh state and mostly indigenous apple varieties.

Conclusion

Four classes of benefits are distinguished in relation to the overall suitability of the apple growing land. The S1 class occupies only 1.23% of the total area of the Municipality or 159.52 ha. It is represented in the following places: Konjodor, Pajalići, Pehlića Kosa, Čava, Radoč, Cinska Dolina, and Čaglica. The S2 class in the municipality occupies mostly marginal parts and covers a total area of 5.51% or 717.24 ha. The S3 class occupies only 2.29% of the total area. The N Class of unfavourable land occupies the largest areas of the pilot study area with 36.68% or 4,772.60 ha. The reason for the very high percentage of this class is certainly the depth of the soil, which is mostly not suitable for apple cultivation (N class 30.82% of the total area of the Municipality) and organic carbon content, which is also dominated by the percentage of N class unfavourable land, with 18.21% of the total area of the Municipality. It is very important to emphasize here that there are no intensive apple orchards in the municipality and they are mostly individual trees, which the locals have as part of gardens, and the fruits are used for their own needs mostly in the fresh state and mostly indigenous apple varieties.

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Погодност земљишта у границама општине Бужим за узгој јабука (*Malus domestica*)

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Сажетак

Посљедице неправилног управљања земљиштем су дугорочне, неповољне за пољопривредну производњу, а одражавају се губитком земљишта, смањеним приносима, ерозијом земљишта итд. Да би се утврдила оптимална улога или погодност земљишта за узгој јабука у општини Бужим, спроведено је истраживање према ФАО методи АЕЗ (ФАО, 1976), а на основу добијених резултата извршена је процјена погодности земљишта за узгој јабука. Утврђено је да је значајан дио земљишта од укупно 13.026,27 ha пољопривредног земљишта у општини Бужим погодан за производњу воћа означених од S1 до N класе погодности.

Дакле, подручја са најбоље оцијењеном класом S1 покривају само 1,23% или 159,52 ha, класа S2 заузима 5,51% (717,24 ha), класа S3 заузима 2,29% (298,24 ha). А највеће површине означене су као неповољне N-класе са 36,68% (4.772,60 ha). Очигледно је да постоје предуслови за производњу јабука у општини. Примјеном потребних мјера поправке земљишта, едукацијом пољопривредних произвођача и уважавајући ограничавајуће факторе који ометају интензивну производњу, као што су: нагиб терена, дубина, стјеновитост и одзив тла; може се постићи напредак у производњи.

Кључне ријечи: општина Бужим, погодност земљишта, јабука, АЕЗ.

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Received: 28.02.2020
Accepted: 18.02.2021