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Options for the sustainable development of livestock production systems in the Western Balkans

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Abstract

Livestock systems occupy about a third of the planet's ice-free terrestrial surface area and, in developing countries, serve as an important risk reduction strategy for vulnerable communities. The livestock sector is very sensitive to external disturbances and has just limited capacity to cope with emerging constraints.

Recently, Western Balkans were affected by armed conflict after the downfall of the former Yugoslavia. In response to these disturbances, new constraints and development gaps emerged, which the local farmers and breeders had to withstand. Those gaps have widened even further over the time and livestock farming adapted to those changes leading to the abandonment of traditional practices.

The main objectives of this thesis were (i) to analyse on a scale of biogeographical regions, taking into account single countries, how the livestock sector is reorganizing, (ii) which constraints are affecting the systems and which set of development options could contribute to their continuity and (iii) how the emerging cow-calf system in different countries diverge in terms of technical efficiency.

The livestock sector is now organised on the remains of the communism period and of the conflicts among newly emerging states in the '90s. Main perceived constraints are highly related to the economic issues. For the upcoming trends a decrease of participants to the systems, but simultaneously an increase of the number of animals per farm are present. In most cases, the current mean number of animals per farm is below the proposed sustainable level and most of the small and medium farms need to increase their size. The importance of rural development programmes together with the designation and implementation of alternative management practices on both regional and local basis are highlighted as the main development options. In terms of efficiency gaps among the analysed cow-calf farms, smaller and less specialised units operate with the highest estimated result.

Riassunto

I sistemi di allevamento occupano un terzo della superficie terrestre e, nei paesi in via di sviluppo, costituiscono un importante strumento per la riduzione del rischio per le comunità rurali. Questi sistemi sono molto sensibili all'azione di disturbo di fattori esterni ed hanno una scarsa capacità di adattamento.

Recentemente, i Balcani occidentali sono stati interessati da conflitti armati dopo la caduta della Jugoslavia. In risposta a questi fattori sono emerse nuove limitazioni e gap di sviluppo che agricoltori ed allevatori hanno dovuto fronteggiare. Tali divari si sono ancor più ampliati nel corso del tempo e le pratiche tradizionali di allevamento sono state abbandonate.

Gli obiettivi principali della tesi sono i seguenti: (i) analizzare, in relazione alle regioni biogeografiche e considerando i singoli paesi, come il settore zootecnico si stia riorganizzando, (ii) quali vincoli stanno influenzando i sistemi di allevamento e quali opzioni di sviluppo possono contribuire alla loro continuità e (iii) come si differenzia nei diversi paesi l'efficienza tecnica del sistema vacca-vitello.

Attualmente, il settore zootecnico è riorganizzato su ciò che rimane dell'assetto strutturale del periodo comunista dopo i conflitti degli anni '90. I principali vincoli risultano legati alle problematiche economiche dei sistemi. I trend individuati delineano una diminuzione degli allevamenti, ma allo stesso tempo un aumento del numero di animali per azienda. Nella maggior parte dei casi, il numero medio di animali per azienda si trova attualmente al di sotto del livello sostenibile e le aziende di piccole e medie dimensioni hanno la necessità di aumentare la loro dimensione. L'importanza dei programmi di sviluppo rurale, insieme alla definizione e all'attuazione di pratiche alternative di gestione, sia a livello di regione biogeografica che locale, sono identificate come le principali opzioni di sviluppo. L'analisi del sistema vacca-vitello evidenzia che le aziende che operano con più elevata efficienza sono quelle di dimensioni minori e meno specializzate.

Contents

List of tables

List of figures

Chapter I: Introduction

1 The study area: countries and biogeographical regions of the Western Balkans

Given the breakup of Yugoslavia and the ensuring war, there has been a massive change in the agricultural structure in the Western Balkan countries.

After the demise of socialism and sometimes violent conflicts among newly emerging states, the Western Balkan region is now in a phase of consolidation and overall economic growth that has for many years exceeded that of the EU's member states. Overall, economic development went hand-in-hand with rising agricultural productivity. However, this does not necessarily imply an increasing competitiveness vis-à-vis European export markets, as prices and producers are often supported by political measures. Most countries in the region are currently net importers of agri-food products, with a rising trade deficit. Among the key weaknesses of the countries' respective agricultural sectors are the predominantly small scale of farms, missing market integration, and a lack of appropriately enforced production and food safety standards (Volk, 2010). Among the former Yugoslav states, so far only Slovenia and recently Croatia have entered into the European Union. The international level of economic development as well as some other conditions across the former Yugoslav republics differed, but development gaps have now widened much further (Bojnec, 2005).

The study area are the former Yugoslav Republics, which are operating now as seven separate nations, excluding the case of Kosovo. Kosovo is due to recent independence declaration and splitting included in the data and trends of the Republic of Serbia.

The countries included in the Western Balkan context of this research are located on four biogeographical regions (Figure I-1, Table I-1).

The Alpine biogeographical region (EEA, 2002a) stretches over a surface of 780,000 km² of which 63,351 km² are located on the territory of Slovenia, Croatia, Bosnia and Herzegovina, Montenegro and Macedonia (from northwest to southeast). In Slovenia the region stretches over 35% of the total country surface and includes the municipalities of: Ankaran/Ancarano, Benedikt, Bled, Bohinj, Borovnica, Bovec, Braslovče, Brezovica, Cerknica, Cerkno, Črna na Koroškem, Dobrova - Polhov Gradec, Dobrovnik/Dobronak, Gornji Petrovci, Grad, Ig, Ilirska Bistrica, Jezersko, Juršinci, Kanal, Kidričevo, Kobilje, Komen, Komenda, Križevci, Krško, Ljutomer, Logatec, Loški, Potok, Luče, Lukovica, Markovci, Mengeš, Moravče, Pesnica, Preddvor, Ptuj, Razkrižje, Rečica ob Savinji, Renče-Vogrsko, Ribnica, Rogašovci, Semič, Šentjernej, Šentjur, Sevnica, Šmarje pri Jelšah, Šoštanj, Sveti Jurij ob Ščavnici, Sveti Tomaž, Trbovlje, Turnišče, Velike Lašče, Videm, Vodice, Vuzenica, Zagorje ob Savi, Žetale and Žužemberk. In Croatia, the Alpine region occupies 22% of the national surface (12,567 km²) and includes the surface of three counties: Karlovac, Lika-Senj and Primorsko-Goranska County. In Bosnia and Herzegovina, the area expands over approximately 51% of the national territory (26,198 km²). In Montenegro, the alpine region covers approximately 53% of the national surface (7,304 km²) and stretches over eleven municipalities: Andrijevica, Berane, Bijelo polje, Kolašin, Moljkovac, Plav, Pljevlja, Plužine, Rožaje, Šavnik and Žabljak. In Macedonia, Pelagonia, Polog and the South-west Macedonia region, including Chashka Municipality from the Vardar region, belong to the alpine biogeographical region. The Alpine region in Macedonia covers 45% or 11,195 km² of the national surface.

The Continental biogeographical region (EEA, 2002b) stretches over a surface of 2,700,000 km² of which 114,086 km² are located on the territory of Slovenia, Bosnia and Herzegovina, Serbia and Macedonia (from northwest to southeast). In Slovenia, the Municipalities of:

Ajdovščina, Apače, Bistrica ob Sotli, Bloke, Brda, Brežice, Cankova, Celje, Cerklje na Gorenjskem, Cerkvenjak, Cirkulane, Črnomelj, Destrnik, Divača, Dobje, Dobrepolje, Dobrna, Dol pri Ljubljani, Domžale, Dornava, Dravograd, Duplek, Gorenja vas-Poljane, Gorišnica, Gorje, Gornja Radgona, Gornji Grad, Hoče-Slivnica, Hodoš/Hodos, Hrpelje-Kozina, Idrija, Ivančna Gorica, Izola/Isola, Jesenice, Kamnik, Kobarid, Koper/Capodistria, Kostanjevica na Krki, Kostel, Kozje, Kranj, Kranjska Gora, Kungota, Kuzma, Lenart, Lendava/Lendva, Ljubljana, Ljubno, Log-Dragomer, Loška dolina, Lovrenc na Pohorju, Majšperk, Makole, Maribor, Medvode, Metlika, Mežica, Miklavž na Dravskem polju, Miren-Kostanjevica, Mirna, Mirna Peč, Mislinja, Mokronog-Trebelno, Moravske Toplice, Murska Sobota, Naklo, Nazarje, Nova Gorica, Novo mesto, Odranci, Oplotnica, Ormož, Osilnica, Piran/Pirano, Pivka, Podčetrtek, Podlehnik, Podvelka, Poljčane, Polzela, Postojna, Prebold, Prevalje, Puconci, Radeče, Radenci, Radlje ob Dravi, Radovljica, Ravne na Koroškem, Rogaška Slatina, Rogatec, Ruše, Šalovci, Selnica ob Dravi, Šempeter-Vrtojba, Šenčur, Šentilj, Šentrupert, Sežana, Škocjan, Škofja Loka, Škofljica, Slovenj Gradec, Slovenska Bistrica, Slovenske Konjice, Šmarješke Toplice, Šmartno ob Paki, Šmartno pri Litiji, Sodražica, Solčava, Središče ob Dravi, Starše, Štore, Straža, Sveta Ana, Sveta Trojica v Slov goricah, Sveti Andraž v Slov goricah, Sveti Jurij v Slov goricah, Tabor, Tišina, Tolmin, Trebnje, Trnovska vas, Tržič, Trzin, Velika Polana, Vipava, Vitanje, Vojnik, Vransko, Vrhnika, Žalec, Zavrč, Železniki, Žiri, Žirovnica and Zreče extend over the surface of 12,460 km² (61% of total surface) and represent the continental region of the country. In Croatia, 17,078 km² are covered by the continental region. The region extends over 30% of the national surface and includes the territories of eight counties: Bjelovar-Bilogora, Brod-Posavina, City of Zagreb, Koprivnica-Križevci, Krapina-Zagorje, Sisak-Moslavina, Varaždin and Zagreb County. In Bosnia and Herzegovina, 15,001 km² or 29% of the total countries surface is covered by the region. The largest extent of the continental region is in Serbia, where 55,887 km² are covered by this region, which amounts to half of the total region in the analysed study area. The furthest to the south of the study area, in Macedonia, the continental biogeographical region occupies 13,660 km². The region extends over the Eastern, North-eastern, South-eastern, Skopje and Vardar region, with the exclusion of Chashka municipality. The continental region is the largest region in the study area.

The Mediterranean region in the study area stretches alongside the Adriatic coast and the western border of the Dinaric Alps. In the global context the region covers a total surface of 1,200,000 km² (EEA, 2002c), from which 32,188 km² are located in Croatia, Bosnia and Herzegovina and Montenegro. The largest part is located in Croatia, where almost half of this biogeographical region is located (28% of the national surface). The region in Croatia incorporates five counties (Dubrovnik-Neretva, Istria, Šibenik-Knin, Split-Dalmatia and Zadar). In Bosnia and Herzegovina approximately 10,000 km² of surface lies in the Mediterranean basin, while in Montenegro 6,425 km² over the municipalities: Bar, Budva, Cetinje, Danilovgrad, Herceg Novi, Kotor, Nikšić, Podgorica, Tivat and Ulcinj.

The Pannonian biogeographical region extends over 133,000 km² (EEA, 2002d) of which approximately 9% lie in Serbia (21,587 km²), 6% in Croatia (11,185 km²) and 1% in Slovenia (1,725 km²). In Slovenia the region includes the surface of the municipalities: Beltinci, Črenšovci, Dolenjske Toplice, Grosuplje, Hajdina, Horjul, Hrastnik, Kočevje, Laško, Litija, Mozirje, Muta, Rače-Fram, Ribnica na Pohorju, Velenje and Veržej. In Croatia the region stretches across five counties including Međimurje, Osijek-Baranja, Požega-Slavonia, Virovitica-Podravina and Vukovar-Srijem County. In Serbia, the region is represented by the administrative unit of Vojvodina, reaching from the river Danube in the south to the Hungarian border in the north and Romania in the east.

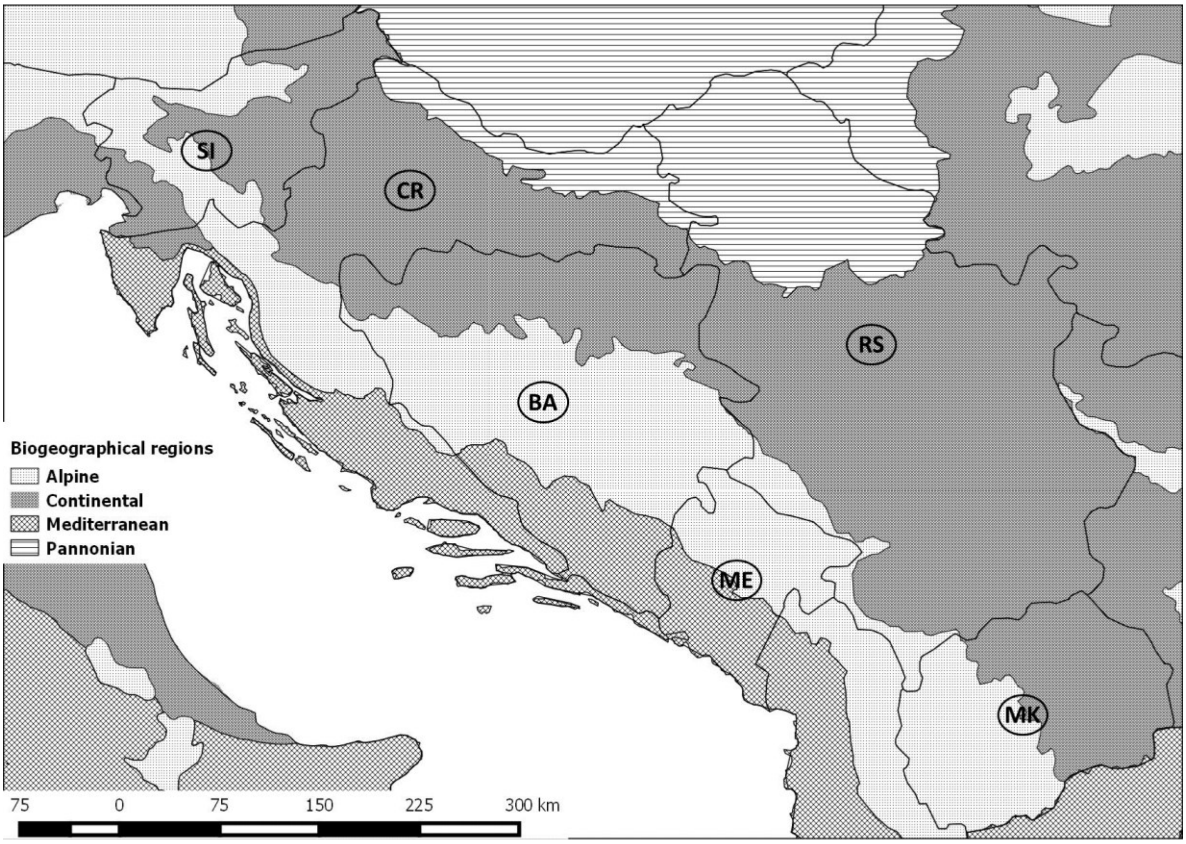

Figure I-1. Map of the Western Balkan countries in the study area with biogeographical region overlay.

Two-letter ISO code (ISO 3166 alpha-2): BA-Bosnia and Herzegovina, CR-Croatia, ME-Montenegro, MK-Macedonia, RS-Serbia, SI-Slovenia

The average population density of 85 people per km² (Table I-1) is much lower than that of the EU (114.4) (Kazakova and Stefanova, 2010). Comparatively low population densities are observed in the alpine region in Montenegro (24), Slovenia (64) and Croatia (38). These regions are subject to substantial ageing and depopulation processes. In general, settlements are small and numerous; there are few large unpopulated areas. A common trend in all countries of the region is migration from rural areas to urban and coastal zones as well as abroad (García-Martínez et al., 2008; Kazakova and Stefanova, 2010).

While in Bosnia and Herzegovina and Macedonia most of the surface in the Alpine biogeographical region in unsuited for agriculture production, in Croatia and Slovenia it is mostly occupied by arable land while in Montenegro by grassland. In the Continental biogeographical region, agriculture area takes up over half of the available surface. Much of the agriculture area in Bosnia and Herzegovina and Serbia is not utilised or abandoned, a minor part is used as arable land and even less as grassland. In Croatia and Slovenia, arable land covers most of the surface belonging to the Continental region. In Macedonia, less than half of the surface is agricultural area, of which half is utilised as arable land. In Bosnia and Herzegovina, most of the Mediterranean biogeographical region is unutilised land with karst features, around 15% are grassland and 5% arable land. In Croatia, arable land and grassland take up to 10% approximately each and unutilised land just 5%, the remaining area is classified as other land and not suited for agriculture production.

Table I-1. Indicators of the Western Balkan countries across BR as percentage of the corresponding BR (totals in km², persons/km², n; percentages in italic).

BR[1]	Country (ISO)[2]	Social			Land use[3]						Livestock		
		Population	Population density (pers./km²)	Surface	TAA	UAA	AA	GA	ABA	OA	Cattle	Sheep	Goats
Alpine	BA	*51.8*	74.2	*41.8*	*20.7*	*20.7*	*8.7*	*38.4*	*20.7*	*63.4*	*46.5*	*51.6*	*48.8*
	CR	*12.7*	37.9	*20.1*	*29.8*	*29.8*	*50.1*	*0.0*	*29.8*	*10.1*	*5.2*	*7.6*	*3.6*
	MK	*20.5*	73.6	*16.7*	*24.8*	*24.8*	*10.4*	*46.0*	*24.8*	*8.4*	*14.2*	*22.4*	*13.3*
	ME	*4.7*	24.3	*11.7*	*10.2*	*10.2*	*12.6*	*6.7*	*10.2*	*13.1*	*7.9*	*10.8*	*9.1*
	SI	*10.3*	63.8	*9.7*	*14.4*	*14.4*	*18.2*	*8.9*	*14.4*	*4.9*	*26.2*	*7.6*	*25.2*
	Total	3,757*	60.0	62,624	31,627	23,720	14,121	9,599	7,907	30,997	688*	1,454*	119*
Continental	BA	*9.5*	74.2	*13.1*	*13.8*	*8.2*	*7.9*	*9.3*	*25.3*	*11.3*	*7.6*	*1.7*	*0.6*
	CR	*16.9*	116.1	*14.9*	*15.7*	*17.5*	*22.4*	*0.0*	*12.0*	*12.9*	*16.7*	*7.1*	*8.9*
	MK	*11.0*	89.9	*12.5*	*7.8*	*8.7*	*8.2*	*10.5*	*6.0*	*24.2*	*7.9*	*21.5*	*32.5*
	SI	*13.0*	122.7	*10.9*	*11.4*	*8.5*	*6.5*	*15.4*	*17.5*	*9.4*	*18.5*	*0.6*	*1.9*
	RS	*49.5*	103.9	*48.7*	*51.3*	*57.2*	*55.0*	*64.8*	*39.3*	*42.2*	*49.2*	*69.1*	*56.1*
	Total	11,727*	102.1	114,813	81,693	54,996	42,876	12,120	26,697	33,120	1,456*	1,775*	160*
Med	BA	*33.0*	74.2	*31.1*	*46.1*	*22.2*	*16.4*	*25.1*	*72.0*	*15.7*	*22.3*	*22.7*	*9.4*
	CR	*47.3*	67.5	*49.0*	*24.2*	*35.0*	*51.9*	*26.4*	*12.6*	*74.2*	*46.0*	*57.6*	*52.8*
	ME	*19.7*	68.8	*20.0*	*29.6*	*42.8*	*31.7*	*48.5*	*15.4*	*10.1*	*31.7*	*19.7*	*37.8*
	Total	2,249*	69.9	32,188	16,259	8,445	2,850	5,594	7,814	15,929	67*	352*	64*
Pannonian	CR	*26.1*	68.1	*32.4*	*30.9*	*30.9*	*26.5*	*60.4*	*30.9*	*38.2*	*37.5*	*28.0*	*15.3*
	RS	*68.9*	93.3	*62.6*	*64.4*	*64.4*	*69.4*	*30.2*	*64.4*	*56.0*	*62.5*	*72.0*	*84.7*
	SI	*5.0*	84.6	*5.0*	*4.8*	*4.8*	*4.1*	*9.3*	*4.8*	*5.9*	*0.0*	*0.0*	*0.0*
	Total	2,921*	84.7	34,497	27,168	20,376	17,774	2,602	6,792	7,329	352*	324*	47*
Aggregate total		20,655*	84.6	244,122	156,747	107,537	77,620	29,916	49,210	87,375	2,563*	3,905*	391*

1: BR - Biogeographical region; Med - Mediterranean.
2: Two-letter ISO code (ISO 3166 alpha-2): BA-Bosnia and Herzegovina, CR-Croatia, ME-Montenegro, MK-Macedonia, RS-Serbia, SI-Slovenia.
3: TAA-Total agriculture area, UAA-Utilised agriculture area, AA-Arable area, GA-Grazed area, ABA-Abandoned area, OA-Other area.
*: value in 000

In Montenegro, most of the Mediterranean region is utilised as grasslands, where animals graze and browse not just grasses and legumes but also on the shrubs and woods. Over 40% of the surface in all three countries (Croatia, Serbia and Slovenia), in the Pannonian region, is utilised as arable land, with just 5% do 15% used as grassland and up to 20% unutilised or fallow land. The distribution of livestock, through the study area, is shown in Table I-1. In the alpine region of Slovenia, the Continental region of Bosnia and Herzegovina, Croatia and Slovenia and in the Pannonian plain of Croatia cattle are the dominant livestock species. In all other regions, sheep are dominant in terms of number of animals. Notable, goats are present in all countries through the regions, but their portion in the total number of livestock is biggest in the Mediterranean region of Croatia and Montenegro and Continental region of Macedonia.

2 Trends and drivers of change of livestock production systems

Given the complexity of human/nature systems and the scale dependency of land-use change drivers, the need for approaches which integrate socio-economic and geo-bio-physical drivers is now widely recognised (Lambin et al., 2001; Liu, 2001; Taillefumier and Piégay, 2003). There is a considerable literature from a development perspective on how farming systems may change in response to key drivers (Thornton et al., 2009). For example, a general model of crop-livestock interactions and intensification first developed by Boserup (1965) and expanded by McIntire et al. (1992) describes system change as endogenous process in response to increased population pressure. Examples of direct and indirect legislation influences on animal numbers are provided by Milne (2005). Land use change, depopulation, abandonment and modernisation affecting livestock systems are analysed and explained by many authors, for example MacDonald et al. (2000). While the trends related to the number of cattle in the region had a similar trajectory with varying intensity by country (Figure I-2), for sheep the trajectories of the population in Slovenia and Macedonia differ from those of the remaining countries (Figure I-3).

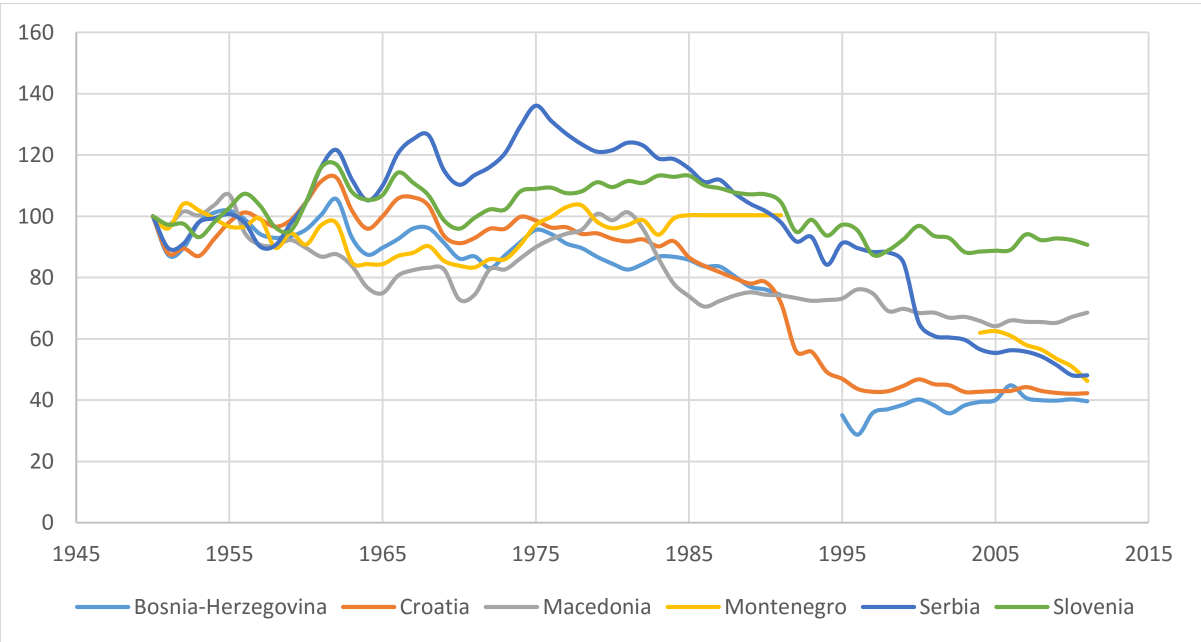

Figure I-2. The evolution of cattle number in the Western Balkans.

By analysing the official statistical records for the agriculture sector of former Yugoslavia for its republics independently, a common trend emerges. In the case of cattle, counting back to

1950, a significant decrease of 41% occurred in the region (Sedic et al., 2014). The intensity of the dynamics was not always the same and did not affect the member states equally. By analysing a set of factors directly related to the changes in the livestock sector, different results are obtained for the six member states. The decrease of rural population is the first factor to emerge in five of the six countries, followed by social disturbances, independence declaration and the total population dynamics (Sedic et al., 2014). The smallest decrease occurred in the two remote countries, Slovenia and Macedonia (decreases of 8% and 31% respectively), while in the countries more engaged in the context related dynamics decreases went from 39% (Serbia), over 41% and 52% (Montenegro and Croatia) to 55% (Bosnia and Herzegovina) (Sedic et al., 2014).

It is yet unclear which group of factors resulted in the downward and upward trends of the number of sheep, but clearly, the two countries fewer involved in the context related external disturbances share a diverse outcome, estimated to be the result of internal factors.

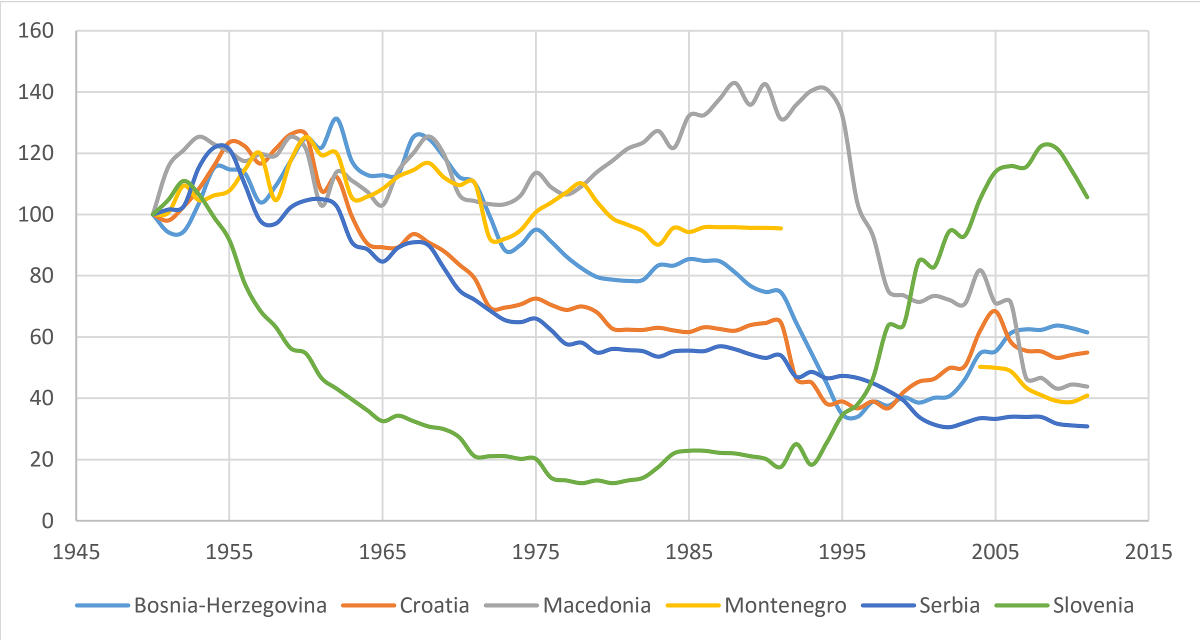

Figure I-3. The evolution of sheep number in the Western Balkans.

New products and new ideas can cause initial changes of the rural society and the transformation of traditional land use in sheep farming systems (Lasanta-Martínez et al., 2005).

In the Spanish Pyrenees after the 1950's and 1960's, the incorporation of highlands in the national market increased the exchange of products and promoted the specialised production in valleys leading to a sharp population decline, shrinkage of the farming area and a drop in livestock numbers (Lasanta-Martínez et al., 2005). Contributed to this decline could have the crisis of the migratory system, which started at the end of the 19th century due to decline in the wool trade. Additionally contributed could have, the promotion of cultivation of bare fields and expansion of irrigated farming in plain areas, in contrast to animal husbandry. Excessive fragmentation of private property and the low productivity are additional causes of emigration and abandonment (Anselmi, 2001).

3 Classification of livestock systems

A large literature exists on classification and description of farming systems both globally and regionally (see, for example, Grigg, 1974; Ruthenberg, 1980; Jahnke, 1982, Seré and Steinfeld 1996). Researchers attempting to make sense of the enormous complexity and variation in farming systems at the global level always have to grapple with the balance between the constraints imposed by lack of suitable data at the broad scale on the one hand, and on the other, the enormous richness of detail that exists at the local level (Kruska et al., 2003).

Livestock production systems are considered a subset of the farming systems. A review of the literature (Ruthenberg, 1980; Jahnke, 1982; Humphrey, 1980; De Boer, 1992; Wilson, 1994) revealed that most farming systems classifications are not backed by quantitative criteria, which would enable cases to be clearly allocated to one class. These classifications are closer to typologies. Up until the work of Seré and Steinfeld (1996), no attempt at developing a classification of world livestock systems by using quantitative statistical methodologies (cluster analysis and related methodologies) could be located in the literature. This probably related to the lack of appropriate data sets for such approaches at a global scale (Seré and Steinfeld, 1996).

A brief list of livestock classification types, by author, is provided by Robinson et al. (2011), which expanded the sources mentioned above by, for example, Fisher et al. (2002) and Dixon et al. (2001) whose scheme was used, together with the approach of Caballero et al. (2009) for the classification framework in this study.

4 Research questions and structure of the thesis

The work aims to justify how the livestock sector is reorganizing on a regional scale and what consequences and responses this process generates. It addresses questions such as the following:

- What shape take the local livestock systems at the regional scale and what remains from traditional forms of production and husbandry practises?
- How independent are Livestock production systems in the local livestock sectors?
- To which set of constraints are the local systems exposed? In which direction is the development expected to progress?
- How wide are the development gaps, seen through the difference of achieved technical efficiency?

This thesis contains six chapters. The introduction is followed by three main chapters, Chapters II, III and IV, which were written as stand-alone manuscripts to be published in international peer-reviewed journals. Each of these main chapters is therefore structured into the subsections introduction, materials and methods, results and discussion, thereby resulting in a limited amount of recurring material throughout the thesis. These three chapters were prepared as follows:

Chapter II: The structure of livestock production systems in the Western Balkans.

Chapter III: Experts perception on the development options for livestock production systems in the Western Balkans.

Chapter IV: Efficiency of the beef system in the Adriatic-Ionian macro region.

Following the three main chapters, the dissertation concludes with a synthesis and outlook chapter.

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Chapter II: The structure of livestock production systems in the Western Balkans

1 Introduction

Livestock systems, especially in developing countries, are changing rapidly in response to a variety of drivers (Herrero et al., 2009). Across Europe and Central Asia, the farming sector is affected by a growing polarisation between intensive commercial agriculture and low-income, less productive farming systems that are increasingly being abandoned. However, agriculture still includes very diverse systems, ranging from large, highly intensive and specialised commercial holdings to subsistence farms mainly using traditional practices (EEA, 2007).

Ruminant farming systems are widely diverse due to their ties to physical conditions, which vary widely according to climate, soil type, altitude and landscape (Gibon et al., 1999). Furthermore, diversity derives from history and local socio-economics as well as the production and trading chains that have been developed locally (Hadjigergiou et al., 2005).

A heterogeneous array of livestock production systems satisfies the demand for animal products globally (Herrero et al., 2009). Some of these systems are more important than others through various regions, but several trends emerge and four simple categories of systems can be recognized: pastoral/agro-pastoral, mixed extensive systems, mixed intensive systems, and specialized/industrialized systems (Herrero et al., 2009).

Farming systems and areas that have lower productivity or are a long way from the main markets have become economically marginalised or have already been abandoned (EEA, 2007). Such trends can be observed particularly in the rural areas of Eastern Europe, Caucasus and Central Asia (EECCA) and South-east Europe (SEE) where political changes in the early 1990's led to a period of economic and market instability (EEA, 2007).

A large literature exists on classification and description of farming systems both globally and regionally (Grigg, 1974; Herrero et al., 2009; Jahnke, 1982; Ruthenberg, 1980; Seré and Steinfeld, 1996). Researchers attempting to make sense of the enormous complexity and variation in farming systems at the global level always have to grapple with the balance between the constraints imposed by lack of suitable data at the broad scale on the one hand, and on the other, the enormous richness of detail that exists at the local level (Kruska et al., 2003).

Livestock production systems are considered a subset of the farming systems. A review of the literature (De Boer, 1992; Humphrey, 1980; Jahnke, 1982; Ruthenberg, 1980; Wilson, 1994) revealed that most farming systems classifications are not backed by quantitative criteria, which would enable cases to be clearly allocated to one class. These classifications are closer to typologies. No attempt at developing a classification of world livestock systems by using quantitative statistical methodologies (cluster analysis and related methodologies) could be located in the literature. This probably relates to the lack of appropriate data sets for such approaches at a global scale (Seré and Steinfeld, 1996).

The objective of this study is to describe and analyse Livestock Production Systems (LPS) in the Western Balkan countries. In the context of this research, the term Wester Balkans encircles the territory once known as Yugoslavia, nowadays known as six independent nations. In order to put interactions between livestock and the environment in a system, on a regional and global perspective, livestock production systems must be defined, described and placed in a geographic context. This is done by providing quantitative estimates of the importance of each system globally and by region in terms of their resource base, human population affected, livestock numbers and outputs. Elements of the classification, used in this study, include criteria variables in the following order: environment (biogeographical region), socio-economic (country), nature based (livestock species) and general management (Production purpose, breeding type, breed structure, farm size and others) criteria. The criteria variables divide the case studies to systems in following order: species, biogeographical region, country, production purpose and breeding type.

More specifically, for the study area relevant livestock systems, this study aims at:

- Delineating and defining elements of a classification of livestock production systems.
- Determine the spatial distribution and scale of the identified systems and quantitatively and qualitatively analyse each livestock production system in terms of feed and livestock resources; livestock commodities produced; production technology; product use and livestock functions; and human populations supported.
- Provide insights into the importance of livestock systems across bio-geographical regions and related trends in order to provide orientation to decision makers involved in livestock development.

This work thus exposes the results of the research to a wider public to be used in priority setting and as a basis for a general foundation on livestock development. Up to date, no such attempt in the chosen area was made. The study covers livestock production systems involving cattle, sheep and goats, while horses and buffalos are mentioned in cases in which they are accessible (example: mixed livestock systems).

2 Materials and methods

2.1 The study area

The systems identified by the experts were analysed according their location in the main biogeographical regions present in the study area (Figure 1): Alpine (EEA 2002a), Continental (EEA 2002b), Mediterranean (EEA 2002c) and Pannonian (EEA 2002d).

The Alpine region is represented on the Julian Alps in northwest Slovenia (SI) (Karawanken Mountains and Kochevje Rog Plateau), extending through the Dinaric Alps from west Croatia (CR) (Gorski Kotar Mountain district and Velebit Mountain). It extends through northwest (Grmech Mountain and Dinaric Alps), central (Borna Mountain and Chemernica Mountain) and southeast Bosnia and Herzegovina (BA) (Bjelashnica, Maglich and Zelengora Mountains). From the north and Northeast of Montenegro (ME) (Golija, Durmitor, Sinjajevina, Moracha and Zhijovo Mountains) passes along the border of Albania and Kosovo (Mokra gora Plateau) and covers the Western half of Macedonia (MK) (Shar, Korab, Slogova, Jablanica, Jacupica, Baba and Kozjak Mountains). The Continental region continues from the eastern border of the Alpine region towards the Pannonian region in SI and CR (Posavina), the northern part of BA (Posavina) alongside the border with CR, and Central and southern part of Serbia (RS) passing through the second half of Macedonia (from Skopje City towards the east). The Mediterranean region stretches from the SI coastline border with Italy, over CRs peninsula Istria, alongside its islands and over the Dalmatian coast. The region takes up to 20% of the surface of southwest BA bordering with CR and continues through the western half of ME. The Pannonian biogeographical region is mainly represented by northern RS, separated from the continental region by the rivers Sava and Danube. Minor parts of the region stretch alongside the SI and CR border with Hungary. In SI, the region makes up 6.56% of the total country surface (Table

II-1). In CR, the region covers, from the north to the east, the plains of Međimurje, Vukovar-Srijem, Virovitica-Podravina, Požega-Slavonia and Osijek-Baranja County.

The study area has a common set of features that were passed on from the former political setup it had during the pre-war period in the Balkans. Most of the farms are small and medium sized properties in private ownership, state owned farms opposed to the private were much larger. The alpine region was used as grazing ground for migrating herds/flocks of animals, both horizontally and vertically (Marković, 2003). The Continental region is used for intensive cropping and mixed agricultural production, grazing is a minor activity in the area. The Mediterranean region is used for permanent crop production and extensive grazing. In the Pannonian region, high fertility of the soil and geographical features are utilised for intensive cropping, specialised livestock production and the production of industrial and cash crops.

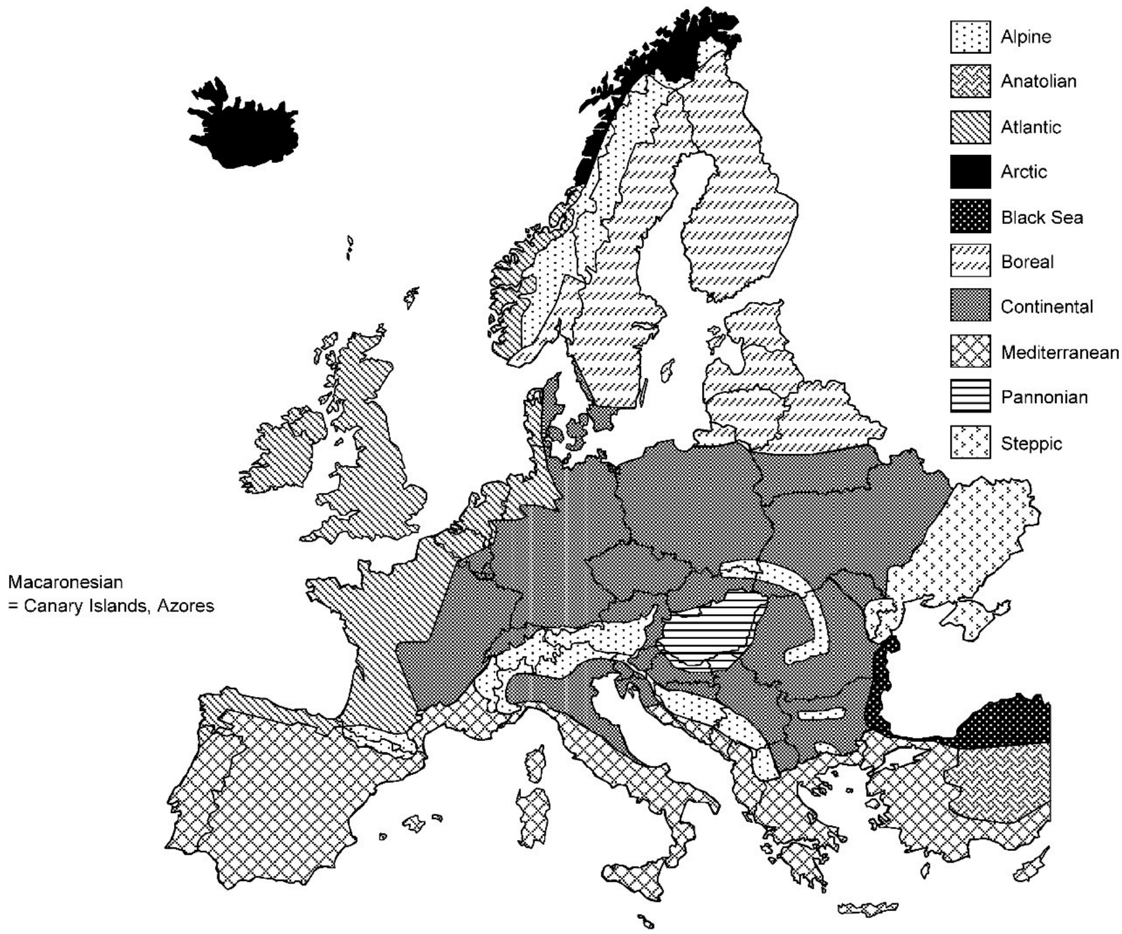

Figure II-1. The biogeographic regions of Europe (adopted from EEA, 1998).

The study area covers a surface of 255,950 km² (Table II-1). Over 50% of the area is Continental, a quarter Alpine and just a fifth of the total surface is either Mediterranean or Pannonian.

Table II-1. Surface of biogeographical regions in the Western Balkans.

Biogeographical region	Percentage of country surface						Total (km^2)
	BA	CR	MK	ME	RS	SI	
Alpine	51.17	22.21	42.10	52.88	-	35.02	64,820
Continental	29.30	30.18	57.90	-	86.45	58.42	131,690
Mediterranean	19.53	27.85	-	47.12	-	-	38,160
Pannonian	-	19.76	-	-	13.55	6.56	21,280
Total surface (km2)	51,197	56,594	25,713	13,812	88,361	20,273	255,950

Two-letter ISO code (ISO 3166 alpha-2); BA: Bosnia and Herzegovina; CR: Croatia; MK: Macedonia; ME: Montenegro; RS: Serbia; SI: Slovenia.

2.2 The sampling tool

A collaborative effort was requested to a group of national experts to their respective livestock production system, and with previous research performed in case studies across the study area, an answer to the relationship between the livestock production systems and, in the introduction mentioned questions, requested. Fourteen institutions were contacted. Around 30 Regional experts on LPS were selected and contacted by e-mail. Together with the questionnaire, a cover letter was sent explaining the objectives of the research initiative and rationale for the research job. A few experts declined the voluntary request for assistance and a few others recommended an alternative national with expertise in particular systems. Attempts to collect the needed information by e-mailing the regional experts failed, and the response rate led to the necessity of applying personal visits. Two visits were performed to collect the necessary information.

The information requested for analysing livestock production systems in the study area was obtained by a questionnaire structured in six sections. The first section (experts' identification, biophysical conditions and organisation of agriculture land) was aimed at obtaining an overview of the analysed study area according to its environmental features. The second section (species, breeding method, farm size, number of farms, number of animals, breed structure, breeding purpose, specific products and animal and land ownership) provided information about the scale and relevance of the system regarding the addressed livestock species. The third section (feeding resources and yield, annual feeding regime, annual grazing cycle, grazing method, stocking density, herding, grassland management, mobility, ownership of grazing animals and facilities) provided information about the resource base for feeding and management details during the grazing period. The fourth section (housing, technology and labour) was aimed at obtaining information about the level of innovations and technological advance applied in the system. The fifth section (consulting and co-operative aspect) provided information about the dependency of participants inside the system towards other stakeholders. The sixth section (management comparison and large-scale aspect) was aimed at obtaining information about competitiveness and environmental effects related management.

The sections contained from six to 25 questions being either qualitative-linguistic with multiple-choice answers, or quantitative requesting a single answer. Section one contained, two qualitative-linguistic and eight quantitative variables; section two, seven qualitative-linguistic and five quantitative variables; section four, seven qualitative-linguistic and three quantitative variables; section five, five qualitative-linguistic and one quantitative variable; section six, 24 qualitative-linguistic and one quantitative variable.

2.3 Classification criteria

After consulting the available statistical records and literature, Livestock Production Systems were analysed according to Caballero et al. (2009). The main discriminatory values used as classification criteria between systems were species, biogeographical region, production purpose, breeding type and mobility of the animals. Results are structured in three elements, a descriptive map, corresponding tables and explanatory text for each species. On a map, which shows the overlays of country borders and biogeographical regions according to the European Environmental agency (EEA, 2005), systems were located as hot spots of farms with broadly similar enterprise patterns, which discriminate the described system from other systems of the same livestock species.

3 Results

According to the expertise of the surveyed persons, land use varies by country and by region (Figure II-2). The alpine region is in both BA and SI mostly forested, and the available area, used for agriculture, serves as grassland surface mainly for pastoral activities. In CR and ME, the alpine region bears karst features and pastures dominate in comparison to forested area.

The Alpine biogeographical region of BA occupies over 51 percent of the total country surface (Table II-1), of which 70 percent are covered by forests. From the remaining 30 percent up to 25 is agriculture land, mainly utilised as grasslands. The Alpine biogeographical region in CR extends over a fifth (Table II-1) of the total national land surface and includes the surface of Karlovac County, Lichko-senjska County and Primorsko-goranska County. The area has a high value for natural conservation because over 50% of the total surface of national parks of Croatia is located in this region. Besides the three national parks "Plitvička jezera" (Plitvice lake), "Paklenica" and "Sjeverni Velebit" (North Velebit Mountain) this area also hosts the natural park and biosphere reserve "Velebit". In ME, just as in BA, over half of the national surface is mountainous. Three national parks are located inside the region (Durmitor, Biogradska gora and Prokletije). The alpine region of MK covers slightly less than a half of the national territory (Table II-1). Due to the small extent it covers on the surface of Serbia, the alpine biogeographical region in the analysis is included as part of the continental biogeographical region.

The continental biogeographical region takes up most of the study area by covering half of it (Table II-1). This region is also the dominant region for CR, MK, RS and SI. In all countries of the study area except MK and ME, agriculture area takes up over half of the available surface (Figure II-2). Much of the agriculture area in BA and RS is not utilised or abandoned, a minor part is used as arable land and even less as grassland. In CR and SI, arable land covers most of the surface belonging to the continental region. In MK, less than half of the surface in the continental region is agricultural area, of which half is utilised as arable land, and the remaining surface equally divided between unutilised land and grassland. The continental region spreads through five of the six analysed countries.

The mediterranean region covers approximately 15% of the total surface of the study area. It is present in three of the six analysed countries and is differently utilised. In BA, most of the mediterranean biogeographical region is unutilised land with karst features, around 15% are grassland and 5% arable land. In CR, arable land and grassland take up to 10% approximately each and unutilised land just 5%, the remaining area is classified as other land and not suited for agriculture production. In ME, most of the mediterranean region is utilised as grasslands, where animals graze and browse not just grasses and legumes but also on the shrubs and woods.

The pannonian region extends on less than 10% of the total surface of the study area. It is represented in three of the six countries and its importance in terms of surface occupied varies strongly (Table II-1). Over 40% of the surface in all three countries (CR, RS and SI) is utilised as arable land, with just 5% to 15% used as grassland and up to 20% unutilised or fallow land (Figure II-2).

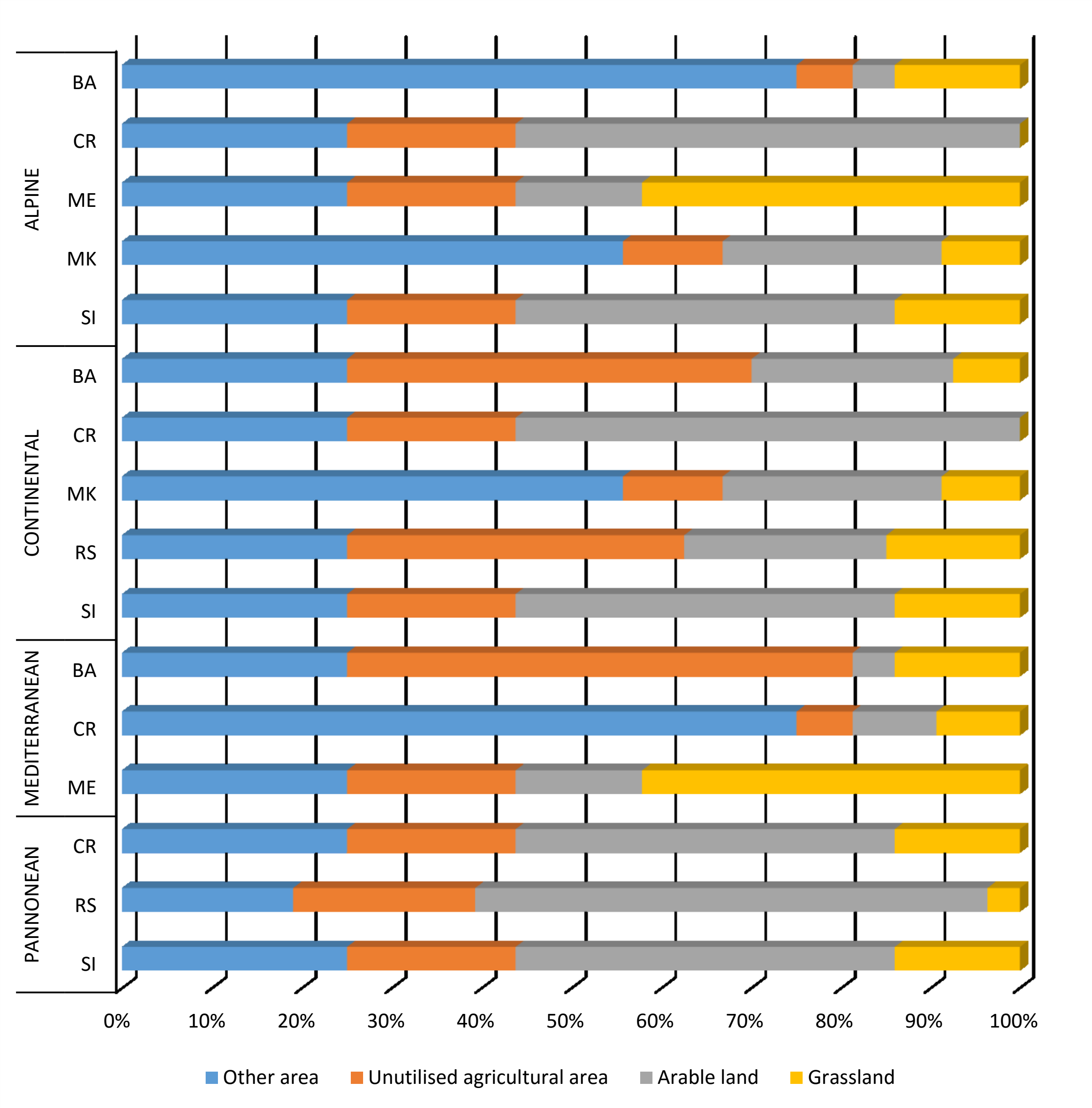

Figure II-2. Land use in the Western Balkans.

The distribution of livestock in numbers, through the region, is shown in Figure II-3. In the Alpine region of SI, the Continental region of BA, CR and SI and in the Pannonian plain of CR cattle are the dominant livestock species. In all other regions, sheep are dominant in terms of number of animals. Notable, goats are present in all countries through the regions, but their portion in the total number of livestock is biggest in the Mediterranean region of CR and ME and Continental MK (Figure II-3).

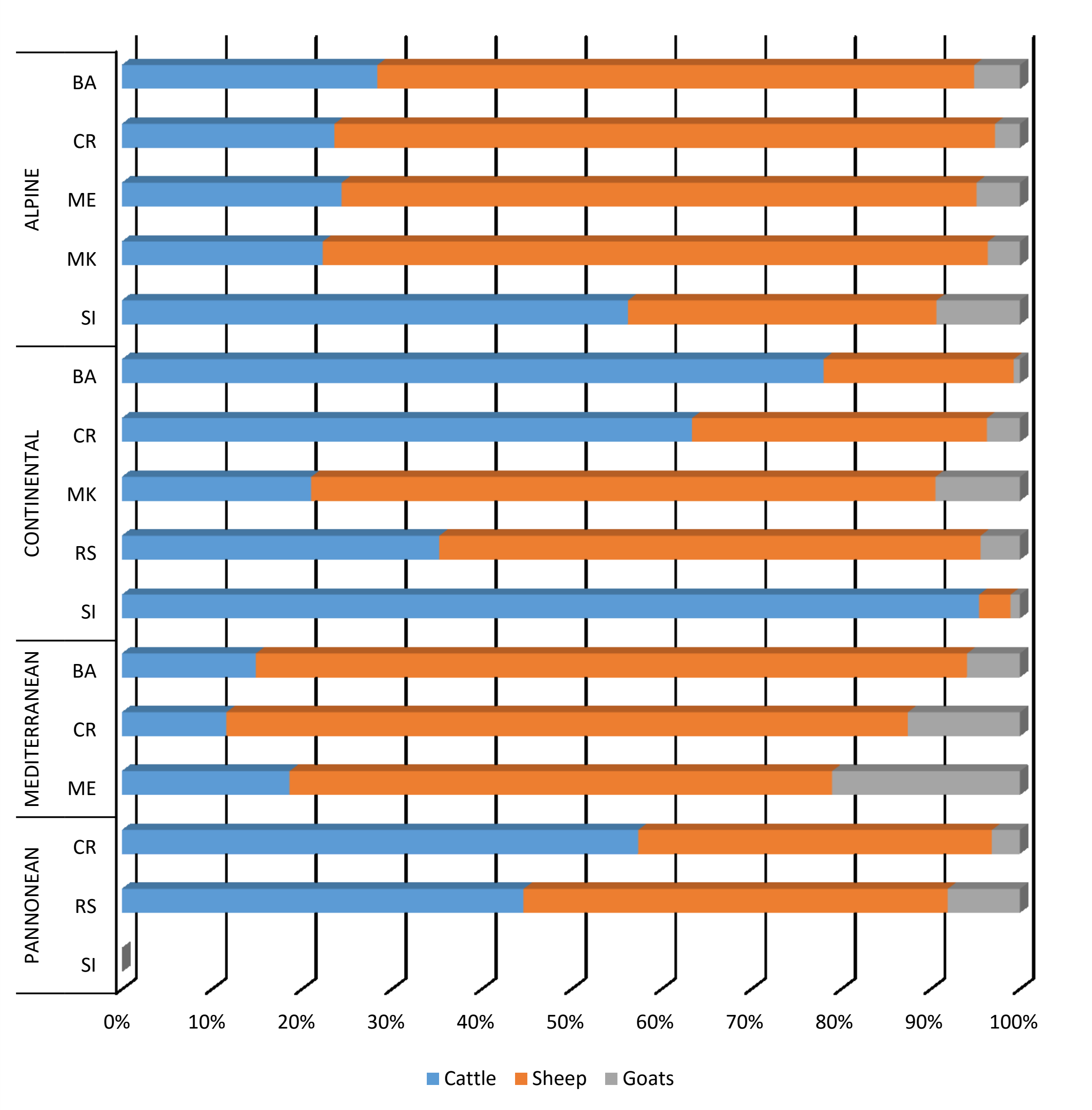

Figure II-3. Distribution of livestock by biogeographical region.

3.1 Cattle systems in the Western Balkan countries

Cattle system in the study area can be distinguished by the main production purpose as either meat or milk production systems. The dairy system depends on the productive performance of dairy and combined cattle breeds to produce milk, which serves as main income factor of the husbandry activity. The meat production system in the study area has two types of producers, depending on the nature of the production cycle and presence of reproductive animals. The cow-calf system is a grassland based beef production system. The cow-calf system produces, besides fattened animals, weaned calves to be fattened on feedlots or directly sold to slaughterhouses. Beef farms operate as intermediary between slaughterhouses or meat industries and dairy or cow-calf farms. In this work, we might come to an enumeration of native breeds.

3.1.1 The Alpine biogeographical region

From the Julian Alps, over the Dinaric Alps until the lakes Ohrid and Prespa towards Albania and the Kaimaki mountain range towards Greece, dairy cattle farms are present as specialised, mixed livestock and mixed cropping farms (Figure II-4). Acclimatised animals of the Simmental breed are the dominant cattle breed from SI (**A10** and **A11**), through CR (**A5**) and BA (**A1**). In MK (**A6**) and ME (**A8** and **A9**) the breed structure shifts from the dual-purpose breed towards the Tyrolean grey, Brown Swiss and Holstein Frisian breeds. Autochthonous breeds such as the Cika in SI (**A11**), the Gatacko breed in BA and the Busha in CR (**A4**) and MK (**A6** and **A7**) are present. The number of animals in the region is estimated to roughly half a million, though the exact number of animals is unavailable (Figure II-3). Husbandry activities are organised with indoor housing during the winter and grazing during summer-autumn (**A1**, **A4**, **A5**, **A8**, **A9**, **A10** and **A11**). The milking is mainly by hand or by milking pail, systems such as pipeline, fishbone and tandem can be found on larger production units, yet rotational milking and the use of milking robots is absent. Most of the small farmers heavily depend on the use of services from other farmers when preparing roughage for winter due to the lack of sufficient mechanisation. Medium and large farms are self-sufficient in terms of mechanisation needs. Besides hay, haylage and grass silage are used, but silage is absent in the high altitude levels of the region. Corn and concentrate fodder are bought from the continental and Pannonian region. Grazing activities once had greater importance in the region as they have now (Marković, 2003). The practice of collective grazing on public grasslands is a common practice in ME and MK, in BA and CR this practice is present in areas in which abandonment took place and abundant pastures are available. Transhumant movements are a practice that farmers still apply. In SI (**A11**) by the local name of "planina", ten farms practice the movement of cattle towards the Julian Alps bordering with Austria and Italy. In CR and BA, these movements are abandoned. In ME by the local name of the settlements which the herders move to, "katun", the practice of vertical transhumance is present (**A9**) in a smaller extent than in the past as reported by (Marković, 2003). The grazing period extents over 180 grazing days both for the sedentary dairy farms and for transhumant. The main production in most of the systems is raw milk (**A1**, **A4**, **A5**, **A6**, **A8**, and **A10**). Product processing into cheeses is a common practice in the transhumant systems (**A9** and **A11**) in which the remoteness restrains farmers to supply the produced milk to dairies. Some product processing and direct selling of processed products to local markets, besides the supply to dairies, are present in most of the systems as an alternative way to generate income. The systems' secondary product in the region are weaned calves. Bigger and more intensive farms tend to sell young weaned calves immediately after the colostrum period with 5 to 10 days of age. On medium and small farms, calves are suckling up to three months after which they are sold to fattening farms or directly to slaughterhouses.

Beef production in the alpine region heavily depends on the availability of agricultural land for the production of silage corn, artificial meadows and fodder grains. Unlike the dairy system, housing is year-round indoor in group-boxes or tethered. Organised beef production is present in both SI (**A12**) and BA (**A2**), and in smaller extends in ME, but not sufficient to treat it as a system. The fattening farms are supplied with calves from both domestic and foreign markets and therefore a heterogeneous breed composition can be found. The Simmental breed is dominant; Limousine, Charolaise, Hereford, Belgian blue-white, Aberdeen Angus, and crosses with the mentioned breeds and dairy breeds are present in the study area. Compared to the extent of the dairy systems inside the region, the beef breeders play a minor rule in terms of animal numbers, farm numbers and supply to markets. Particularities of the beef system are smaller number of farms with a larger number of animals per farm, no reproduction cycle, unifeed fodder and higher stocking densities than in dairy breeding. The system specific final products are live animals supplied to slaughterhouses. Negative trade balance and high demand for beef meat counteract the export of beef meat in all countries of the study area. The beef systems in the Alpine region have a small extent concerning the number of animals involved in the production. Its importance is seen through the supply of a larger quantity of animal protein to the market obtained from a single breeding female, opposed to slaughter of calves or skinny animals.

Cow-calf breeding in the alpine region is organised on an extensive management scheme by maximising the use of natural pastures and partly forested or shrubby surfaces through year-round grazing. Cow-calf breeding is compared to the long past of dairy breeding, like beef production on feedlots, a relatively young production practice in the study area. First generation farmers manage most of the farms. The farms are younger than one or maximum two decades. The breed composition is heterogeneous, from beef breeds like Limousine, Aberdeen Angus, Charolaise and Hereford towards dual-purpose breeds like Simmental and even Holstein Frisian, Tyrolean Grey and Brown Swiss are present (**A3** and **A13**). Autochthonous breeds like the podolian Busha cattle (**A7**) or the Cika (**A13**) are present in smaller extent. The Cow-calf system emerged as potential land use solution for abandoned, fallow and less favoured land. Grazing activities last effectively from spring until winter and extend over eight months. Depending on the site conditions and weather during winter, year-round grazing with supplementary feeding on pasture or paddock are a management practice some farmers adopt. Grazing on public land with additional grazing fees are a practice in MK (**A7**). System specific final products are weaned calves, which are fattened mostly on feedlots in other regions; pasture fed adult animals, and rarely feedlot animals fattened by the cow-calf breeder himself. Cow-calf breeders have besides the husbandry activity also additional income from raising other animals besides cattle, or attend to jobs unrelated to livestock production.

3.1.2 The Continental biogeographical region

From eastern SI (**C13**), through Central CR's Zagorje, Posavina and partly Slavonia (**C5**), Posavina in north BA (**C1** and **C2**), central, west, east and north RS (**C10**, **C11** and **C12**) and the eastern half of MK (**C8**) dairy cattle farming is the dominant breeding method. The breed structure in the Continental is less heterogeneous than in the Alpine region. The Simmental and Holstein Frisian breed including crosses with these two breeds make up the major part of cattle present on dairy farms in all systems (**C1**, **C2**, **C5**, **C8**, **C10**, **C11**, **C12** and **C13**). The Brown Swiss (**C5** and **C8**) and Grey Alpine (**C8**) cattle breeds appear in small numbers as residual animals from previous imports and crossbreeding in the study area. Autochthonous breeds such as the Busha in MK (**C8**) are present in less extent due to the higher production intensity in the Continental region compared to the Alpine and Mediterranean. In terms of number, family households with less than 10 cows (**C1**, **C2**, **C8**, **C11** and **C12**). Medium sized farms (**C5**, **C10** and **C13**) are minor in terms of unit number on the study area, but these systems participate more frequently with a market share and supplement the dairy industry. Large farms are present through the continental region, but their share in terms of animal number in the whole population of cattle inside the region accounts to 1% and is rather insignificant. Husbandry activities are organised with indoor housing during the winter and grazing during the summer and autumn season (**C2**, **C11** and **C12**). Mechanisation self-sufficiency is higher compared to the alpine region but the needs for the use of mechanised units are also higher. Milking mechanisation and technological solutions increase at farm level proportional to the increase of animal number per farm. Grazing activities are related to the pressure of other agricultural production in the area, and the availability of grasslands to which usually just the small farms of the region have proper access, due to their remoteness. Grazing activities are organised on a daily return basis with sedentary herds. The duration of the activity lasts from five months in the hilly-low mountain area of RS (**C12**), over six months in the low hill RS (**C11**) to seven months in BA (**C2**) on approximately 20% of the farms. System specific final products are milk distributed to dairies and various types of cheeses processed on the farmstead. On small and medium farms, fattened calves contribute to the general income in an extent to which some farmers decide to provide the whole produced amount of milk to the calf until weaning. The dairy industry plays a big role in the regional development and stability of the system and high levels of dependence to dairies from the farmers exist.

From Continental SI (**C14**) over Bjelovar and Daruvar in CR (**C6**), through Posavina in BA (**C3** and **C4**) the importance and scale of beef system, organised on feedlots, varies. The "baby beef" production in CR (**C6**) is a well-known production practice since the communism period. The beef system is organised in fattening farms without any grazing activities (**C3**, **C6** and **C14**) by using unifeed rations based on corn silage, haylage, hay and concentrate rations. Some fattening farms with the access to paddocks and grazing during summer fattening are present (**C4**). System specific final products include fattened calves and fattened bullocks at various ages depending on the market preferences. Minor fattening activities are present also in other countries (RS, MK) in smaller extents.

Cow-calf breeding in the continental region is organised in remote hilly-mountainous and regions with unfavourable features. In CR (**C7**), traditional mixed grazing systems in the Basin of Sava River on the territory of the natural park "Lonja plain" is organised by breeding cattle, horses and pigs with horizontal movements. A similar mixed pattern is present in MK (**C9**) and SI (**C15**) though the extent of other species never outnumbers the number of cattle in any of the cases. During the communism period, the breed structure in SI (**C15**) was organised in cooperative operations by rearing the Aberdeen Angus breed of which just few populations remain. Limousine, Charolaise and Simmental are the preferred breeds (**C7** and **C15**). Crosses with autochthonous breeds such as Busha can be found towards the south of the Continental region (**C9**). The housing is organised in open stables, with permanent access to pasture or paddocks, or in closed stables with stalling just during the winter (**C7**). Cow-calf breeding is performed as side activity. System specific final products include live animals for the local beef producing farms and fattened animals on farms that have the capacity to organise the fattening process.

3.1.3 The Mediterranean biogeographical region

Dairy production in the Mediterranean region is organised on small and medium sized holdings (**M1**, **M5**, **M7** and **M9**), few larger farms are present but except in CR (**M6**) not representative as system. The breed structure is similar to other regions, the availability of genetic material and the will of farmers to change their breeds and management alternatives it would require limit the choices to Simmental, Holstein Frisian, Brown Swiss and particularly Busha in CR (**M5**). Housing is very poor, and the use of technological innovations as well. Milking is manual; mechanisation in the region is scarce and outdated. Some of the producers in the region laid hopes into the food industries whose by product were available as free fodder, but the lack of suitable meadows and arable surfaces for crude fodder production made attempts to organise production based on industrial residuals unsustainable (**M1** and **M9**). Grazing in the area is organised just sedentarily (**M1** and **M7**) in small and medium farms. Some farms do not practice grazing activities due to the competitiveness for arable land with other agricultural productions (**M9**). Large farms towards the Adriatic coast positioned near urban settlements, combined with dry and scarce grassland gain few benefits of performing grazing in these areas (**M6**). Grazing during summer including horizontal movements in remote places is a practice that few farmers adopt (**M5**). Milk is distributed to dairies that process products such as cheese and fermented drinks. Weaned calves for fattening are a secondary product of the system.

Indoor fattening on feedlots is rare, and just few farms utilise fattening of calves for the domestic market (**M2**). The presence of cow-calf breeders and dairy farms serves as source for the supply of fattening material. Less than the half of fattening farms have organised a grazing period with supplementary feed for bulls (**M3**). The fattening period includes all-year grazing and supplementary corn on natural pastures.

Cow-calf breeding in the Mediterranean region is organised in two major locations. The Istrian peninsula in CR is the hotspot of the autochthonous podolian Istrian cattle breed (local name "Boshkarin"), which is reared in an extensive cow-calf system (**M8**) based on the use of scarce Mediterranean pastures. The whole population is under protection status and is under subsidy schemes to support the continuity and expansion of the breed. In BA (**M4**), cow calf breeding emerged as potential land use solution for the abandoned rural areas in the karst hills of Herzegovina region. The system is relatively new on this territory, and such as this has few but raising recognition. The lack of competitiveness and existing demand for beef meat favours this breeding type. Grazing activities last from 8 to 9 months, including a short indoor period. Grazing is performed on semi-natural pastures and neither artificial pastures nor meadows are sown. System specific final products are weaned calves and fattened adult animals. The recognition and advertising of the Istrian cattle including its protection status (PDO meat) made it possible to discriminate this product among commercial products in the Dalmatian cuisine and tourist offers.

3.1.4 The Pannonian biogeographical region

Stretching from the SI border with Austria and Hungary, through north-east CR alongside the national border with Hungary towards the Pannonian plain of Serbia and the whole territory of Vojvodina region (Banat, Baranja and Srem) intensive indoor dairy cattle breeding systems are present (**P1** and **P5**). Breed composition includes Holstein Frisian and Simmental cattle (**P1** and **P5**) in farms that are more intensive and just Simmental and crosses in farms with lower production intensities (**P4**). Housing is either indoor chained or free stalling with collective grazing activities in remote areas (**P4**). Grazing activities are limited to fallow land and public pastures on which farmers from villages collectively graze adopting a daily return. Due to good soil fertility and versatile ways of use, this system competes with other agricultural productions, such as oil seed, grain production and other crop productions. The feeding regime in the system includes corn and grass silage from artificial meadows, concentrate and protein fodder crops and legume hay. System specific final products include milk and young calves.

With approximately 30 farms, the beef breeding is a side line system (**P2**). In RS (**P6**) the practice of commercial fattening of animas is new and just a side line activity of the farmers. Fattening animals on feedlots, in group-boxes, up to 600 kg live weight is a practice that ensures the use of domestic calves that serve as surplus in the dairy system. Despite the small number of farms, the amount of domestically produced calves often does not satisfy the capacities of beef farms, and calves from Hungary and Romania are imported. No grazing activities and no product processing are present in this system.

Cow-calf breeding in the Pannonian biogeographical region can be found under one of four main conditions. The area is protected as natural or national park such as "Kopački rit" and "Papuk" and can only by maintained by grazing (**P3**). The area is heavily abandoned and remote (**P3**). The area is located in river estuary's and is flooded during the winter and spring. The area is mainly made of shallow topsoil and fallow land and unsuitable for other types of production (**P3** and **P7**). The breed structure is composed of Hereford, Aberdeen Angus, Charolaise and Limousine. The grazing extends from the end of March until the end of September and is mainly organised on natural pastures without rotational movements, but can extend over the whole year depending on the winter season. This system has just little importance due to its marginalisation in the region.

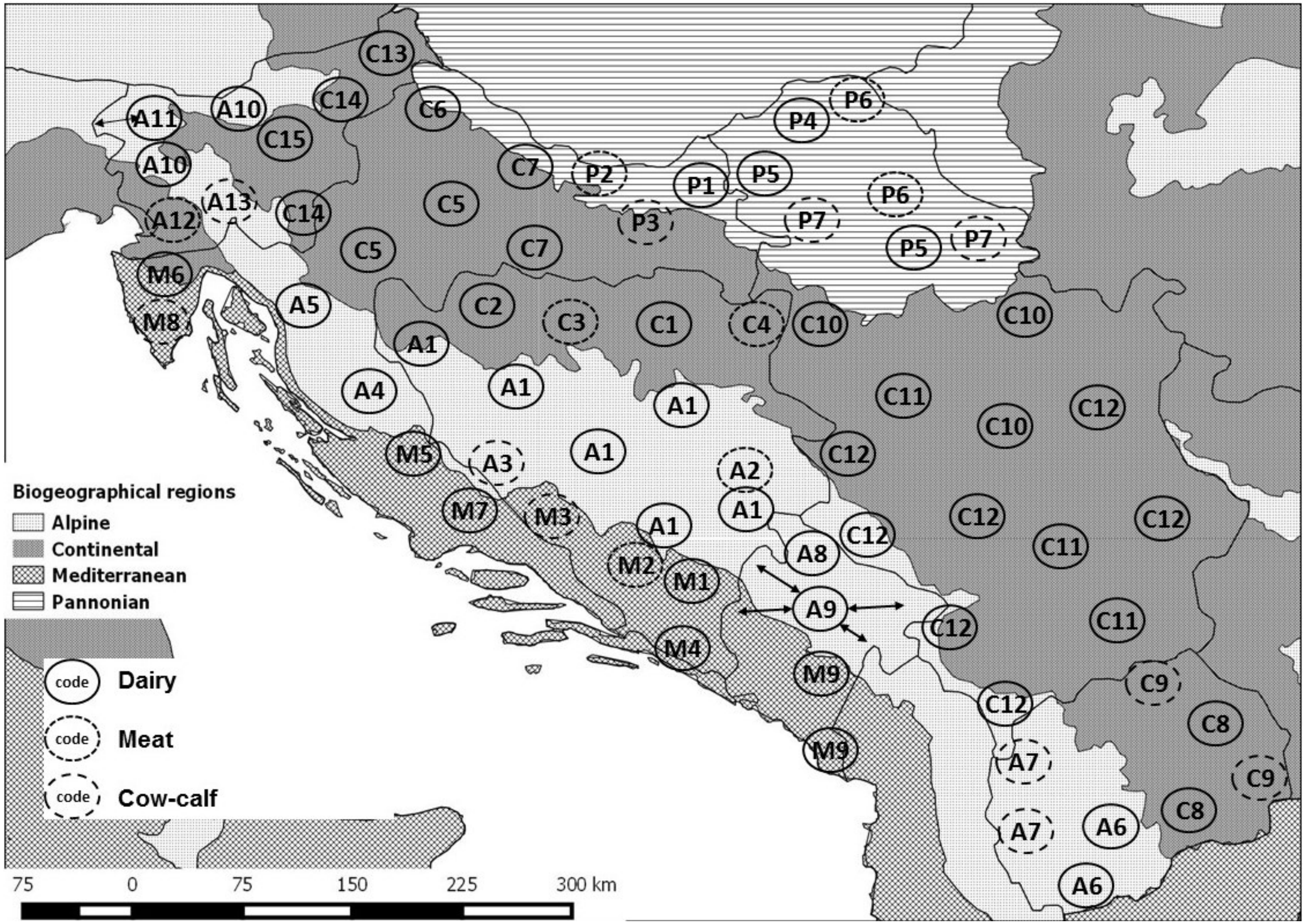

Figure II-4. Distribution of Cattle systems on biogeographical regions of the Western Balkan countries.

The system identification code (SIC) is used as a reference value to link the geographical position described by the map with the complementary entry in the table and text. The SIC consists of two elements, a letter corresponding to the biogeographical region in which it is located (A: Alpine, C: Continental, M: Mediterranean, P: Pannonian), and a progressive number (1-15) for each system entry from the complementary tables.

Table II-2. Cattle Systems in the Alpine Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	A1	Dairy	Indoor/outdoor	40000	SIM, HF	5	>75	80	H, S, C	150	1.00	C	S	P	5	10-30	F
	A2	Meat	Indoor	100	SIM, HF	50	>75	80	H, S, C		1.00					50-100	F
	A3	Cow-calf	Indoor/outdoor	25	AN, CH, LM	80	>75	<10	H, C	240	1.00	C, R	H	M	80	>100	F
CR	A4	Dairy	Indoor/outdoor	15	BU	15	100	50	H, S, C	180	0.70	C, R	H	M	15	10-30	C, F, O
	A5	Dairy	Indoor/outdoor	413	SIM, BS	20	100	75	H, S, C	180	0.70	C	H	M	40	10-30	C, F, O
MK	A6	Dairy	Indoor	9500	BS, GA, HF, BU	10	>75	50	H, S, C		1.30					30-50	F, C
	A7	Cow-calf	Indoor/outdoor	1400	BU	4	>75	10	H, C	180	0.25	C	H, V	M	30	5-10	F, C
ME	A8	Dairy	Indoor/outdoor	1500	BS, HF, SIM, GA	7	>75	30	H, S, C	180	0.40	C	S	PB	7	10-30	C, F, O
	A9	Dairy	Indoor/outdoor	2000	BS, SIM, GA	9	>75	30	H, S, C	180	0.20	C	V, H	PB	30	10-30	C, F
SI	A10	Dairy	Indoor/outdoor	2000	BS, HF, SIM	20	>75	60	H, S, C	180	1.00	C, R	S, H	P, M	20	10-30	C, F, O
	A11	Dairy	Indoor/outdoor	100	BS, HF, SIM, Cika	10	>75	30	H, S, C, U	150	0.74	C	V	P, M	10	10-30	C, O
	A12	Meat	Indoor	15	SIM, CH, LIM	150	<50	50	H, S, C, U							>100	C, F, M
	A13	Cow-calf	Indoor/outdoor	5000	CH, LIM, Cika	10	>75	30	H, S	300	0.50	C, R	S, H	M	10	30-50	C, F, O

1 – HF-Holstein Frisian; SIM-Simmental; HE-Hereford; AN-Aberdeen Angus; CH-Charolaise; LM-Limousine; BU-Busha; BS-Brown Swiss; GA-Grey Alpine.
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

Table II-3. Cattle Systems in the Continental Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	C1	Dairy	Indoor	10000	SIM, HF	7	>75	40	H, S, C							10-30	C, F, M, O
	C2	Dairy	Indoor/outdoor	1800	SIM, HF	5	>75	40	H, S, C	210	4.00	C	S	P	10	10-30	C, F, M, O
	C3	Meat	Indoor	700	SIM, HF	40	<50	40	H, S, C							30-50	F
	C4	Meat	Indoor/outdoor	50	SIM, HF, HE	35	<50	40	H, S, C	210	2.50	C	S	P	35	50-100	C, F, O
CR	C5	Dairy	Indoor	9000	SIM, HF, BS	20	>75	40	H, S, C		0.80					50-100	C, F, O
	C6	Meat	Indoor		SIM, LIM, CH	150	>75	40	H, S, C		1.20					>100	C, F
	C7	Cow-calf	Indoor/outdoor	50	SIM, LIM, CH, AN	80	>75	30	H, S	240	0.70	C, R	H	M	60	50-100	C, F
MK	C8	Dairy	Indoor	10500	BS, GA, HF, BU	10	>75	50	H, S, C		1.30					30-50	F, C
	C9	Cow-calf	Indoor/outdoor	1600	BU	4	>75	10	H, C	180	0.25	C	V, H	M	30	10-30	F, C
RS	C10	Dairy	Indoor	9000	SIM, HF	35	90	85	H, S, C							30-50	C, F, O, M
	C11	Dairy	Indoor/outdoor	18000	SIM	13	90	90	H, C	180	0.40	C	S	M	13	5-10	C, F, O, M
	C12	Dairy	Indoor/outdoor	17000	SIM	5	<75	90	H, C	150	0.40	C, R	S	M	5	5-10	C, F, O, M
SI	C13	Dairy	Indoor	1300	SIM, HF	40	>75	40	H, S, C							30-50	C, F, O
	C14	Meat	Indoor	100	SIM, HF	20	>75	40	H, S, C							30-50	C, F, O
	C15	Cow-calf	Indoor/outdoor	100	SIM, AN, LIM	10	>75	35	H, S, C	210	1.90	R	H	P	10	30-50	C, F, O

1 – HF-Holstein Frisian; SIM-Simmental; HE-Hereford; AN-Aberdeen Angus; CH-Charolaise; LM-Limousine; BU-Busha; BS-Brown Swiss; GA-Grey Alpine.
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

Table II-4. Cattle Systems in the Mediterranean Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	M1	Dairy	Indoor/outdoor	400-750	SIM, BS	5	>75	80	H, C	150	0.20	C, R, O	S	M	25	10-30	O, F
	M2	Meat	Indoor	10	SIM	100	>75	80	H, S, C							30-50	O, F
	M3	Meat	Indoor/outdoor	<10	SIM	12	>75	70	H, C	360	0.20	C, R	S	M	12	30-50	O, F
	M4	Cow-calf	Indoor/outdoor	12	AN, HE, LM	100	>75	50	H, S, C	270	0.20	C, R	H	M	100	30-50	O, F
CR	M5	Dairy	Indoor/outdoor	30	BU	15	<75	30	H, S, C	240	0.30	C, R	H	M	15	10-30	C, F, O
	M6	Dairy	Indoor	30	BS, HF	40	<75	30	H, S, C		0.60					10-30	C, F, O, M
	M7	Dairy	Indoor/outdoor	1500	SIM, HF	15	<75	30	H, C	240	0.30	C	S	M	40	10-30	C, F
	M8	Cow-calf	Indoor/outdoor	140	Istrian	11	>75	30	H, C	240	0.30	C, R	S	M	11	10-30	C, F, O, M
ME	M9	Dairy	Indoor	500	HF, SIM	20	<75	40	H, S, C		1.10					5-10	C, F

1 – HF-Holstein Frisian; SIM-Simmental; HE-Hereford; AN-Aberdeen Angus; CH-Charolaise; LM-Limousine; BU-Busha; BS-Brown Swiss; GA-Grey Alpine.
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

Table II-5. Cattle Systems in the Pannonian Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
CR	P1	Dairy	Indoor	700	HF, SIM	50	>75	20	H, S, C							10-30	C, F, O, M
	P2	Meat	Indoor	30	SIM, HE, AN, CH, LM	40	>75	30	H, S, C							>100	C, F, O, M
	P3	Cow-calf	Indoor/outdoor	10	HE, AN, CH, LM	40	<75	10	H	360	0.50	C	H	M	40	50-100	C, F, O, M
RS	P4	Dairy	Indoor/outdoor	14000	SIM	10	>75	80	H, S, C	270	0.50	C	S	PB	100-150	10-30	C, F
	P5	Dairy	Indoor	1000	HF, SIM	20	>75	80	H, S, C							10-30	C, F
	P6	Meat	Indoor	2	HF, SIM, HE, AN, CH, LM	2000	>75	80	H, S, C							>100	C
	P7	Cow-calf	Indoor/outdoor	13	HE, AN, CH, LM	40	>75	80	H, C	270	0.50	C	S	P	40	50-100	C

1 – HF-Holstein Frisian; SIM-Simmental; HE-Hereford; AN-Aberdeen Angus; CH-Charolaise; LM-Limousine; BU-Busha; BS-Brown Swiss; GA-Grey Alpine.
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

3.2 Sheep systems in the Western Balkan countries

Sheep production in the study area is organised in extensive or semi-extensive mainly meat oriented, family own and private sheep farms. The diversity in terms of environmental heterogeneity lead to the specification of many breeds and strains derived from primarily one breed, the local Pramenka. The autochthonous local breeds in many areas developed isolated strains which differ from other strains to the extent that they were classified as new breeds such as the Istrian sheep, Pag sheep, Cres sheep, Krk sheep, Ljaba sheep and others. Crossing with other breeds in the past, and introduction of central and western European breeds in the domestic flocks' for the improvement of milk, wool and fattening performances were present. Despite the introduction of foreign breeds, the local producers express a preference towards the breeding of domestic breeds.

The seasonality is a common feature of the whole sheep population, with different extents depending on the biogeographical region. Lambing is favoured in winter and summer, and the availability of lambs is highest during the Easter time, the first of May and Christmas. Sheep meat consumption varies through the area, but lamb meat is a common part of the local dietary culture and trademark for tourist activities.

All-year grazing, poor or none supplementary feeding, large flock sizes and migration over the Dinaric Alps are features of the traditional transhumant flocks of central Bosnia, Western Croatia, Montenegro and Macedonia. An extensive analysis from an anthropogeographic point of view of the traditional transhumant movements in the western Balkans is available by Marković (2003).

Sheep rearing in Serbia is mainly realized by small family holdings (farms) in flocks of 10 to 15 animals, from 70 to 100, and on fewer farms from 200 to 500 (Petrović et al., 2011).

Experts were able to locate the present sheep production systems in the corresponding biogeographical regions (Figure 2). Even if potential and actual area affected by sheep production systems may differ greatly, hot spots in the corresponding national map indicate locations where identified sheep systems are most dense.

3.2.1 The Alpine biogeographical region

The Alpine region houses the majority of sheep in SI, BA and ME but just a small percentage of these animals belong to the dairy systems (**A1**, **A3**, **A6**, **A8** and **A10**). Dairy sheep breeding in the Julian Alps in SI takes the form of two different management practices dividing sheep breeders into sedentary breeders (**A8**) and traditional transhumant cheese producers (**A10**). Sedentary sheep breeding in the alpine region is present through the whole study area. The extent varies, but the practice to raise animals on pasture, milk after the weaning of lambs and transform raw milk into cheeses represents a traditional management practice. The territory for dairy sheep systems overlaps with the meat sheep systems, but hotspots can be defined through geographical locations. In SI, farmers of the traditional "planina" system (**A10**) practice vertical movements to the Julian Alps, and utilise mountain pastures and grassland plateaus, a practice similar to those performed in MK on Shar Mountain (**A5**). In ME movements to "katuns" on Sinjajevina, Durmitor, Morača and Golija mountains (**A6**) and in BA movements to Vlašić Mountain, Kupres and Bjelašnica (**A1**) were once a common practice which exists now as residual activity. Sedentary breeding of sheep for milk production is oriented towards the commercial production of milk (Sedić et al., 2014b). Farms of this type are present through the whole area, but compared to the meat system, make up just 20% of the total population of farmers (**A3** and **A8**). The breed composition of dairy systems of the territory is heterogeneous. Most of the animals belong to the autochthonous Pramenka breeds, which developed, due to selection, isolation and crossing, through time various strains and even breeds. In SI (**A8** and **A10**) Bovec sheep, Improved Bovec sheep, Istrian sheep and Jezersko Solchavska sheep are breed for milk production. In CR (**A3**) and BA (**A1**) the Dubian sheep is the dominant breed of the system. Besides the Dubian breed in BA (**A1**), Kupres sheep and Privorian sheep are breed in the dairy system. In ME (**A6**) local breeds such as Pivska sheep, Sjenica sheep and Bardoka are present. In MK Sharplanina sheep, named according to the main mountain of the region, is used as main breed for the transhumant movements of the system (**A5**). The Housing varies through the region, from concrete stables without paddock or pasture during winter, to open wooden stables or shelters with access to either paddock or pasture. Traditional systems such as the "planina" (**A10**), the "katun" (**A6**) and transhumant systems in BA (**A1**) and MK (**A5**) adopt daily return grazing activities to summer huts or settlements in the mountain area. Dry walls are used as shelter for the animals during the night (**A5** and **A6**) in the south of the region. Grazing is year-round or limited to a hay-fed diet during the winter season. Despite the milking activity, all systems, besides the milk, produce weaned lambs. The system specific final products include sheep cheeses sold at farmstead or in local markets, weaned lambs in spring and winter, and milk distributed to dairies where the industry has the capacity to convert sheep milk separately from cattle milk (e.g. In BA - Travnik). Roughly two third of the systems income is still generated by selling the weaned lambs for reasons such as lower demand for human labour during the suckling period, small overall milk production of the local breeds and small amount of milk yielded after the weaning.

The Meat sheep system in the alpine region spreads through the whole area. The importance concerning the number of animals involved into meat production varies from approximately 40% in BA (**A2**) to 80% in CR (**A4**) and SI (**A9**). The breed composition is similarly to the dairy system based on autochthonous breeds such as the Dubian, Kupres, Herzegovinian and Privorian sheep (**A2**), Lika sheep (**A4**), Pivska and Sjenica sheep (**A7**) and Jezersko-Solchavska and Belokranjska Pramenka (**A9**). In average, meat systems have larger flock sizes, due to the lower demand for labour and larger amount of animals' one herder can manage. In statistical records, small flock sizes are the result of mixed breeding with other species, in which the farmers prefer a diversified livestock production to the breeding of a single species to cope with market fluctuations. Housing is similarly to the dairy systems organised in poor stables, and animals are kept in stables together with other species such as cattle or goats. The grazing period lasts from 180 days to yearlong grazing. Sheep graze in natural parks, such as Velebit in CR or Triglav in SI, but the use of sheep for the maintenance of open surfaces in areas with protective status is not regulated. More often, the animals are treated as burden and hindrance than solution. The feeding is adapted to the availability local resources, and the low stocking densities of the region allow for a large source of feedstuff during the year. Movements of the animals towards summer pastures are a practice that loses its importance due to the decreased number of animals in the region. In most cases, just 5-10% of the animals participate in movements towards lowlands during winter and mountains during summer (**A2**, **A4** and **A7**). System specific final products are lambs weaned from April until June. The lambs are sold as live animals with weights of approximately 25 kg or as carcass directly from the farmstead.

3.2.2 The Continental biogeographical region

Dairy sheep systems in the continental region have through the region various levels of importance and management organisation. In CR, the dairy system (**C4**) has an equal if not higher importance than the meat production system of the region. The system receives various types of support, which combined with favourable product market conditions lead to the growing interest of farmers to participate in this system. Through BA, no dairy sheep breeding in the continental region is present. Extensive dairy production with a combined management of weaning lambs during the first four lactation months and afterwards milking the animals for further five months is a common practice through the whole region. Based on the agricultural census of 2012 in RS sheep breeders are homogeneously dispersed over the continental region (Popović, 2014). Particular hotspots for sheep production are the footholds of mountains on the national borders towards the west, east and south (Sjenica plateau, Svrljig County, between Borsko Lake and the border towards Romania, Suva and the Balkan Mountains). In MK, the dairy sheep system has two main hotspots, one in the Ovchepolian plateau (**C5**) and the second in the high altitude hills around Osogovske Mountains, Plachkovica Mountain and Ograzhden Mountain towards Bjelasica Mountain (**C6**). The breed composition of the region is based on the use of local Pramenka strains and types, as reported by Porcu and Marković (2006). Some of the autochthonous breeds include the Dubian sheep (**C4**), Ovchepolian sheep (**C5** and **C6**), Karakachanian sheep (**C5** and **C8**), Privorian sheep, Svrljig sheep, Krivovir sheep, Sjenica sheep and Pirot sheep (**C8**). The population of sheep in the dairy systems varies. In CR, the dairy sheep system (**C4**) involves approximately half of the animals of the region and has the highest production intensity. In MK, all producers apply milking of the animals after weaning of the lambs. In RS, the dairy system has a lower importance than in CR and MK, but the extent to which farmers perform dairy or meat-oriented management could not be estimated. Housing conditions are in all cases limited to a five-month indoor period during the winter, and a seven-month grazing season, which extends towards the south of the region up to year-round grazing (**C6**). In CR, the farmers already apply mechanical milking, and adopt sophisticated methods to concurrence with the European regulations regarding milk quality standards. In RS (**C8**) and MK (**C6**), traditional methods are applied with milking mostly organised on summer pastures. Access to facilities to organise milking other than by hand is unavailable. The grazing in all systems is continuous. If the herder organises daily return, grazing may follow on different pastures, but no fencing or splitting of existing pastures for rotational stocking are present. In RS, vertical movements to mountain plateaus are present on Sjenica plateau in the west, and the Balkan Mountains on the east. System specific final products are local cheeses sold on farmstead, milk distributed to dairies, which is mostly the case in CR (**C4**) and weaned lambs which still make over 50% of the profit farmers generate through the year.

Meat production in the continental region is organised in an extensive and semi intensive production, and just in BA, a small number of farms perform intensive rearing of fattened lambs (**C1**). Around half of the population of sheep in CR is breed in a semi intensive production system (**C3**) involving besides the local also imported European breeds and crosses such as the Romanov sheep and Wurttemberg. The meat system in RS is located in the flat plains south of the Sava river and alongside Morava river in the Podunavlje region. The breed composition in RS similar to CR consists of Wurttemberg, but also Cigaja, Lipe sheep and Ill de France. Housing is poorly organised in wooden barns and stables, often are the animals kept with animals of other species inside the same building. Grazing extends over six to eight months during spring and summer, to late autumn. The animals receive during winter meadow hay and corn as supplementary feed. The use of concentrates increases with the increase of production intensity. A winter regime of 100 kg hay and 100 kg corn per animal is applied in conditions in which animals have access to pastures or paddocks through the whole year. System specific products are lambs weaned after approximately 4 months of suckling.

3.2.3 The Mediterranean biogeographical region

In the Mediterranean region, sheep systems are present from the Istrian peninsula, through the Dalmatian coast, including the CR islands, over Herzegovina (BA) and the west of ME. Heterogeneity of the systems is most common due to the breed diversification. In CR, three dairy systems can be identified. The Intensive dairy breeding of the Istrian autochthonous breed on the Istrian peninsula (**M3**), the semi intensive breeding on the islands Pag and Krk (**M4**) and the extensive dairy sheep breeding on the Dalmatian coast south from the alpine region (**M5**). An extensive dairy system spreads through the Mediterranean region of ME, with a higher density of animals in the vicinity of Shkoder lake bordering with Albania. The Breed composition in the north is composed of the Istrian sheep, and east Frisian sheep or crosses of both breeds. On the Kvarner Islands former Pramenka strains isolated and selected became breeds named by the island on which each type is breed (Krk, Pag, Cres, Rab), of which the Pashka sheep on Pag island and 20% of the breeders of Krk sheep perform semi intensive milk production. In ME, the production is similar to the Dalmatian coast very extensive. The largest flocks in CR are in the Istrian region (**M3**) and on Pag Island (**M4**), followed by the populations of Krk. The flock sizes towards the south decrease to approximately 35 animals per flock. In terms of housing, the system is based on year-round grazing with shelter during winter. Housing conditions towards the north are improving for the needs of the milk production. On the islands and in Dalmatia open shelters or dry walls are mostly all infrastructures the animals are kept in (**M4**, **M5** and **M8**). Grazing activities are on the Istrian peninsula (**M3**) and Kvarner islands (**M4**) both rotational and continuous, depending on the practice adopted by the farmer, as by the availability of pastures. On the Dalmatian coast (**M5**) in BA (**M1**) and in ME (**M8**) just continuous stocking is present, with densities below 0.5 livestock units per hectare. Movements of the animals were once a common practice, and involved transboundary movements between the countries. Today movements are limited to vertical movements towards the local mountains and alongside slopes of Velebit in Dalmatia (**M5**) and between the Mediterranean and alpine region in BA (**M1**). Joint flocks are rare and as practice, performed by less than 10% of the breeders in BA (**M1**), but include up to 40% of the animals in the region. System specific final products range from milk, cheese, dry sheep meat to carcasses of weaned lambs to live animals. Obtaining the protection status of products like the case with Pashka cheese and Pashaka lamb meat (PDO) can contribute to the advertising of particular products and their demand.

Meat production systems in the Mediterranean region are exclusively extensive. No, or just rarely, are animals raised with supplementary feed, artificial forage crops, or particular fattening methods to increase yields. The lamb breeding reaches from the Konavle islands, Cres and Rab, on the west of CR (**M6**) over the Dalmatian coast (**M7**), through the Herzegovina region in BA (**M2**). The Dalmatian meat system involves approximately 90% of the sheep population on the Dalmatian coast. Vertical movement from the coastline towards the Dinaric Alps are present and include breeders from the area between the city of Zadar and Podgora close to Hvar Island (**M7**). Sheep breeders tend to have few goats in the sheep flock. The feeding is fully adapted to the environment, and grazing on scrublands and grasslands serves as the main source of feedstuff for the animals. The shepherding activity on Rab Island (**M6**) includes year-round grazing close to the farmstead during winter until May-June when the animals move to distant pastures in the hilly area. Important geographic locations for sheep breeders in this system are the Islands Goli Otok and St. Grgur on which once the establishment of prisons lead to the banning of migration of animals towards these islands from Rab Island. After those prisons closed in 1968 and 1988 shepherds started after decades again to move their sheep and lambs to those islands during the grazing period from March to December (Barać et al 2006). Milking is performed on a minority of animals after weaning of the lambs and directly on the pasture (Barać et al 2008). A common feature of this sheep system is the utilisation of poor pastures endangered by scrub encroachment through year-round grazing on plots physically separated by once established stonewalls. The main product of the system are live lambs, carcasses and dry sheep meat.

3.2.4 The Pannonian biogeographical region

Dairy sheep production is not a common agricultural practice because dairy production on sheep farms never exceeds the value of produced lambs, and most breeders exploit just a portion of the possible milk yield. Overall territory of Banat and on the west of Sremska Mitrovica are hotspots for the dairy sheep system in RS. The system is based on the use of combined sheep breeds. The production is pasture based with a seven-month grazing period and indoor during winter. Fruška gora and Deliblato sands are undesired pasture grounds but grazing in these two national parks is frequent. Other grassland areas with protected status include; Stari begej - Carska swamp, Vršac Mountains, Palić Lake and Lake Ludash. The final weight of lambs exceeds 30 kilograms. Processing of milk on the farmstead and direct selling are common among the farmers.

In the Pannonian region of both CR and RS, meat systems are dominant compared to milk systems. Farms across the region are located close to surfaces with unsuited conditions for intensive crop production. In CR (**P1**), the system is characterised by the use of Cigaja, Württemberg and Jezersko-Solchavska breed, with accent on the Cigaja breed, which is breed just in this region of Croatia. In RS (**C2**) Chokanska Cigaja, Bergamo, Suffolk and Texel are breed. The average farm size in both systems is approximately 30 animals. Housing conditions are organised on an indoor/outdoor management. Indoor breeding lasts for five months in which the animals lamb, are supplementary feed and are prepared for the grazing season. The grazing season lasts seven months in average. The animals in the system of CR (**P1**) are, compared to RS (**P2**), additionally fed with supplementary corn during the whole year. Because of good fertility of the soil, grazing is located on fallow land, in remote areas and on crop residuals. The nutrition for animals often uses secondary products from other agricultural productions. System specific final product are weaned lambs, with higher body weights in RS compared to CR.

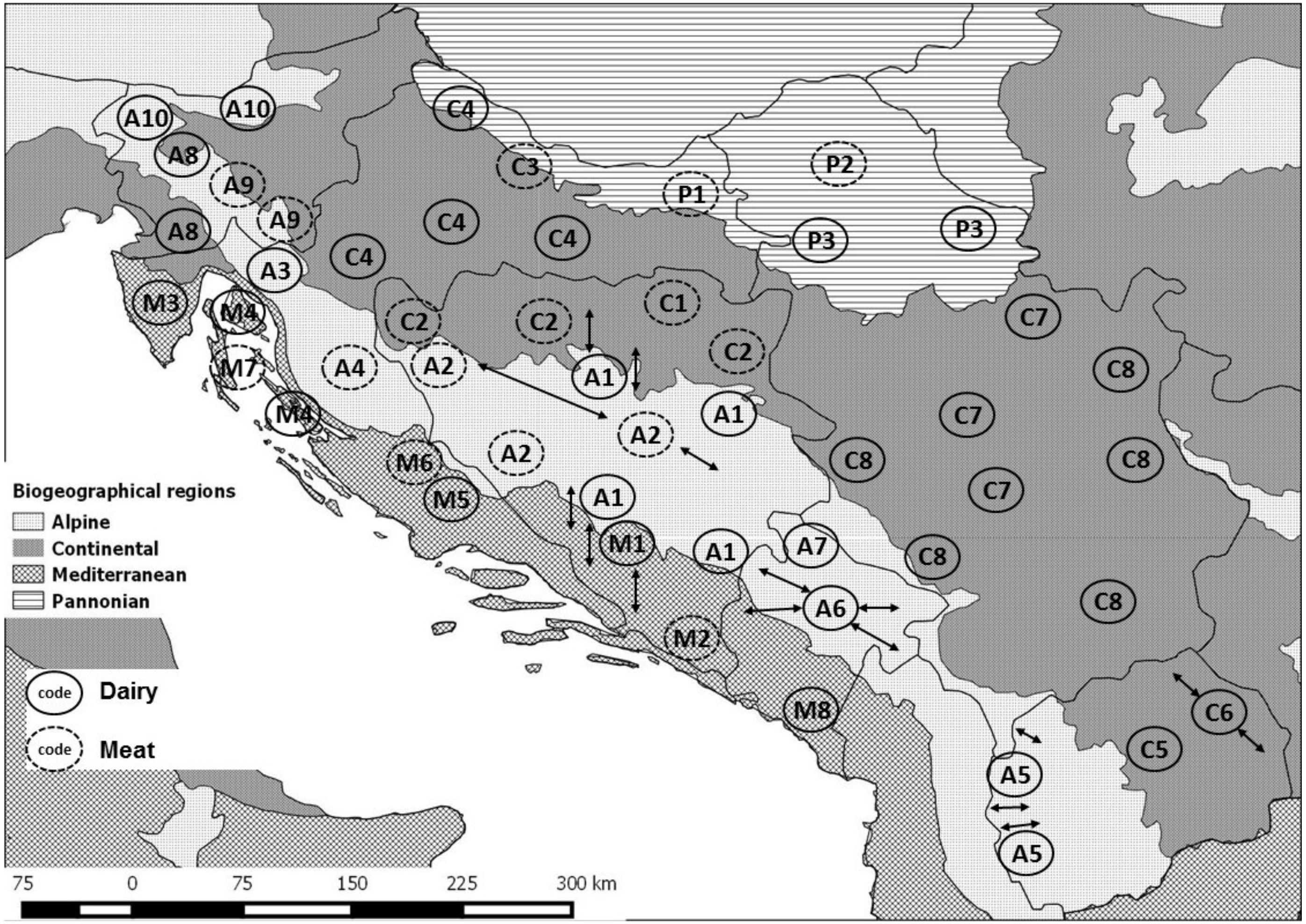

Figure II-5. Distribution of Sheep systems on biogeographical regions of the Western Balkan countries.

The system identification code (SIC) is used as a reference value to link the geographical position described by the map with the complementary entry in the table and text. The SIC consists of two elements, a letter corresponding to the biogeographical region in which it is located (A: Alpine, C: Continental, M: Mediterranean, P: Pannonian), and a progressive number (1-14) for each system entry from the complementary tables.

Table II-6. Sheep Systems in the Alpine Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	A1	Dairy	Extensive	4500	DP, KP, PP, XP	80	>75	40	H, C	240-360	1.00	C	S, V	M	80	>100	C, F
BA	A2	Meat	Extensive	2500	DP, KP, HP, XP	80	>75	40	H, C	240-360	1.00	C	S, V	M	200	>100	C, F
CR	A3	Dairy	Extensive	700	DP	32	>75	25	H, C	210	0.70	C	H	M	32	30-50	C, F
CR	A4	Meat	Extensive	2800	LP	32	>75	25	H, C	210	0.70	C	H	M	32	50-100	C, F
MK	A5	Dairy	Extensive		Sharplanina		>75		H, C	360		C	V	M		>100	C, F, O
ME	A6	Dairy	Extensive		PI, SP, BS	63	>75	30	H	180	0.50	C	H, V	P	63	30-50	C, F
ME	A7	Meat	Extensive		PI, SP,	63	>75	30	H	210	0.50	C	H, V	P	63	30-50	C, F
SI	A8	Dairy	Extensive	216	BO, OPB, IS	28	>75	50	H, C	180	1.00	C	S	M	30	30-50	C, F
SI	A9	Meat	Extensive	947	JSO, OJS, BKP	23	>75	50	H, C	240	1.00	C	S	M	30	30-50	C, F
SI	A10	Dairy	Semi intensive	20	BO, OPB, IS	30	>75	25	H, C	180	0.50	C	V	M	30	30-50	C, F

1 – BS - Bardoka, BKP – Belokranjska Pramenka, BE - Bergamo, BO-Bovec, OPB-Improved Bovec, C - Cigaja, CC - Chokanska Cigaja, CP - Creska, DAP-Dalmatian, DP-Dubian, EF-Frisian, HP-Hercegovian, IF-Il de France, IS-Istrian, JSO-Jezersko Solchavska, KAP-Karakachanian, KP-Kupres, KR-Krivovir, LI - Lipe, LJ - Ljaba, LP-Lichka, OP - Ovchepolian, PIP-Pirot, PI - Pivska, PP-Privorian, RA - Racka, RP-Ruda, RO-Romanov, SP - Sjenica, SU - Suffolk, SVS-Svrljig, TX-Texel, WB-Wurttemberg, ZZ - Zetas yellow faced, XP - Pramenka crosses,

2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.

3 – C-Continuous; R-Rotational; RO-Roped.

4 – S-Sedentary; V-Vertical; H-Horizontal.

5 – P-Private; M-Mixed; PB-Public.

6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

Table II-7. Sheep Systems in the Continental Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	C1	Meat	Intensive	100	XP, TX, R, WB, IF	50	>75	40	H, C	270	1.50	C	S, H	P	50	30-50	C, F
BA	C2	Meat	Extensive	900	XP, JSO, IF, R	25	>75	40	H, C	360	1.50	C	S, H	P	25	10-30	C, F
CR	C3	Meat	Semi intensive	3216	R, WB, JSO	20	>75	45	H, C	210	0.80	C	S	M	20	50-100	C, F
CR	C4	Dairy	Semi intensive	3216	IF, DP	20	>75	45	H, C	210	0.80	C	S	M	20	30-50	C, F
MK	C5	Dairy	Extensive		OP, KAP					180		C	S	M		>100	C, F
MK	C6	Dairy	Extensive		OP, WB					360		C	H	M		>100	C, F
RS	C7	Meat	Extensive		WB, C, IF, LI	30				150		C	S	M	30	30-50	C, F
RS	C8	Dairy	Extensive		SP, KR, BS, KAP, SVS, PIP	50				150		C	S, V	M	50	>100	C, F

1 – BS - Bardoka, BKP – Belokranjska Pramenka, BE - Bergamo, BO-Bovec, OPB-Improved Bovec, C - Cigaja, CC - Chokanska Cigaja, CP - Creska, DAP-Dalmatian, DP-Dubian, EF-Frisian, HP-Hercegovian, IF-Il de France, IS-Istrian, JSO-Jezersko Solchavska, KAP-Karakachanian, KP-Kupres, KR-Krivovir, LI - Lipe, LJ - Ljaba, LP-Lichka, OP - Ovchepolian, PIP-Pirot, PI - Pivska, PP-Privorian, RA - Racka, RP-Ruda, RO-Romanov, SP - Sjenica, SU - Suffolk, SVS-Svrljig, TX-Texel, WB-Wurttemberg, ZZ - Zetas yellow faced, XP - Pramenka crosses,
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

Table II-8. Sheep Systems in the Mediterranean and Pannonian Biogeographical region.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	M1	Dairy	Extensive	180	XP, DP, KP, HP	60	>75	50	H, C	360	0.50	C	V	M	400	>100	C, F
BA	M2	Meat	Extensive	170	XP, DP, KP, HP	60	>75	50	H, C	360	0.50	C	V	M	400	>100	C, F
CR	M3	Dairy	Intensive	33	IS, XP	83	>75	45	H, C	360	0.70	C, R	S, H	M	83	30-50	C, F
CR	M4	Dairy	Semi intensive	316	Pashka, Krchka	95	>75	45	H, C	360	0.70	C, R	S, H	M	95	50-100	C, F
CR	M5	Dairy	Extensive	267	IS, EF	31	>75	25	H	360	0.15	C, R	S, H	M	31	30-50	C, F
CR	M6	Meat	Extensive	2409	DAP, DP, R, RP	44	>75	25	H	360	0.15	C	S, V	M	44	30-50	C, F
CR	M7	Meat	Extensive	391	CP, Rab	55	>75	45	H	360	0.70	C	S, H	M	55	30-50	C, F
ME	M8	Dairy	Extensive	5000	ZZ, LJ	40	<75		H, C	300	0.50	C	S	M	100	50-100	C, F
CR	P1	Meat	Semi intensive	2783	C, WB, JSO	33	100	75	H, C	230	0.85	C	S	P	33	>100	C, F
RS	P2	Meat	Extensive		CC, BE, SU, TX, IF, RA	50	>75	<75	H, C	180		C	S	P		30-50	C, F
RS	P3	Dairy	Extensive		C, XP	80	>75	<75	H, C	270		C	S	P		50-100	C, F

1 – BS - Bardoka, BKP – Belokranjska Pramenka, BE - Bergamo, BO-Bovec, OPB-Improved Bovec, C - Cigaja, CC - Chokanska Cigaja, CP - Creska, DAP-Dalmatian, DP-Dubian, EF-Frisian, HP-Hercegovian, IF-Il de France, IS-Istrian, JSO-Jezersko Solchavska, KAP-Karakachanian, KP-Kupres, KR-Krivovir, LI - Lipe, LJ - Ljaba, LP-Lichka, OP - Ovchepolian, PIP-Pirot, PI - Pivska, PP-Privorian, RA - Racka, RP-Ruda, RO-Romanov, SP - Sjenica, SU - Suffolk, SVS-Svrljig, TX-Texel, WB-Wurttemberg, ZZ - Zetas yellow faced, XP - Pramenka crosses,

2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.

3 – C-Continuous; R-Rotational; RO-Roped.

4 – S-Sedentary; V-Vertical; H-Horizontal.

5 – P-Private; M-Mixed; PB-Public.

6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

3.3 Goat systems in the western Balkan countries

Since the banning of goat breeding in 1954, records about the goat production started around 1992. The present population of goats in the study area are residual animals from the past decades and imported European milk breeds, mainly Alpine and Saanen goat. The lack of tradition and knowledge on organised goat production made it difficult to establish an organised production on goat farms. The first few attempts to establish commercial farms with over 100 breeding animals were often doomed to failure. At present, the farmers who managed to overcome the difficulties and challenges of goat breeding are present on the market and expanding due to the absence of competitiveness and increasing demand for goat products.

The goat production in based on the autochthonous breeds: Balkan goat, Croatian spotted goat, Croatian White goat, Serbian spotted goat, Istrian goat, Drezhnica goat; and imported Alpine and Saanen goats.

From the way of establishment goat producers are either former sheep breeders who passed over to goat breeding over time, newbies without any affiliation or past in any husbandry activity and farmers who keep goats as “pets” but are sheep or cattle breeders.

3.3.1 The Alpine biogeographical region

Dairy goat systems in the Alpine region are present on few hotspots in which the density of animals due to the presence of commercial dairy farms exceeds the territorial average. In SI, goat breeding has a small extent, and is organised by breeding the autochthonous Drezhnica goat breed. The Alpine region in CR hosts just 7.12% of the total population of goats in the country, in MK and ME the percentages are 23.32 and 31.00 but with lower densities considering that, 42.12% and 53.20% of the national surface belong to the Alpine region. No rule is applicable to the alpine region regarding the location of hotspots for the breeding of dairy goats. The breed composition is homogeneous, through both BA and MK Alpine goat and in a smaller extent Saanen goat make up for the commercial dairy goat systems in the region. Autochthonous breeds such as the Balkan goat are present in small numbers on other livestock oriented farms. The farm sizes vary but commercial farms exceed with over 80 animals in average. The housing is indoors, grazing activities in BA (**A1**) are absent compared to MK (**A2**) where grazing activities in the alpine region are organised exclusively on the slopes of local hills and mountains. No grazing in the plains or on mountains are present. System specific final products include goat milk distributed to dairies (**A1**) and goat cheeses sold directly from the farmstead (**A2**).

3.3.2 The Continental biogeographical region

Dairy goat systems are distributed homogeneously through the continental region. The organisation divides the systems based on the intensity of the production into extensive (**C1**, **C5**), semi intensive (**C4**) and intensive systems (**C2**, **C3** and **C6**). The breed composition changes according to the production intensity from domestic breeds such as the Balkan goat and Serbian white goat (**C5**) for the extensive towards Serbian spotted goat (**C6**), Croatian white goat (**C3**), Saanen goat and Alpine goat for intensive systems. Approximately 41.08% of the total goat population in the study area is located in the continental region. Circa 70% of the total population of goats in both RS and MK is located in the continental region, but just 23.99% of the goat population from CR. The average farm size varies from just 12 animals in CR (**C3**) to 55 in RS (**C6**). The goat system compared to other small ruminant systems in CR is intensive, in terms of feeding, yield per animal, mechanisation and labour input. All commercial goat farms are technically sufficient, have mechanical milking and intensive feeding regimes based on hay and concentrate fodder (**C3**). Grazing is performed through the whole year and has a sedentary character. The tradition of goat breeding is not present due to the banning of goat breeding during the past few decades. Minor movements between four and 7 kilometres to pastures with daily return are present during the summer when the pasture is scarce. Grazing spots are in vicinity of watering points. Despite the browsing and grazing nature of the species, the small number of animals and small size of flocks does not suffice to subdue the expansion of shrubby plants and weeds. The abundance of natural pasture on slopes in the hilly area suffices for the forage needs and natural meadows are mainly the only feeding resource used by the farmers for winter, only in few cases the need for artificial meadows prevails. Fertile grasslands are grazed after the first hay harvest, but no grazing is present on mountains or valleys in which grain and vegetable production take place. The lack of goats on the grasslands on the eastern part of the continental biogeographical region led to the degradation of grasslands and biodiversity loss (**C5**). The self-sufficiency for fodder is high and all farmers are able to supply roughage and part of grain fodder. As grains in use are wheat which does not satisfy the criteria of mill industry and barley. Very few breeders cultivate artificial meadows for the production of hay. Natural meadows are the main feedstuff for the animals during the indoor period. Grazing in protected areas on any levels is prohibited.Production of the farm is oriented towards the production of milk which is processed at farmstead to cheese and directly sold to the market in quantities of 4 and 7 kilograms (**C4**). The whole goat production is oriented towards milk and cheese. Kids are considered as secondary product and are sold by the age of two months. Slaughtered kids end up on the marked as lamb carcasses instead as kid carcasses. Live weights of slaughtered animals are approximately 17 kilograms.

3.3.3 The Mediterranean biogeographical region

The Mediterranean region hosts 16.36% of the total goat population in the area. Among the countries, most notable is the distribution of goats in ME of which 69% are located in this region. Dairy goat systems are based on the use of alpine breed (60%), Saanen breed (20-25%) and crosses of these two breeds with domestic goats. Farm sizes are heterogeneous from 10 animals up to 100 in BA (**M1**). The housing conditions depend on the farm size and orientation of the farmer because many animals are kept in small numbers on mixed livestock farms. The production cycle has two seasons, the grazing season and winter indoor feeding (**M1**), whereas in ME larger commercial farms operate indoor without any grazing activity (**M3**). Roughly, 90% of the goat population in the region is breed on 50 farms (**M1**). The milking is mechanised, milking pails and pipeline-milking systems are applied. System specific final products include goat milk, and various goat cheeses (“Sir iz mijeha”, “Tvrdi koziji sir”). A secondary product of the system are kids, due to the lack of consumer habits and tradition towards goat meat. No organised kid market exists, selling at farmstead as live animal or carcass is present.

The Croatian spotted and Croatian white goat for meat production in the Mediterranean biogeographical region are breed in the Dalmatian coast (**M2**). Small flocks of approx. 18 animals in average are spread through the whole territory. The production is very extensive and organised on a year-round grazing period with sedentary grazing and some vertical movements with local shepherds. The small number of animals in the region results in low stocking densities, and under grazing occurs. The systems final products are kids, sold mostly alive, rarely as carcass. Just two farms with the Croatian spotted goat milk the animals.

3.3.4 The Pannonian biogeographical region

In all regions of the Pannonian plain in RS, goat breeding is a practice with increasing popularity and commercialisation. Of the 40,000 animals in the region, approximately 10% is breed in an intensive dairy oriented production system based on commercial breeds such as Alpine and Saanen goat. The Medium sized and large dairy farms came to exist due to the enlargement of flocks by keeping all reproductive females and buying commercial breeds into flocks with autochthonous breeds (**P2**). The base for these farms the autochthonous Balkan goat, improved by crossing with the Alpine breed. The second way of establishment is rapid investment and import of flocks with over 100 reproductive females (**P2**). Small and medium sized farms are oriented towards the combined production of meat and milk. The dairy production is dominant compared to the production of kids that are usually seen as secondary product (**P1**). Effective family own flocks are up to 60 animals, but the average size in the system lays around 20 animals. The existence of dairies supplied by intensive goat farms provides access to markets, which are unlike in other branches of animal production stable and short-term contract bound. The small and medium sized farms are unlike the large intensive dairies bound to grazing activities from spring until winter (**P1**). Grazing is performed on public pastures, governed by municipalities (**P1**). The intensive system (**P2**) has no grazing activity and the whole production is organised indoor. Grazing on private and/or rented pastures is not common practice and the importance of grazing faded away compared to its importance it once had. The protection of the domestic genetic heritage was during the past decades of the banning of goat breeding assured by small family farms in remote locations which kept the animals despite being prohibited (**P2**). Product processing is present, with the tendency to modernise the processing facilities and supply with goat milk from small farms. Two specialised dairies are operating in the system (**P2**). The target of those dairies is to specialise on goat milk, but the present production in the region does not satisfy even 60% of the production capacities of both. The system final products are milk, cheeses and kids. The production management is oriented towards milk production and kids are kept only for 10 to 15 days with the lactating female after which they are sold (**P2**).

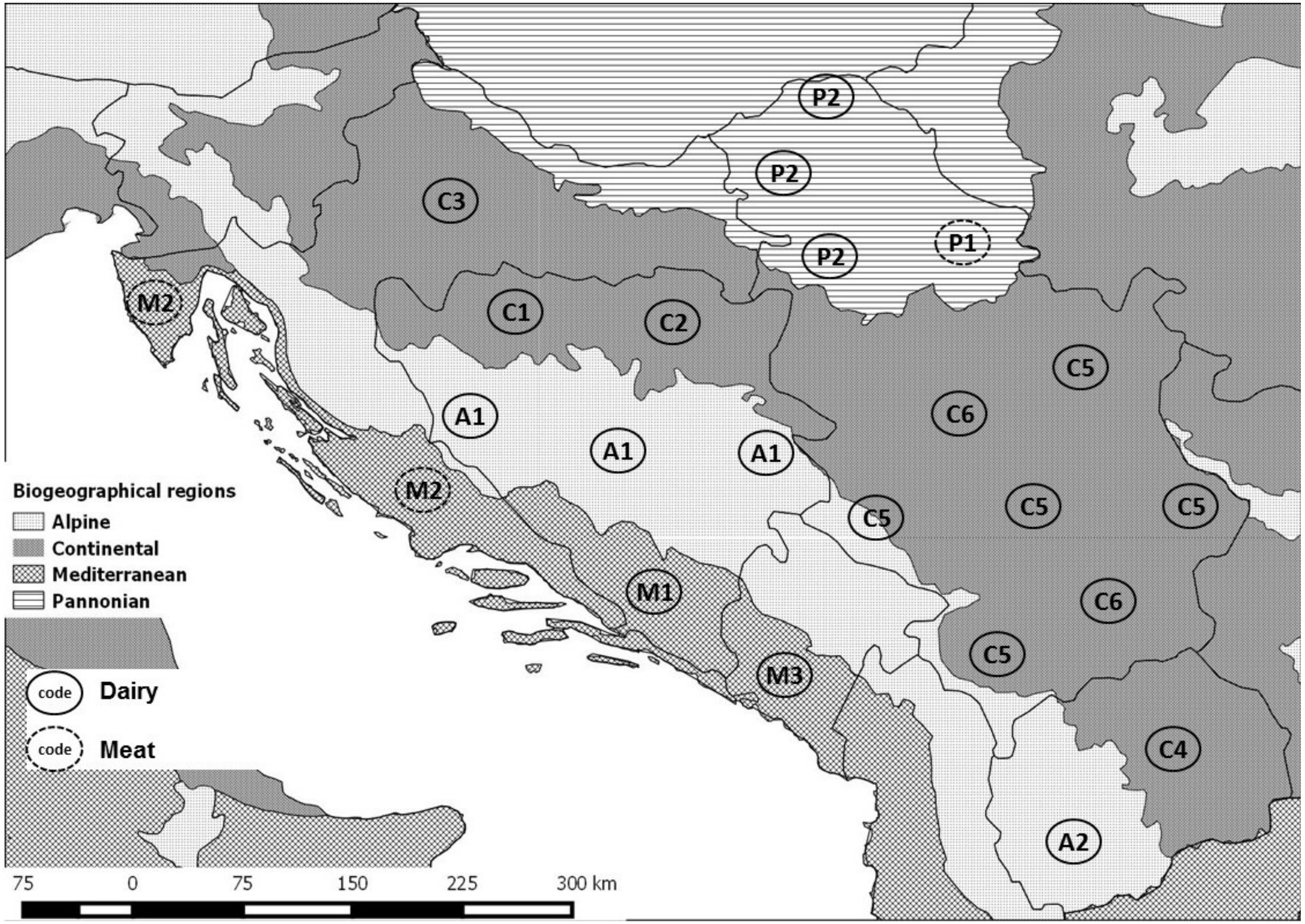

Figure II-6. Distribution of Goat systems on biogeographical regions of the Western Balkan countries.

The system identification code (SIC) is used as a reference value to link the geographical position described by the map with the complementary entry in the table and text. The SIC consists of two elements, a letter corresponding to the biogeographical region in which it is located (A: Alpine, C: Continental, M: Mediterranean, P: Pannonian), and a progressive number (1-14) for each system entry from the complementary tables.

Table II-9. Goat Systems in the Western Balkan countries.

Country	System identification code	Production purpose	Breeding type	Number of farms	Breeds[1]	Animals per farm (n)	Self-sufficiency (%)	Self-owned land (%)	Feedstuff[2]	Grazing length (days)	Stocking density (LU/ha)	Stocking method[3]	Mobility[4]	Ownership of grazing resources[5]	Grazing animals per herd (n)	Labour dependency (animal/worker)	Type of support[6]
BA	A1	Dairy	Semi intensive		AG, BG				H, C								
MK	A2	Dairy	Extensive		AG, BG												
BA	C1	Dairy	Extensive		AG, BG												
BA	C2	Dairy	Intensive		AG, BG												
CR	C3	Dairy	Intensive	1200	CWG, AG, SG	12	>75	45	H, C	210	0.80	C	S	M	12	10-30	C, F, O, M
MK	C4	Dairy	Semi intensive		AG, BG								S	M			
RS	C5	Dairy	Extensive		BG, SWG	25										10-30	
RS	C6	Dairy	Intensive	20	SSG, AG	55										50-100	
BA	M1	Dairy	Semi intensive	50	AG, SG, BG	100	100		H, C	210	0.30	C	S	M	100	50-100	
CR	M2	Meat	Extensive	1891	CSG	18	>75	45	H	360	0.15	C	S, V	M	18	10-30	C, F, O
ME	M3	Dairy	Semi intensive		AG, BG												
RS	P1	Dairy	Extensive	< 1800	BG	20	>75		H, C	210		C	S, H	M	20	10-30	F, C
RS	P2	Dairy	Semi intensive	10	AG, SG	350	>75		H, C, S							>100	F, C, M, O

1 – AG - Alpine, BG - Balkan goat, CSG - Croatian spotted, CWG - Croatian white, SG - Saanen, SSG - Serbian spotted, SWG – Serbian white
2 – H-Hay; S-Silage; C-Concentrate feed grains, U-Unifeed.
3 – C-Continuous; R-Rotational; RO-Roped.
4 – S-Sedentary; V-Vertical; H-Horizontal.
5 – P-Private; M-Mixed; PB-Public.
6 – C-Consulting; F-Financing; O-Organisation; M-Marketing.

4 Discussion and conclusion

After the demise of socialism and sometime violent conflicts among newly emerging states, the Western Balkan region is now in a phase of consolidation and overall economic growth that has for many years exceeded that of the EU's member states (Volk, 2010).

The livestock sector is now organised on the remains of the communism period, which lasted for five decades, until the early 90's. The present trends indicate the need to cope with the demands of the European Union to access markets, and in the mind-set of policy makers, it takes high priority.

Due to the regionalisation based on administrative borders and differentiation in legislation adopted by the single former Yugoslav republics, livestock systems are classified based on various criteria. All systems, despite the type, location and scale, play an important role in the socio-economic context of the analysed study area. The sector serves as social buffer, provides goods and services for the domestic market and society, both formal and informal workplaces and contributes to poverty reduction (Gerber et al., 2010; Thornton, 2010). Once agriculture production received support from the state owned agricultural cooperatives called "zadruga", which like a proxy absorbed all produced goods and delivered those to the food industry or consumers. Today, such cooperatives ceased to exist, globalisation and the need to operate in a market-oriented environment led to the demise of some of the participants in systems. Agricultural cooperatives after the market liberalisation and migration from communism to democracy tried, but often failed to replace the retired state owned cooperatives in terms of both scale and function. Today, agricultural cooperatives serve mainly as unions of farmers when needed to influence government decisions and policy makers, and express dissatisfaction towards policies in the individual sectors.

Common issue for all the analysed systems is the lack, or slow, of knowledge supply through the advisory service, where once adhered husbandry methods, sometimes outdated, are still in use (e.g. manual milking, housing and traditional practices). These production practises reflect cultural heritage that lead to the decline of production systems due to the lack of readiness to adapt production to changing demands (Jahnke, 1982). The scale of operations for farmers are often constrained with issues such as small parcel sizes and land ownership dispute, just as absence of grazing rights and proper grazing infrastructures for pastoralists (FIPA, 2013). Together with low competitiveness towards systems across regions, the mentioned factors just contribute to the constraints that the farmers are facing. The mentioned issues are not unique, yet with differing intensity, are commonly present also in other regions (FAO, 2011; Sedić et al., 2014a).

As observed by other authors (e.g. Caballero and Fernández-Santos, 2009; Rosić and Vujičić, 2000; Volk, 2010), this research revealed that both internal and external factors shape the structure and evolution of a system (Dixon et al., 2001). Those system structures incorporate ecological, social and economic components that if misunderstood for the corresponding system could cause failure for applied interventions, downward trends and at the end abandonment (Caballero, 2012; Jahnke, 1982). An example of this misunderstanding or misinterpretation of measures was the global banning of goat production in the study area that lasted from the mid-1950s to the breakup of the SFRJ (Socialist Federal Republic of Yugoslavia) in the early 1990s. Consequences that followed were the loss of genetic resources and variability of the goat population, a decline in the number of goats, an emerging gap in the market for goat products, abandonment of traditional breeding practises and husbandry methods (Cremene et al., 2005; Fisher et al., 2012), loss of knowledge on the system and land abandonment.

Pastoral sheep, cattle and the mixed livestock systems in the different biogeographical regions of the study area are treated as extensive traditional systems while indoor systems are intensively managed. The strategy choice of whether to promote the extensive agro-pastoral or intensive livestock-cropping system in a country is largely determined by the baseline internal situation. A territory dominated by traditional pastoralism will hardly be able to completely ignore that system and become intensive (Jahnke, 1982). Over the decades, farming systems may differentiate into sub-types that continue to evolve along recognisably different pathways (Dixon et al., 2001). Such as the emergence of the beef system throughout the region, or the cow-calf system everywhere in BA and in few cases in the Pannonian region of RS.

Site-specific characteristics and internal dynamics of the livestock systems have to be considered to identify sustainable development options (Caballero, 2012).

A common classification criterion of cattle systems prior to the application of this framework was not present in the study area. Despite, the surveyed experts were able to distinguish systems based on classification criteria such as main production purpose, husbandry practises feeding resources etc. The diagnostic framework applied in this study slightly diverts from mapping and classification criteria proposed by other authors (e.g. Grigg, 1974; Herrero et al., 2009; Jahnke, 1982; Ruthenberg, 1980; Seré and Steinfeld, 1996). The reasons, no existing framework could be applied, were the lack of appropriate data, the scale on which the classification and mapping took place and the final needs of this research.

The dairy cattle system, homogeneously defined as population of market oriented milk producers, is most widespread in all four biogeographical regions of the study area. In CR for example, dairy systems are those in which breeding females achieve an average milk yield of 6.500 kg per year. Milk producing farms, which have average yields below this threshold, but still provide raw milk to the market, are classified as suckling farms. Both of these groups were defined by policy makers to design proper support schemes, yet by our survey were grouped into the dairy system. Cattle farms oriented towards the production of beef, through fattening are classified as the beef system. The beef system has different levels of importance through the region and while in CR, the baby beef breeding receives more attention and regards, in other regions it is marginalised because of the small number of animals it includes, or small number of participants in the system (e.g. BA, RS and ME). To the beef system belongs also the pasture based cow-calf system. The cow-calf system emerged recently in the study area; or rather, the existence of such a system became official acknowledged. Extensive grazing to produce weaned calves either for further fattening or for direct selling was present before the setting of the first policy schemes and guidelines needed for the subsidy framework profile of e.g. BA. Farms that distribute no milk to markets, and whose breed structure is based on beef and/or dual-purpose breeds and produce just live animals for the market are classified as cow-calf breeders. Commercial beef farms without reproduction cycle and breeding females are considered as fattening farms, or baby beef farms.

In most WBs, beef or milk production occupy the first place of livestock production. Livestock production itself improved in recent years (Volk, 2010), but the organisation level among farmers to operate as unions often fails to achieve lobbying capacities.

The cattle production in the Alpine region is organised on small and medium enterprises, which excel in a mixed production of milk and meat. The breed structure shifts, over the time, from domestic to imported breeds such as the Simmental, Brown Swiss and Tyrolean grey. The feed resources in use are mostly natural pastures, meadows and corn supplements. The Continental region transit from the pasture based systems to mixed cropping systems. The breed structure remains represented by the Simmental breed with minor changes in the proportion of other breeds compared to the alpine region. A slightly intensified production with higher yields and input use is present. The Mediterranean region hosts extensive pasture based cow-calf and dairy farms. Karst features of the area provide a poor fodder base for uses other than pastoralism. The Pannonian region hosts the study area's livestock systems with the highest production intensity. The fodder base here shifts from natural to artificial pastures and meadows. Pastoral activities are present as residual activities. The local livestock production competes with the production of industrial and cash crops. Case studies belonging to the same system, despite providing the same type of products to the market, have a different structure when comparing across regions. These differences have to be taken into account prior to the creation of support and agricultural policy.

As in most of the cattle systems in the WBs study area, cattle production is moving towards specialisation (García-Martínez et al., 2008; Ryschawy et al., 2012; Stalgiene and Kuipers, 2014), small family farms either close and orientate towards multi-functionality by other economic activities or enlarge to generate more income and make better use of available labour. New, medium sized farms emerge over the time and take a share in the unsaturated domestic markets. The beef sector is reorganising in a manner in which surplus calves from the dairy system are bought off and fattened in commercial indoor farms. This practice allows for a better exploit of meat per bred animal compared to the traditional calf slaughter. The decreased cattle and human population, including the change in distribution of the remaining population, led to the abandonment of large agricultural surfaces that are currently exploited in an extensive manner with beef oriented farms (e.g. Mediterranean region of BA) (García-Martínez et al., 2008; Nikodemus et al., 2005).

Sheep production systems are commonly seen as extensive and semi intensive meat/lamb production systems of which just a small number of farmers milk their animals. The breed choice of the producers is influenced by the availability of local breeds, which in most cases are breeds for the combined production of meat, milk and wool.

The size of herding operations has a wide range and goes from a couple dozen animals to over thousand animals in single cases. No nucleus farms are present with the sole purpose of breed preservation, nor exists an organised breeding programme for the production of crossed animals. Purebred populations dominate through the study area, and the breed composition is made up of domestic breeds contributing to the preservation of animal biodiversity (Porcu and Marković, 2006). The estimated total number of animals located in the study area is 3.9 million. Through the four regions, 37% of the animals are located in the Alpine region, 46% in the continental region, 9% in the Mediterranean and 8% in the Pannonian. Most of the producers in the Alpine region are small and medium enterprises that utilise autochthonous breeds in an extensive feeding and production regime mainly meat oriented. Milking is rare and performed just by the minority of breeders that adopt migrations to mountain pastures during the summer. Lambs contribute to over 60% of the total income achieved in the sheep production across the whole study region.

The sheep sector is taking shape in different manners through the study region. While in some parts of the region dairy production, thanks to the support of the dairy industry, policy support schemes for dairy production and endangered breeds (such as in Croatia due to EU rural development programmes) records increases in both number of animals and output per animal. Contrary, in other places (e.g. Alpine region of Bosnia and Herzegovina), the number of animals is slowly decreasing due to the lack of interest and support in the less favoured areas. Sheep products have a high potential as labelled local products in the domestic markets, diverse types of sheep cheeses, named by the geographic location of origin, can already be found in the region. The only export potential in the region is found in lamb production from Montenegro (Marković and Marković, 2010).

The goat production is organised in either small or medium family farms or large commercial farms. In both cases, milk production is the dominant product orientation where in some cases kids are treated as secondary or by-product. Small and medium farms operate with domestic breeds, while increasing the flock size the breed structure shifts in favour to imported dairy breeds. A common criterion to distinguish between producers is the level of commercialisation and production intensity, which divides breeders in extensive and sometimes semi intensive from intensive breeders. Goat breeding was once labelled as prohibited in the study area, and thus after the banning was lifted, the goat population rapidly rose to fill the market demand for goat products. The population of goats in all countries is expected to increase.

To classify a system, quantitative data are necessary, and many times in the developing countries, these data are not available or not accessible. The success of measures for improvement can only be assessed through a measurable change of the state for which properly working mechanisms have to be set in place before applying major development strategies.

It is difficult to draw a line between systems as they tend to overlap in some cases, but policy schemes and development frameworks could contribute greatly to develop a clear distinction between systems (Caballero, 2012). A pattern of mixed production on small-scale farms is dominant and farmers tend to keep more than a single animal species to diversify the production and provide diverse sources for income. This diversification on one hand provides better economic stability of the single farms, but on the other hand, it encumbers to apply classification criteria and appropriate schemes for rural development.

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Chapter III: Experts perception of development options for livestock production systems in the Western Balkans

1 Introduction

Livestock production provides goods and services for human needs. Demand for livestock products in the future could be heavily moderated by socio-economic factors such as human health concerns and changing socio-cultural values (Thornton, 2010). Considering the insight a single farm can provide the livestock production is generally treated as a system, consisting of a population of farms sharing a similar enterprise pattern to provide the same services and goods to a wider population (Dixon et al., 2001). Livestock production systems heavily depend on environmental conditions, both natural (soil, climate, wildlife) and artificial such as policy setups, social cohesion, and context related dynamics. Over the time environmental conditions change, and direct exposure to these changes is inevitable. To ensure the continuity of livestock systems is not just to preserve the number of producers, the number of animals or quality and quantity of produced goods over time, but also the environment in which these procurers operate and coexist.

Since the 1972 UN Stockholm Conference on the Human Environment, awareness of the inherent fragility of the world's ecosystems has grown, leading to vast numbers of reports reviewing the relationship between economic development and environment (Fresco and Kroonenberg, 1992). The term sustainability is generally used to indicate the limits placed on the use of ecosystems by humans, or more specifically to the way in which resources can be used to meet changing future needs without undermining the natural resource base (Fresco and Kroonenberg, 1992). The concept sustainability can be applied to any dynamic, stochastic and purposeful system (Hansen and Jones, 1995) and the concept of assessment of sustainable farming systems should combine social, economic, and environmental criteria, where a proper set of indicators can be devised for assessing each criteria (Caballero et al., 2008).

Given the breakup of Yugoslavia and the ensuring war, there has been a massive change in the agricultural structure in the Western Balkan countries. The international level of economic development as well as some other conditions across the former Yugoslav republics differed, but development gaps have now widened much further (Bojnec, 2005).

The pace of change, in effect, is not unique. Main disturbances in livestock production systems are (or have been) land use abandonment and/or intensification (Caraveli, 2000; MacDonald et al., 2000), loss of region-specific production practices, deterioration of institutional management and social cohesion and, in the long term, extreme weather events. These processes have taken place at different temporal and spatial scales and the resilience to change depended on the general socio-economic environment (e.g. demographic trends, off-farm income opportunities, agricultural support policies and even, in some cases, international conventions).

Our aim is to assess the sustainability of livestock production systems emerging from those changes, from the point of view of local experts. To perform this task, the survey should be largely conceptual, as we cannot assure the presence of quantitative indicators for the broad set of livestock production systems. In devising sustainability questionnaires, the degree of detail is largely dependent on the space scale and objectives (Lightfoot and Noble, 2001).

In this exercise, a generalised set of case study livestock production systems in the Western Balkans was chosen to answer a set of questions linked to sustainability and identify a set of options for systems with a low perception of sustainability. A low perception of sustainability will result in the exposure of compromised components and current constraints. The key question here is which set of development options could be used to achieve sustainability under current conditions for the long time continuity of the addressed systems?

Our main argument is that the continuity and coherence of these farming systems is relevant in the South-East European (SEE) context and deserve the design and implementation of a framework scheme of agricultural support for rural and regional development. We will test whether or not criteria and indicators are independent and whether cut across or are generalised across systems.

2 Materials and methods

2.1 The sampling tool

Information, about the sustainability and continuity of LPS were analysed with a questionnaire requesting responses in form of quantitative and qualitative-linguistic variables divided into five sections. The first section (experts' identification, location and size of the operation and biophysical and grazing conditions) was aimed at recording sampling frequencies for the main factors of variation across the identified livestock systems in the study area. The first section recorded 10 factors of variation (FV).

Section two contained 24 qualitative-linguistic variables grouped under four criteria: general identity (A), environment (B), economics (C) and social (D). Under each criterion, six questions (variables) were submitted for consideration. The experts' perception towards the 24 variables was rated on a five-point Likert-type scale (Babbie, 1973) ranging from strongly agree (five points) to strongly disagree (one point), with undecided in the middle (three points). This way the linguistic responses referred to numerical data for the statistical analysis (Cornelissen et al., 2001). Questions were drafted in such a way that a high score would represent higher sustainability. At the end of the questionnaire, a feedback was requested on whether experts were confident with the responses or express doubt for understanding. The main objective of this section was to transform perception-views to a quantitative scale and thus rating LPS by potential sustainability criteria.

The main objective of section three was to unveil the main current constraints (CC variables) for continuity and coherence in a quantitative scale. Up to 27 worded constraints were submitted for consideration addressing the ten perceived constraints and an ordinal response was requested from the first and most important constraint (1) to the least important (10) in a scale of unrepeated numbers. Responses were transformed to a cardinal scale (from 1 to 0) by defining a line with two points of equivalence ($x1=1$, $y1=1$ and $x2=10$, $y2=0.1$) for statistical analysis.

Section four of the identity questionnaire elicited data on the experts' opinion on the direction towards which the LPS would evolve in the future. Experts were requested to freely word up to ten trends. The responses were afterwards grouped based on the criteria used for section one in general identity, environmental, economic and social. Upon grouping, the number of responses was transformed into a score of 0 to 1 based on the proportional frequency of each response in the total number of responses taken for each case study. Rather than each response individually, the partial score for each group was used for statistical analysis, including the number of total responses per case study (TG, TE, TX, TS, and TT).

Table III-1. Classification criteria adapted from Steyaert and Jiggins (2007).

Variable	Description	Adapted
Stakeholding	"Stakeholding" is the process in which stakeholders become aware of their role in a context. Stakeholding overtakes the concept of classical stakeholders' analysis and it surveys how the interests and social positions of the people involved may change over the time in relation to the issues at stake.	DO addressing the improvement between stakeholders in the LPS
Ecological constraints	This variable relies on what stakeholders know about the ecological components and processes of ecosystems. What is known about ecological constrains tends to be fragmentary and based on expert, sectoral knowledge.	DO devised to cope with constraints based on the environmental limitations
Institutions and policies	This variable issues with the constitutive elements of the 'institutional frameworks' (laws and social norms), constraints and deriving outcomes (e.g., new norms).	DO directed towards improvements in the institutions and policies affecting the LPS
Facilitation	Facilitation is defined as a combination of skills, activities and tools used to support and guide learning processes among stakeholders. Its main role is to bring about systemic change in complex situations for achieving concerted action.	DO methods for the improvement of LPS through facilitation tools
Others		DO addressing technical changes and production practice related alternatives

On section five, experts were requested to freely word up to seven development options (DO) that under its own expertise and available evidence may produce beneficial effects. Experts rated these alternatives on the type of potential effects being environmental, socio-economics or both (win-win situation) and on the type of available evidence (knowledge-based, common sense or farmers' practice). The main objective of this section was to test whether these DO's for a wide array of LPS can be embedded in a framework of policy options and thus may constitute a focus for funds' allocation and a rationale for policy reforms. An adapted version of the SLIM DF tool developed by Steyaert and Jiggins (2007) was used to group the worded responses into five groups (DO_S, DO_E, DO_I, DO_F and DO_O). SLIM DF was created for dealing with stakeholders in participatory approaches (multi-stakeholder involvement) which in our case addressed just local experts, but as classification tool including all components of the systems (Economical, Ecological, and Social dimensions), it proved to fit the needs of the approach (Table III-1). Other DO, which did not fit the SLIM DF model, were addressing technical solutions not applicable to the previous four groups. Responses aggregated in to the five main categories were further grouped into subgroups for a better perception on the taken worded responses.

2.2 Collecting and refining information

The sampling tool was created with the intention to collect information on a wide range of livestock systems in the WB region putting focus on ruminant systems. Attempts to collect the needed information by e-mailing the regional experts failed, and the response rate led to the necessity of applying personal visits. During two visits, of which the first served to collect information on the identity, scale and location of the systems and the second, which was addressed towards the sampling of sustainability, trend and development information a total of 86 responses were obtained.

The choice of a sample of experts with focus on livestock production systems was provided by an existing network of Balkan universities. The Network of the Balkan universities/researchers in the area of ex-Yugoslavia started early as 2001, through the Norwegian project "Norwegian SEE Programme in Agriculture: Competence transfer and institutional contact and co-operation between faculties of Agriculture, Forestry and Veterinary Medicine in SEE" financed by the Norwegian government. The project involved University of Sarajevo, University of Novi Sad, University of Belgrade, University of Osijek, University of Skopje, University of Podgorica, University of Mostar and University of Banja Luka. Contact with the University of Ljubljana and the University of Zagreb, as well as the Institute in Maribor and Nova Gorica was established through participation to the agriculture conference.

Around 30 Regional experts on LPS were selected and contacted by e-mail. Together with the questionnaire, a cover letter was sent explaining the objectives of the research initiative and rationale for the research job. A few experts declined the voluntary request for assistance and a few others recommended an alternative national with expertise in particular systems. Attempts to collect the needed information by e-mailing the regional experts failed, and the response rate led to the necessity of applying personal visits. During two visits, of which the first served to collect information on the identity, scale and location of the systems and the second, which was addressed towards the sampling of sustainability, trend and development information a total of 86 responses were obtained. The first phase elapsed from August 2013 (date of sending the first questionnaire) to November-December 2013 (date of performing the first visit and filling of the questionnaire). A large majority of questionnaires (90%) were the subject of a refining exercise to clear some responses or to fill unreported variables. All questionnaires were send back to the experts during April 2014 for a feedback on the inserted values, upon sorting and refining the data with additional information. The second visit was performed from January to June 2015 to collect information needed for sections two to five.

The Balkan countries and number of case studies represented in the sample were as follow: Bosnia and Herzegovina (21); Croatia (24); Macedonia (9); Montenegro (7); Serbia (15) and Slovenia (10). The map of environmental zones (biogeographical regions) provided by the European Environment Agency (Metzger et al., 2005) was used in the first visit performed to locate the sampled study areas with geographical data supported by the experts.

2.3 Data analysis

The data analysis and graphical output was generated using SAS/Studio® software, Version 3.4 of the SAS System for Windows. Factors of variation were grouped by levels and frequencies of representation in the 86 case studies (Table III-2). Criteria-variables, aggregate scores by criteria, total score, current constraint variables and trend variables were the subject of descriptive statistical analysis and variance analysis. For the former, mean ± SD, median and Wilck test of normality Shaphiro and Wilk (1965) were used. W-values near than 1 indicate symmetrical (normal) distribution. For the latter, case-study systems were grouped by levels under each factor of variation and one-way ANOVA performed. The Levene test was used for testing the homogeneity of variances, and the significance of mean differences between pairs of group was tested by the Bonferroni (homogeneity) or the Tamhane (heterogeneity) tests. By this way, the whole set of 56 variables was related to the wide array of factors of variation in the sample and typology of the expert providing assistance.

Table III-2. Grouping Livestock production systems (LPS) case studies by main factors of variation, levels and observations.

Factor of variation (FV)	Frequency with levels/categories					
	1	2	3	4	5	6
[a]Experts Affiliation (FV1)	68 U	15 R	3 M			
[b]Biogeographical region (FV2)	25 AL	29 CO	20 MED	12 PAN		
[c]Country (FV3)	21 BA	24 CR	7 ME	9 MK	15 RS	10 SI
[d]Species (FV4)	29 S	44 C	13 G			
[e]Breeding purpose (FV5)	52 MI	24 ME	10 CC			
[f]Breeding type (FV6)	20 IN	66 IN/O				
[g]Production intensity (FV7)	27 INT	16 SEMI	43 EXT			
[h]Size of holdings (FV8)	33 S	26 M	18 L	9 NA		
[i]Ownership of grazing resources (FV9)	12 PR	3 PU	44 M	27 NG		
[j]Mobility (FV10)	24 S	35 M	27 NA			

[a]FV1: U-University professor, R-Public/private research, M-Management.
[b]FV2: AL-Alpine, CO-Continental, MED-Mediterranean, PAN-Pannonian.
[c]FV3: BA-Bosnia and Herzegovina, CR-Croatia, ME-Montenegro, MK-Macedonia, RS-Serbia, SI-Slovenia.
[d]FV4: S-Sheep, C-Cattle, G-Goats.
[e]FV5: MI-Milk, ME-Meat, CC-Cow-calf (cattle only).
[f]FV6: IN-Indoor, IN/O-Indoor/outdoor (including 6 outdoor systems).
[g]FV7: INT-Intensive, SEMI-Semi intensive/extensive, EXT-Extensive.
[h]FV8: S-Small (<10 LU), M-Medium (10-30 LU), L-Large (>30 LU), NA-No estimation available.
[i]FV9: PR-Private, PU-Public, M-Mixed, NG-Not grazing system.
[j]FV10: S-Sedentary, M-Mobile (either horizontal or vertical), NA-Not available (not grazing system).

Grouping of case study systems by clusters was performed considering changes in cluster centres (K-means Cluster Analysis), chosen clusters to maximize the differences among case studies in different clusters and testing the significance of the clustering factor by ANOVA and Discriminant Analysis.

2.4 Livestock production systems

Livestock production takes place through the whole study area. No region is excluded when it comes to the human-nature intervention to raise domestic animals and provide services. The extent to which this activity is widespread through every region may vary and be difficult to assess. Indicators such as the distribution of population and animals of various species, the use of land and population density through the region may provide some insight on the importance of livestock on a spatial scale, as provided in Table III-3.

Table III-3. Indicators for the study area.

[a]BGR	Surface (%)	Population (%)	Population density (pop/km^2)	[b]Land use (000 ha)					Animals (%)		
				TAA	Other area	UAA	AA	GA	Cattle	Sheep	Goats
AL	25.65	18.19	59.99	31.63	30.99	7.91	14.12	9.60	26.83	37.23	30.46
CO	47.03	56.78	102.14	81.69	33.12	26.70	42.88	12.12	56.81	45.47	41.08
MED	13.19	10.89	69.88	16.26	15.93	7.81	2.85	5.59	2.63	9.02	16.36
PAN	14.13	14.14	84.67	27.17	7.33	6.80	17.77	2.60	13.73	8.29	12.10
Total (000)	244.12	20,654	84.61	156.75	87.38	49.21	77.62	29.92	2,563	3,905	390

[a]BGR (biogeographical region): AL-Alpine, CO-Continental, MED-Mediterranean, PAN-Pannonian.
[b]Land use: TAA-Total agriculture area, Other area (urban area, forests), UAA-Utilised agricultural area, AA-Arable area, GA-grassland.

The information gathered in Table III-3 should be used carefully because of the loss of individuality of the single countries, which account for the aggregate data. For example, CR has a high proportion of sheep and goats residing on the Dalmatian coast in the Mediterranean region that makes up 38% and 57% of the national population respectively.

2.4.1 The Alpine biogeographical region

The alpine biogeographical region is stretching from the Julian Alps in the north, over the Dinaric Alps until the lakes Ohrid and Prespa towards Albania and the Kaimaki mountain range towards Greece in the south. It is present in all countries of the study area, but due to its small occurrence in RS, it is for this country included in the continental biogeographical region.

The dairy cattle system, or milk oriented cattle production is spread through the whole region. It is represented by case studies **1, 4, 5, 6, 8, 9, 10** and **11**. The farms are mainly small and medium sized holdings which besides the production of milk also tend to organise side activities such as breeding of other species of domestic animals, fattening of calves or fruit production. The participants of the system are self-sufficient in terms of mechanisation corresponding to the size of holding. Larger farms in general possess all necessary machinery for the production, while smaller farms depend on the use of services from other farms. Grazing is performed by a part of the farmers and depending of the altitude and availability of grasslands lasts from four to seven months. The breed composition is mainly based on the Simmental or its crosses. Holstein Frisian cattle are located on larger farms, while towards the south of the region the breed composition shifts towards the Tyrolean grey and Brown Swiss.

The alpine cattle meat (beef) system is represented by case studies **2** and **12**. Unlike dairy cattle breeding, housing is year-round indoor in group-boxes or tethered. Beef production in the alpine region heavily depends on the availability of agricultural land for the production of silage corn, artificial meadows and fodder grains. Organised beef production is present in both SI (**12**) and BA (**2**), and in smaller extends in ME. The fattening farms are supplied with calves from both domestic and foreign markets and therefore a heterogeneous breed composition can be found. Compared to the extent of the dairy systems inside the region, the beef breeders play a minor rule in terms of animals, farms and supply to markets. Particularities of the beef system are smaller number of farms with a larger number of animals per farm, no reproduction cycle, unifeed fodder and higher stocking densities than in dairy breeding.

Cow calf system is represented in the alpine region by case studies **3**, **7** and **13**. The system is organised on an extensive management scheme by maximising the use of natural pastures and partly forested or shrubby surfaces through year-round grazing. Compared to the long past of dairy breeding, Cow-calf breeding is a relatively young production practice in the study area and first generation farmers manage most of the farms. The breed composition is heterogeneous (Limousine, Aberdeen Angus, Charolaise and Hereford towards dual-purpose breeds like Simmental and even Holstein Frisian, Tyrolean Grey and Brown Swiss are present (**3** and **13**)) and autochthonous breeds like the podolian Busha cattle (**7**) or the Cika (**13**) are present in smaller extent. Grazing activities last effectively from spring until winter and extend over eight months. Depending on the site conditions and weather during winter, year-round grazing with supplementary feeding on pasture or paddock are a management practice some farmers adopt.

Despite the economical weight lamb meat represents in the sheep production, a third of the total income generated by sheep breeding belongs to the production of milk. Sheep systems that adopt milking are represented by case studies **14**, **16**, **18**, **19**, **21** and **22**. The dairy sheep production is either sedentary or transhumant as in case studies **18**, **19** and **22**. Sedentary sheep breeding in the alpine region is present through the whole study area. The extent varies, but the practice to raise animals on pasture, milk after the weaning of lambs and transform raw milk into cheeses represents a traditional management practice. In SI, farmers of the traditional "planina" system (**22**) practice vertical movements to the Julian Alps, and utilise mountain pastures and grassland plateaus, a practice similar to those performed in MK on Shar Mountain (**18**). In ME movements to "katuns" on Sinjajevina, Durmitor, Morača and Golija mountains (**19**) and in BA movements to Vlašić Mountain, Kupres and Bjelašnica (**14**) were once a common practice which exists now as residual activity. Grazing activities are limited to the growth period and last up to 7 months. Sedentary breeding of sheep for milk production is oriented towards the commercial production of milk. The breed structure is compared to the cattle systems heterogeneous, and almost every micro region is rearing its local strain of the Pramenka sheep.

The meat sheep system in the alpine region spreads through the whole area. The importance concerning the number of animals involved into meat production varies from approximately 40% in BA (**15**) to 80% in CR (**17**) and SI (**23**). In average, meat systems have larger flock sizes, due to the lower demand for labour and larger amount of animals' one herder can manage. In statistical records, small flock sizes are the result of mixed breeding with other species, in which the farmers prefer a diversified livestock production to the breeding of a single species to cope with market fluctuations. The feeding is adapted to the availability local resources, and the low stocking densities of the region allow for a large source of feedstuff during the year (e.g. abandoned cropland and public land). Movements of the animals towards summer pastures are a practice that loses its importance due to the decreased number of animals in the region. In most cases, just 5-10% of the animals participate in movements towards lowlands during winter and mountains during summer (**15**, **17** and **20**). System specific final products are lambs weaned from April until June. The lambs are sold as live animals with weights of approximately 25 kg or as carcass directly from the farmstead.

Goat system in the Alpine region is mainly dairy oriented and present on few hotspots in which the density of animals due to the presence of commercial dairy farms exceeds the territorial average. That system is represented by case studies **24** and **25**. In SI, goat breeding has a small extent, and is organised by breeding the autochthonous Drezhnica breed. The Alpine region in CR hosts just 7.12% of the total population of goats in the country, in MK and ME the percentages are 23.32 and 31.00 but with lower densities considering that, 42.12% and 53.20% of the national surface belong to the Alpine region. The breed composition is homogeneous, through both BA and MK Alpine goat and in a smaller extent Saanen goat make up for the commercial dairy goat systems in the region. Autochthonous breeds such as the Balkan goat are present in small numbers on other livestock oriented farms. The farm sizes vary but commercial farms exceed with over 80 animals in average. Animals are reared indoors, grazing activities in BA (**24**) are absent compared to MK (**25**) where grazing activities in the alpine region are organised exclusively on the slopes of local hills and mountains, but n grazing in the plains or on mountains are present. System specific final products include goat milk distributed to dairies (**24**) and goat cheeses sold directly from the farmstead (**25**).

2.4.2 The Continental biogeographical region

Parallel to the alpine biogeographical region, stretching alongside its eastern border from the Julian Alps in the north towards the northern border of Greece on the south and the pannonian plain on the north-northwest covers the continental region. The region extends over 47.03% of the study area. It is present in five out of the six countries of the study area (BA, CR, MK, RS and SI).

The dairy cattle system is like in the alpine region spread through the whole region and the dominant cattle breeding method. Case studies representing this system are **26**, **27**, **30**, **33**, **35**, **36**, **37** and **38**. In terms of number, family households with less than 10 cows (**26**, **27**, **33**, **36** and **37**) dominate as systems regarding the number of animals present in these units. Medium sized farms (**30**, **35** and **38**) are minor in terms of unit number on the study area, but these systems participate more frequently with a market share and supplement the dairy industry. Large farms are present through the continental region, but their share in terms of animal number in the whole population of cattle inside the region accounts to 1% and is rather insignificant. Mechanisation self-sufficiency is higher compared to the alpine region but the needs for the use of mechanised units are also higher. Milking mechanisation and technological solutions increase at farm level proportional to the increase of animal number per farm. Grazing activities are related to the pressure of other agricultural production in the area, and the availability of grasslands to which usually just the small farms of the region have proper access, due to their remoteness. Grazing activities are organised on a daily return basis with sedentary herds. The dairy industry plays a big role in the regional development and stability of the system and high levels of dependence to dairies from the farmers exist.

From Continental SI (**39**) over Bjelovar and Daruvar in CR (**31**), through Posavina in BA (**28** and **29**) the importance and scale of the beef system, organised on feedlots, varies. The “baby beef” production in CR (**31**) is a well-known production practice since the communism period. The beef system is organised in fattening farms without any grazing activities (**28**, **31** and **39**) by using unifeed rations based on corn silage, haylage, hay and concentrate rations. Some fattening farms with the access to paddocks and grazing during summer fattening are present (**29**). System specific final products include fattened calves and fattened bullocks at various ages depending on the market preferences. Minor fattening activities are present also in other countries (RS, MK) in smaller extents.

Cow-calf breeding in the continental region is organised in remote hilly-mountainous and regions with unfavourable features (case studies **32**, **34** and **40**). In CR (**32**), a traditional mixed system in the Basin of Sava River on the territory of the natural park “Lonja plain” is organised by breeding cattle, horses and pigs with horizontal movements. A similar mixed pattern is present in MK (**34**) and Si (**40**) though the extent of other species never outnumbers the number of cattle in any of the cases. The housing is organised in open stables, with permanent access to pasture or paddocks, or in closed stables with stalling just during the winter (**32**). Cow-calf breeding is performed as side activity to extensively utilise agriculture land, because of the lack of interest of producers to utilise it or because of protection status of the area. System specific final products include live animals for the local beef producing farms and fattened animals on farms that have the capacity to organise the fattening process.

The dairy sheep system in the continental region is represented by case studies **44**, **45**, **46** and **48**. Through the region its importance varies depending on the country, even the type of support and attention towards the production of sheep milk vary strongly through the region. In CR, the dairy system (**44**) has an equal if not higher importance than the meat production system of the region. Based on the agricultural census of 2012 in RS sheep breeders are homogeneously dispersed over the continental region (Popović, 2014). Housing conditions are in all cases limited to a five month indoor period during the winter, and a seven month grazing season which extends towards the south of the region up to year-round grazing (**46**). In CR, the farmers already apply mechanical milking, and adopt sophisticated methods to concurrence with the European regulations regarding milk quality standards. In RS (**48**) and MK (**46**) traditional methods are applied with milking mostly organised on summer pastures. System specific final products are local cheeses sold on farmstead, milk distributed to dairies, which is mostly the case in CR (**44**) and weaned lambs which still make over 50% of the profit farmers generate through the year.

The meat sheep system (case studies **41**, **42**, **43** and **47**) in the continental region is organised in an extensive and semi intensive production, and just in BA, a small number of farms perform intensive rearing of fattened lambs (**41**). Around half of the population of sheep in CR is breed in a semi intensive production system (**43**) involving besides the local also imported European breeds and crosses such as the Romanov sheep and Wurttemberg. The meat system in RS is located in the flat plains south of the Sava river and alongside Morava river in the Podunavlje region. Housing is poorly organised in wooden barns and stables and often are the animals kept with animals of other species. Grazing extends over six to eight months during spring and summer, to late autumn. The animals receive during winter meadow hay and corn as supplementary feed. The use of concentrates increases with the increase of production intensity. A winter regime of 100 kg hay and 100 kg corn per animal is applied in conditions in which animals have access to pastures or paddocks through the whole year. System specific products are lambs weaned after approximately 4 months of suckling.

The dairy goat system is distributed homogeneously through the continental region and represented by case studies **49**, **50**, **51**, **52** and **53**. The organisation divides the systems based on the intensity of the production into extensive (**49** and **53**), semi intensive (**52**) and intensive systems (**50**, **51** and **54**). The goat system compared to other small ruminant systems in CR is intensive, in terms of feeding, yield per animal, mechanisation and labour input. All commercial goat farms are technically sufficient, have mechanical milking and intensive feeding regimes based on hay and concentrate fodder (**51**). The self-sufficiency for fodder is high and all farmers are able to supply roughage and part of grain fodder. As grains in use are wheat which does not satisfy the criteria of mill industry and barley. Very few breeders cultivate artificial meadows for the production of hay. Natural meadows are the main feedstuff for the animals during the indoor period. Production of the farm is oriented towards the production of milk that is processed at farmstead. Kids are considered as secondary product and are sold by the age of two months. Slaughtered kids end up on the marked as lamb carcasses instead as kid carcasses. Live weights of slaughtered animals are approximately 17 kilograms.

2.4.3 The Mediterranean biogeographical region

The mediterranean biogeographical region stretches along the Mediterranean Sea from the border of Italy and Slovenia in the north, over the Istrian peninsula and Dalmatian coast on the west until Shkoder Lake between ME and Albania in the south covering 13% of the surface of the study area (Table III-3). Towards the west, it leans on the Dinaric Alps.

The dairy cattle production system in the Mediterranean region is organised on small and medium sized holdings (**55**, **59**, **61** and **63**) and few larger farms in CR (**60**). The breed structure is similar to other regions. Housing is very poor, and the use of technological innovations as well. Milking is manual; mechanisation in the region is scarce and outdated. Some of the producers in the region laid hopes into the food industries whose by product were available as free fodder, but the lack of suitable meadows and arable surfaces for crude fodder production made attempts to organise production based on industrial residuals unsustainable (**55** and **63**). Grazing in the area is organised just sedentarily (**55** and **61**) in small and medium farms. Some farms do not practice grazing activities due to the competitiveness for arable land with other agricultural productions (**63**). System specific final products include milk distributed to dairies, processed products such as cheese and fermented drinks and weaned calves for fattening.

The beef system is represented by case studies **56** and **57**. Indoor fattening on feedlots is rare, and just few farms utilise fattening of calves for the domestic market (**56**). The presence of cow-calf breeders and dairy farms serves as source for the supply of fattening material. Less than the half of fattening farms have organised a grazing period with supplementary feed for bulls (**57**). The fattening period includes all-year grazing and supplementary corn on natural pastures.

The Cow calf system in the Mediterranean region is organised in two major locations. The Istrian peninsula in CR is the hotspot of the autochthonous podolian Istrian cattle breed (local name “Boshkarin”) reared on the use of scarce Mediterranean pastures (case study **62**). The whole population is under protection status and is under subsidy schemes to support the continuity and expansion of the breed. In BA (**58**), cow calf breeding emerged as potential land use solution for the abandoned rural areas in the karst hills of Herzegovina region. The system is relatively young on this territory, and such as this has few but raising recognition. The lack of competitiveness and existing demand for beef meat favours this breeding type. Grazing activities last from eight to nine months, including a short indoor period. Grazing is performed on natural pastures and neither artificial pastures nor meadows are sown. System specific final products are weaned calves and fattened adult animals.

In the Mediterranean region, the dairy sheep system is present from the Istrian peninsula, through the Dalmatian coast, including the CR islands, over Herzegovina (BA) and the west of ME. Heterogeneity of the system is most common due to the breed diversification. In CR three dairy systems can be identified. The Intensive dairy breeding of the Istrian autochthonous breed on the Istrian peninsula (**66**), the semi intensive breeding on the islands Pag and Krk (**67**) and the extensive dairy sheep breeding on the Dalmatian coast south from the alpine region (**68**). An extensive dairy system spreads through the Mediterranean region of ME, with a higher density of animals in the vicinity of Shkoder Lake bordering with Albania. In terms of housing, the system is based on year-round grazing with shelter during winter. Housing conditions towards the north are improving for the needs of the milk production. On the islands and in Dalmatia open shelters or dry walls are mostly all infrastructures the animals are kept in (**67**, **68** and **71**). System specific final products range from milk, cheese, dry sheep meat to carcasses of weaned lambs to live animals.

The sheep meat production system in the Mediterranean region is exclusively extensive. No, or just rarely, are animals raised with supplementary feed, artificial forage crops, or particular fattening methods to increase yields. The lamb breeding reaches from the Konavle islands, Cres and Rab, on the west of CR (**69**) over the Dalmatian coast (**70**), through the Herzegovina region in BA (**65**). The Dalmatian meat system involves approximately 90% of the sheep population on the Dalmatian coast. The feeding is fully adapted to the environment, and grazing on scrublands and grasslands serves as the main source of feedstuff for the animals. Milking is performed on a minority of animals after weaning of the lambs and directly on the pasture (Barać et al., 2006). A common feature of this sheep system is the utilisation of poor pastures endangered by scrub encroachment through year-round grazing on plots physically separated by once established stone walls. The main product of the system are live lambs, carcasses and dry sheep meat.

The dairy goat system is based on the use of alpine breed (60%), Saanen breed (20-25%) and crosses of these two breeds with domestic goats. Farm sizes are heterogeneous from 10 animals up to 100 in BA (**72**). The housing conditions depend on the farm size and orientation of the farmer because many animals are kept in small numbers on mixed livestock farms. The production cycle has two seasons, the grazing season and winter indoor feeding (**72**), whereas in ME larger commercial farms operate indoor without any grazing activity (**74**). Roughly, 90% of the goat population in the region is breed on 50 farms (**72**). System specific final products include goat milk, and various goat cheeses ("Sir iz mijeha", "Tvrdi koziji sir"), the selling of kids at farmstead as live animal or carcass is present.

The Croatian spotted and Croatian white goat for meat production in the Mediterranean biogeographical region are breed in the Dalmatian coast (**73**). Small flocks of approx. 18 animals in average are spread through the whole territory. The production is very extensive and organised on a year-round grazing period with sedentary grazing and some vertical movements with local shepherds. The small number of animals in the region results in low stocking densities, and under grazing occurs. The systems final products are kids, sold mostly alive, rarely as carcass. Just two farms with the Croatian spotted goat milk the animals.

2.4.4 The Pannonian biogeographical region

The pannonian region is located in three of the six countries of the study area, covering a surface of 14% (Table III-3). It is located in north RS and along the northern border of CR. Due to its small extent the PAN region is included in the continental region for SI.

The dairy cattle system in the PAN biogeographical region is an intensive indoor breeding system (case studies **75** and **79**). Breed composition includes Holstein Frisian and Simmental cattle (**75** and **79**) in farms that are more intensive and just Simmental and crosses in farms with lower production intensities (**78**). Housing is either indoor chained or free stalling with collective grazing activities in remote areas (**78**). Grazing activities are limited to fallow land and public pastures on which farmers from villages collectively graze adopting a daily return. Due to good soil fertility and versatile ways of use, this system competes with other agricultural productions, such as oil seed, grain production and other plant productions. System specific final products include milk and young calves.

With approximately 30 farms, the beef system is a side line system (case studies **76** and **80**). In RS (**80**) the practice of commercial fattening of animas is new and just a secondary activity of the farmers. Fattening animals on feedlots, in group-boxes, up to 600 kg live weight is a practice that ensures the use of domestic calves that serve as surplus in the dairy system. Despite the small number of farms, the amount of domestically produced calves often does not satisfy the capacities of beef farms, and calves from Hungary and Romania are imported. No grazing activities and no product processing are present in this system.

Cow-calf breeding in the Pannonian biogeographical region can be found under one of four main conditions: the area is considered protected as natural or national park such as “Kopački rit” and “Papuk” and can only by maintained by grazing (**77**); the area is heavily abandoned and remote (**77**); the area is located in river estuary’s and is flooded during the winter and spring; the area is mainly made of shallow topsoil and fallow land and unsuitable for other types of production (**77** and **81**). The breed structure is composed of Hereford, Aberdeen Angus, Charolaise and Limousine. The grazing extends from the end of March until the end of September and is mainly organised on natural pastures without rotational movements, but can extend over the whole year depending on the winter season. This system has just little importance due to its marginalisation in the region.

Dairy sheep production is not a common agricultural practice because dairy production on sheep farms never exceeds the value of produced lambs, and most breeders exploit just a portion of the possible milk yield. It is represented by one case study from RS (**84**). Overall territory of Banat and on the west of Sremska Mitrovica are hotspots for the dairy sheep system in RS. The system is based on the use of combined sheep breeds. The production is pasture based with a seven month grazing period and indoor during winter. Fruška gora and Deliblato sands are undesired pasture grounds but grazing in these two national parks is frequent. Other grassland areas with protected status include; Stari begej - Carska swamp, Vršac Mountains, Palić Lake and Lake Ludash. The final weight of lambs exceeds 30 kilograms. Processing of milk on the farmstead and direct selling are common among the farmers.

In the Pannonian region of both CR and RS, the sheep meat system is dominant compared to the milk system. Farms across the region are located close to surfaces with unsuited conditions for intensive crop production. The system is represented by case studies **82** and **83**. Housing conditions are organised on an indoor/outdoor management. Indoor breeding lasts for five months in which the animals lamb, are supplementary feed and are prepared for the grazing season. The grazing season lasts seven months in average. The animals in the system of CR (**82**) are, compared to RS (**83**), additionally fed with supplementary corn during the whole year. Because of good fertility of the soil, grazing is located on fallow land, in remote areas and on crop residuals. The nutrition for animals often uses secondary products from other agricultural productions. System specific final product are weaned lambs, with higher body weights in RS compared to CR.

Through the whole Pannonian plain in RS goat breeding is a practice with increasing popularity and commercialisation. Of the 40,000 animals in the region, approximately 10% is breed in an intensive dairy oriented production system based on commercial breeds such as Alpine and Saanen goat. The dairy production is dominant compared to the production of kids that are usually seen as secondary product (**85**). The existence of dairies supplied by intensive goat farms provides access to markets. The small and medium sized farms are unlike the large intensive dairies bound to grazing activities from spring until winter (**85**). Grazing is performed on public pastures, governed by municipalities (**85**). The intensive system (**86**) has no grazing activity and the whole production is organised indoor. Product processing is present, with the tendency to modernise the processing facilities and supply with goat milk from small farms. The system final products are milk, cheeses and kids.

3 Results

3.1 Experts perception on sustainability of livestock production systems

The partial scores of individual case studies by criteria of identity (A), environment (B), economics (C) and social (D) character and the aggregate total score of the four criteria are also aggregate responses of corresponding experts to the six worded variables by criteria in the sustainability questionnaire. All individual criteria-variables and the aggregate score for the economic and social variables showed asymmetrical distribution while the aggregate variables for identity and environment and the total score showed normal distribution in the Shapiro-Wilck test of normality. The full list of partial scores is shown in Table III-4.

As individual variables showing asymmetrical distribution, the means of the smallest variable by criteria across study areas, the median range and the variables showing the lowest and highest values are more representative than the variable means. The mean of the smallest variable across study areas were 2.73 ± 1.02, 2.44 ± 0.81, 2.71 ± 0.94 and 2.74 ± 0.90 for identity, environment, economic and social criteria, respectively. The median ranged from 2.5 in A3 to 4 in A1 and A4 for the identity variables; from 2 in B5 to 5 in B1 for the environment variables; from 2 in C4 to 5 in C3 for economic variables; and from 3 in D2, D3 and D4 to 4 in D1, D5 and D6 for the social variables.

On the identity criteria, variables with the highest scores were A4 and A1. For the former, 92% (for goats) and 100% (for cattle and sheep) of experts agree or strongly agree that external help to LPS in the form of technical and institutional support or effective agricultural policy schemes is still required. For the latter, 67% (66% cattle, 76% sheep and 54% goats) of experts agree or strongly agree that despite external and internal disturbances the LPS have still a recognisable structure with regional identity. On the opposite side of the identity criteria, we found variable A3, for which, 45% of experts (45% cattle and 59% sheep) disagree or strongly disagree on that the community of livestock farmers is well-organised for lobbying capabilities and transmitting values to the whole society.

For variables on the environment criteria, B1 and B3 reached the highest score and 90% of experts (84% cattle, 97% sheep and 92% goats) agree or strongly agree on that the LPS are still based on the use of locally available forages (pasture, fodder crops). For the latter, 80% of the experts (70% cattle, 93% sheep and 85% goats) agree or strongly agree that beneficial management alternatives can be implemented for improving environmental services of LPS. On the other side of the scoring scale, we found variable B5 with the lowest scoring of all criteria variables (2.44 ± 0.98), for which, 60% of respondents (69% sheep and 85% for goats) disagree or strongly disagree on that environmental non-governmental organisations (NGO) are working appropriately with farmers in the pursuit of beneficial management practices, as observed by Caballero et al. (2012) for European Large scale grazing systems. Support of environmental NGO’s based on the received responses is mostly limited to the duration and extent of financial support provided for the activities, where those NGO’s are present.

Table III-4. Partial score by criteria and total score of case-study livestock production systems.

Biogeographical region (FV2)	[a]Species (FV4)	[b]Breeding purpose (FV5)	Case study	General (ΣA)	Environmental (ΣB)	Economic (ΣC)	Social (ΣD)	Total score
Alpine	Cattle	MI	1	12	19	21	16	68
		ME	2	13	19	21	17	70
		CC	3	14	19	21	17	71
		MI	4	19	28	18	17	82
		MI	5	19	23	22	20	84
		MI	6	19	21	19	19	78
		CC	7	17	23	18	18	76
		MI	8	23	20	22	19	84
		MI	9	20	21	22	19	82
		MI	10	22	20	23	19	84
		MI	11	22	24	25	20	91
		ME	12	19	19	23	18	79
		CC	13	19	22	22	19	82
	Sheep	MI	14	21	22	21	20	84
		ME	15	21	22	21	20	84
		MI	16	21	19	22	16	78
		ME	17	21	19	22	16	78
		MI	18	22	20	26	21	89
		MI	19	20	24	22	19	85
		ME	20	17	24	19	20	80
		MI	21	18	24	24	22	88
		MI	22	19	24	22	22	87
		ME	23	17	24	21	21	83
	G	MI	24	20	22	21	20	83
		MI	25	16	18	20	19	73
Continental	Cattle	MI	26	23	19	20	22	84
		MI	27	23	20	20	22	85
		ME	28	22	19	20	22	83
		ME	29	22	20	20	22	84
		MI	30	26	18	22	23	89
		ME	31	25	22	18	26	91
		CC	32	20	22	16	19	77
		MI	33	19	21	19	19	78
		CC	34	17	23	18	18	76
		MI	35	24	23	22	22	91
		MI	36	22	24	22	20	88
		MI	37	20	24	22	20	86
		MI	38	15	17	18	15	65
		ME	39	14	17	18	15	64
		CC	40	16	17	18	15	66
	Sheep	ME	41	18	21	19	19	77
		ME	42	19	21	19	19	78
		ME	43	20	26	20	16	82
Continental	Sheep	MI	44	19	26	22	16	83
		MI	45	19	19	23	22	83
		MI	46	19	19	23	20	81
		ME	47	20	24	23	19	86
		MI	48	21	24	23	19	87
	Goats	MI	49	19	21	20	19	79
		MI	50	20	21	20	19	80
		MI	51	23	19	20	20	82
		MI	52	16	18	20	19	73
		MI	53	18	22	21	19	80
		MI	54	18	22	22	21	83
Mediterranean	Cattle	MI	55	20	22	21	23	86
		ME	56	19	20	21	19	79
		ME	57	19	21	23	20	83
		CC	58	20	23	23	22	88
		MI	59	18	25	26	16	85
		MI	60	27	23	28	20	98
		MI	61	22	23	24	22	91
		CC	62	26	22	24	23	95
		MI	63	21	16	19	15	71
	Sheep	MI	64	21	22	22	20	85
		ME	65	21	22	22	20	85
		MI	66	25	21	27	25	98
		MI	67	29	19	26	20	94
		MI	68	15	25	18	14	72
		ME	69	21	24	18	15	78
		ME	70	21	24	18	15	78
		MI	71	19	22	20	19	80
	Goats	MI	72	22	22	23	19	86
		ME	73	23	24	20	19	86
		MI	74	20	22	23	21	86
Pannonian	Cattle	MI	75	24	21	19	17	81
		ME	76	24	20	23	15	82
		CC	77	20	21	24	18	83
		MI	78	27	22	21	19	89
		MI	79	19	25	17	19	80
		ME	80	22	22	22	19	85
		CC	81	20	24	21	17	82
	Sheep	ME	82	18	26	20	16	80
		ME	83	17	18	19	21	75
		MI	84	16	20	19	21	76
	G	MI	85	16	20	19	21	76
		MI	86	21	18	23	17	79

[a]Species: G-Goats.
[b]Breeding purpose: MI-dairy, ME-meat, CC-cow-calf (cattle only).

In the economic criteria, variable C4 showed the lowest scoring (2.71 ± 0.94). It was besides B5, the only variable with median=2 and 54% of respondents showing disagreement or strong disagreement on that the current participants in the LPS have social, financial and technical capabilities and are well-organised for access to markets. A large majority of experts (86%) agree or strongly agree on that the delivery of indigenous products with marketing capabilities is or can be an important sign of identity (variable C3). The highest score on agreement or strong agreement was observed for the possibility to implement beneficial management alternatives to improve economic results in the individual LPS (variable C2) with a consensus of 92%. Experts agree or strongly agree, with 70% of responses, that the continuity of LPS is essential for side-economic activities in the area (variable C5). On the other side, variable C1 was inversely correlated to variable C3 (r=-0.351).

The social criteria showed the lowest aggregate score (19.16 ± 2.41) and the not-so-strong consensus was concentrated on three low scoring variables (D2 and D4) and a higher-scoring one (D1). About half of the experts (42%) disagree or strongly disagree on the delivery of services to be a rationale for devising and implementing production practices (D4). On the criteria variable that husbandry activities are the main economic activity insuring the presence of population in the territory and assuring social cohesion of the area, 59% of the experts provided agreement or strong agreement (77% for goats). Around half of the experts agree that external disturbances to the system have more importance than internal ones (56%). A third of the responses (37% for total, and 41% for sheep, but 30% and 38% undecided for cattle and goats) disagree that young farmers are interested in the farming operation to assure family business turnover (D2). For the last social variable (D6), a large minority of experts (57% agree or strongly agree with 20% undecided) had the perception that land accessibility is properly governed by normative rules and not by informal rules and unclear claims of land property, but these opinions were strengthened mostly by the observations for cattle systems (68%), rather than sheep (52%) or goat systems (31%).

The whole set of criteria-variables showed a low level of correlation amongst responses. Out of 276 single inter-correlations of the 24 variables, 13 cases showed correlation coefficients higher than ± 0.4, but 79 correlation coefficients had a significance below $P<0.05$. For the aggregate criteria scores a correlation coefficients higher than ±0.4 was found for the variables ΣA and ΣC. For the aggregate criteria scoring (ΣA, ΣB, ΣC, ΣD), only the means differences of the environmental criteria with that of the economic criteria were significant ($P<0.01$).

All of this suggests that criteria-variables are independent and grouping case studies by aggregate criteria scores gives insight. If we fixed the attention in the half 12 lower-scoring variables (A2, A3, A5, A6, B4, B5, C1, C4, C6, D2, D3 and D4) and on the subsample of eight lower scoring LPS case studies by their total score (case studies Nº1, 2, 3, 26, 27, 28, 37 and 67 and total score ranging from 64-72), a concerning consensus (disagree or strongly disagree response) of 100% was reached for variables A3 and D4. A consensus of 87.5% for variables A2, A5, C6 and D3, 75% for D2, 62.5% for A6 and B5 and of 50% for variables B4, C1 and C4. Similar observations (10 of 12 variables) were made by Caballero (2012) for European large scale grazing systems.

3.2 Current constraints

The, by the survey tool proposed, 20 worded current constraints extended to 27 by the option of including additional responses by the experts. The 27 worded current constraints (CC) and their scoring are presented in Table III-5. They were rated on a scoring scale ranging from 0 below the importance threshold, over 0.1 (less important) to 1 (top constraint). Current constraints were like the sustainability criteria variables also inter-correlated. Out of 174 single cases, 81 showed correlation coefficients higher than ± 0.4. Rating of particular constraints was more illustrative. Across the whole set of case-study LPS, 18 constraints reached scores higher than ±0.6 (except CC5 and CC11). Only constraints related to products market conditions and the loss of knowledge on the management in the systems were not correlated with other constraints.

Table III-5. Global rating of potential current constraints in 86 Livestock Production Systems (LPS).

[a]Nº	Wording of current constraint (CC)	Repetitions	[b]Mean ± SD
CC1	Ecological constraints	18	0.41 ± 0.32
CC2	Insensitive policies and inadequate normative system	47	0.57 ± 0.27
CC3	Absence of supporting policies/regulations	55	0.63 ± 0.24
CC4	History of the situation	25	0.56 ± 0.23
CC5	Unfavourable products market conditions	67	0.67 ± 0.27
CC6	Lack of sufficient income generation from the livestock operation	52	0.76 ± 0.25
CC7	Context and socio-economic dynamics	48	0.58 ± 0.30
CC8	Costly and scarce waged labour	51	0.58 ± 0.34
CC9	Lack of livestock farmers' affection and tradition towards the farming operation	27	0.49 ± 0.24
CC10	Lack of family business turnover	56	0.49 ± 0.24
CC11	Loss of knowledge on the management of the described system	60	0.47 ± 0.30
CC12	Deficient or inoperative advisory and training services	43	0.50 ± 0.25
CC13	Constraints in access to capital for sustainable investments	58	0.63 ± 0.22
CC14	Lack of potential forage/grazing resources	33	0.58 ± 0.29
CC15	Disturbances for mobility or accessibility to grazing/forage resources	23	0.56 ± 0.32
CC16	Unsatisfactory infrastructures	46	0.51 ± 0.26
CC17	Current practices represent a hard-working operation	47	0.41 ± 0.24
CC18	Lack of participative management planning	36	0.29 ± 0.14
CC19	Lack of recognition of the ecosystem services provided by the systems	6	0.28 ± 0.21
CC20	Lack of research on the topic	19	0.38 ± 0.32
CC21	Lack of appropriate farmer associations	4	0.50 ± 0.00
CC22	Lack of breeding programs for small ruminants	4	0.40 ± 0.00
CC23	Lack of marketing for autochthonous products	4	0.30 ± 0.00
CC24	Small parcel sizes and fragmentation	10	1.00 ± 0.00
CC25	Foresting	7	0.90 ± 0.00
CC26	Poor landownership policies	7	0.80 ± 0.00
CC27	Pressure by policies and controls	7	0.10 ± 0.00

[a]Random order of potential constraints in the questionnaire. Experts provided individual ordinal responses from 1 (most important constraint) to 10 (lest important). This response was transformed by regression to a scale ranging from 1 (most important) to 0.1 (least important) for statistical analysis.
[b]Constraints CC4, CC9, CC14 and CC19 showed symmetrical distribution while all other constraints had asymmetrical distribution (Shaphiro-Wilk test).

The constraint with the highest inter-correlations with other criteria variables were CC4 and CC15 with 13 inter-correlations each, followed by CC8 and CC20 with 12 inter-correlations. History of the situation (CC4) and the disturbance for mobility and/or accessibility for land (CC15) were the most correlated constrains depicted by the local experts. Constraint criteria variables CC21 to CC27 were excluded due to the lack of pairs for analysis. The strongest correlation (r=1) was found between (CC18 and CC19) the lack of participative management planning and the lack of recognition of the ecosystem services of the systems. The strongest negative correlation (r=-1) was found between the pairs of constraints CC1:CC18, CC9:CC19 and CC9:CC20. Other six correlations with values below r=-0.88 were found.

Based on the frequency of the responses with 67, with an agreement of 78% by the experts, the unfavourable products market conditions (CC5) is found to be the most chosen constraint for the continuity through all case studies. With 60 responses, the loss of knowledge on the management of the described system (CC11), had an agreement of 70% of the experts and was rated as second constraint, chosen by frequency.

If considering just constraints chosen by majority of the experts in at least half of the case studies (43 out of 86 replies), eleven constraints emerge. The highest scoring constraint receiving the highest importance was the lack of sufficient income generation from the livestock operation (0.76 ± 0.25). The second most important criteria based by score and the support of at least, half of the expert were unfavourable products market conditions (0.67 ± 0.27). The constraints CC3 and CC13 had both a score of 0.63, 0.63 ± 0.24 and 0.63 ± 0.22 respectively, with an agreement of 64% and 68% from the experts. It seems that the consensus reached by experts on their response to particular constraint variables is more illuminating for amending purposes. All four variables were from the group of economic constraints, highlighting the importance of market conditions, income generation, policy support and subsidies and capital for investments.

The weakest constraint (0.41 ± 0.24) supported by the majority of experts (55% of agreement) was “current practises represent a hard-working operation” (CC17).

The whole rating of constraints suggest that one important issue for reversing the current downward trend is the design and implementation of policy schemes in support of the farming operation.

3.3 Factors of variation

The effects of the 10 factors of variation recorded in the first section of the questionnaire (Table III-2) on 86 dependent variables in the following sections are presented in Table III-6. Twenty-four criteria-variables (six of each A, B, C and D criteria), 27 current constraints (CC), four of aggregate score by criteria and one of total score across the four criteria were tested. Total cases analysed were 560 (56 variables×10 factors).

Out of these cases, 99 showed global significance ($P<0.05$) and only 70 showed at least one difference of means with significance ($P<0.05$). Significance of means was tested with the Bonferroni test in the case of homogeneity in the error variances (64 cases) or with the Tamhane test in the case of heterogeneity (35 cases). Of the 99 cases with significance, 53 corresponded to criteria-variables, 25 to CC variables, 12 to aggregate score by criteria and total score and 9 to the future trends. Most influential factors of variation were FV1 (experts affiliation), FV2 (biogeographical region), FV3 (country), FV8 (size of holdings) and FV9 (ownership of grazing resources). For the other five factors, only six or less number of variables showed significance (Table III-6).

Table III-6. Significance of 10 factors of variation on 61 variables recorded in 86 Western Balkan livestock production systems.

[a]Factor	[b]Variables with significance and levels of significance	[c]Cases
FV1	A1 (0.005); A2 (0.000); B4 (0.000); B6 (0.003); C3 (0.000); C4 (0.019); C6 (0.000); D1 (0.000); D2 (0.005); D3 (0.000); D4 (0.000); D5 (0.000); ΣA (0.001); ΣC (0.047); ΣD (0.000); ΣTOT (0.000); CC7 (0.040); CC10 (0.030); CC18 (0.002); TT (0.013)	20
FV2	A2 (0.013); A3 (0.034); A4 (0.027); A6 (0.000); B4 (0.000); B5 (0.000); C3 (0.015); D1 (0.000); D2 (0.000); ΣA (0.011); ΣTOT (0.023); CC5 (0.012); CC10 (0.024); CC12 (0.017); CC13 (0.035); CC16 (0.010);	16
FV3	A3 (0.001); A5 (0.002); A6 (0.000); B4 (0.000); B5 (0.049); C1 (0.004); C3 (0.010); C6 (0.000); D1 (0.000); D4 (0.002); D5 (0.000); D6 (0.005); ΣA (0.022); ΣTOT (0.035); CC2 (0.001); CC3 (0.045); CC5 (0.012); CC7 (0.020); CC12 (0.032); CC16 (0.001); CC18 (0.020); TG (0.002); TE (0.011); TX (0.043); TS (0.029)	25
FV4	B5 (0.009); C3 (0.008); C6 (0.014); CC7 (0.009); TG (0.002); TX (0.007)	6
FV5		0
FV6	A1 (0.024); TG (0.049)	2
FV7	B5 (0.049); C3 (0.002); D1 (0.003); CC7 (0.043)	4
FV8	A2 (0.022); A3 (0.021); B4 (0.029); C3 (0.000); D4 (0.012); ΣA (0.010); ΣC (0.009); ΣTOT (0.006); CC6 (0.024); CC12 (0.005); CC16 (0.029)	11
FV9	A1 (0.003); A2 (0.010); A4 (0.030); B5 (0.002); C3 (0.008); C6 (0.026); ΣA (0.011); CC2 (0.031); CC3 (0.035); TX (0.003)	10
FV10	A6 (0.045); D6 (0.031); CC1 (0.014); CC10 (0.038); CC16 (0.009)	5

[a]Factors of variation (Table III-2).
[b]Variables A(6), B(6), C(6) and D(6) are within criteria variables (Table III-4)
[b]Variables Σ (4) are aggregate within criteria A (general identity), B (environmental), C (economic) and D (social). ΣTOT is aggregate across criteria (Table III-4).
bVariables CC (27) are current constraints (Table III-5).
[b]Variables TG, TE, TX and TS are future trend scores and TT future trends response frequency (Table III-7).
[c]Total number of variables in parenthesis is 70. Total cases with significance in the last column are 99. Total cases analysed 61x10=610.

Relevant criteria-variables showed dependency on some factors of variation. On the identity criteria, the response to A1 was influenced by the experts' affiliation (FV1), the breeding type (FV6) and ownership of the grazing resources for grazing systems (FV9). Experts engaged in research are expressing stronger attachment to the identity of systems than those engaged in management (difference of means of 1.40, P<0.05), while the differences with the responses from university professors showed significance. Ownership of the grazing resources including, pastures, fences, watering points, shelter, barns influenced the score for the identity of the systems. Systems utilising public resources have a higher identity score than those using private (1.67, P<0.05) resources. Even systems using both public and private resources (mixed), and non-grazing systems had a higher identity score than systems grazing on private resources (difference of means of 0.91 and 0.85 respectively, P<0.05). Grassland based systems with grazing activities performed on private land had the lowest identity among the systems. Possessing knowledge on the system with a wide perception on the values of the system (A2) was dependent on four of the ten factors of variation. Both University professors and researchers provided a higher score than in management engaged experts (difference of means U>M 1.96, R>M 1.87, P<0.05, FV1). In terms of the organisation of livestock farmers and their lobbying capabilities (A3) dependence towards the biogeographical region (FV2) was found. Significant differences between group means were found between the alpine and other three regions (CO>AL 0.74, MED>AL 0.98 and PAN>AL 0.96, P<0.05). No differences in the group means between CO, MED and PAN were found. Split opinions about the lobbying capacities and organisation of farmers (A3) was found between the analysed countries (FV3). The differences between means of BA with other countries were generally positive and higher than other means (BA>MK 1.08, BA>SI 1.19, BA>ME 1.48, P<0.05), just like the case with Croatia (CR>MK 1.06, CR>SI 1.17, CR>ME 1.45, P<0.05). No differences between the group means were identified for RS, and no differences were present between any combinations of SI, ME and MK. For the identity variable A3 dependence was found towards the size of the farms in the system (FV8). Systems with larger farms have a better community of farmers and better lobbying capacities than those systems with small holdings (L>S 0.85, P<0.05), while the mean score for systems with medium sized farms had no significant differences. The need towards the external help to the system (A4) was dependent on two factors of variation. For the biogeographical region (FV2) the highest scoring group was the alpine region showing stronger agreement on the need for external help (difference of means AL>CO 0.47, P<0.05), followed by the Mediterranean region (difference of means MED>CO 0.39, P<0.05). The continental region had the lowest score and therefore the fewest needs towards external help to its systems, followed by the PAN region which showed no significand differences between the means with the other three regions. The second factor of variation on which identity criteria A4 depends was the ownership of grazing resources (FV9). One difference between the four groups was found for the sore between the use of mixed and private resources. Systems whose farmers use mixed grazing resources had a higher score towards the need for external help than those system who were depending on the self-owned resources (difference of means 0.45, P<0.05). Identity variable A5 (External help to the system is well organised and effective) showed dependence for the country (FV3). Lower means for this identity variable were obtained for BA compared to RS (difference of means RS>BA 1.41, P<0.05), CR (difference of means CR>BA 1.39, P<0.05) and ME (difference of means ME>BA 1.38, P<0.05) indicating that the lowest agreement (highest disagreement) of the experts on the proper functioning and organisation of external help for LPS is present in BA. The last identity criteria variable in the group (A6) addressing the institutional and normative framework showed dependence on factors of variation FV2 and FV3. For the biogeographical regions (VF2) Mediterranean systems had the highest average mean score and showed significant differences with the mean of the alpine region (difference of means 0.79, P<0.05), followed by the mean of the continental region whose mean also had significant difference with the mean of the alpine region (difference of means 0.61, P<0.05). Factor of variation 3, exposed a unique result regarding the institutional and normative framework based on the country in which the systems are located. The highest score, with significant means with all other means per country were for CR and ranged from 0.68 to 1.08 (CR>RS 0.68, CR>SI 0.82, CR>ME 0.85, CR>BA 1.04, CR>MK 1.08, P<0.05). No other significant differences between the means for FV3were found. The aggregate score for the general identity variables (ΣA) showed dependency on FV1 (experts affiliation; U>M 5.26, R>M 4.87, P<0.05), FV2 (biogeographical region; MED>AL 2.61, P>0.05), FV3 (country; CR>BA 2.44, CR>MK 3.69 and CR>SI 3.82, P<0.05) and FV9 (ownership of grazing infrastructures; PU>PR 5.17, P<0.05).

On the environment-criteria variables, B4, B5 and B6 were the variables showing at least one mean difference with significance. Variable B4 (current agricultural policies are congenial with the delivery of environmental values) was dependent on FV1 (experts affiliation), FV2 (biogeographical region), FV3 (country) and FV8 (size of holdings). University professors had s stronger agreement that systems are based on the use of local forages opposed to the responses taken from researchers (mean difference 0.54, P<0.05) and managers (1.54, P<0.05). Depending on the size of the holding inside the systems, smaller systems have a higher score than medium sized systems and a mean difference of 0.64 (P<0.05). The appropriate work of environmental non-governmental organisations in the pursuit of beneficial management practices (B5) showed dependency on biogeographical regions (FV2), countries (FV3), dominant species (FV4), production intensity (FV7), ownership of the resources (FV9) and mobility of the animals (FV10). In the alpine region higher scores were obtained than both in the Mediterranean (0.54, P<0.05) and continental (0.74, P<0.05) biogeographical region (FV2).

The means comparison for environmental criteria variable B5 by species (FV4) exposed the opinion that cattle systems have a higher score than goat systems (0.76, P<0.05). Depending on the experts' affiliation (FV1), the proper work of environmental non-governmental organisations (B6) showed differences of means between the opinions of researchers with management experts (1.93, P<0.05) and between university professors and management experts (1.38, P<0.05).

Although a consensus of 50% of the experts on the disagreement or strong disagreement was reached regarding the economic sustainability of the LPS operation without some type of support (C1) this variable showed dependency on FV3. A significant difference of group means between the countries was obtained for the comparison of SI with other countries. Slovenia had scores which were below those of other countries ranging from -1.86 (P<0.05) in comparison with BA, -2.14 (P<0.05) with ME, -2.22 (P<0.05) with MK, -2.29 (P<0.05) with CR and -2.67 (P<0.05) with RS. The highest variance regarding the economic criteria was obtained for C3 (the delivery of local products with marketing capabilities is or can be a main characteristic for the identity of the system), this variable showed dependency on FV1, FV2, FV3, FV4, FV7, FV8 and FV9. For FV1 (experts affiliation) university professors had in average a 0.76 (P<0.05) lower group mean than managers. Significant differences between the group means for FV3 (biogeographical region) were observed between Mediterranean systems and continental systems, the former had a higher mean of 0.53 (P<0.05) than the later. Regarding the species (FV4) cattle systems had a higher group mean than both sheep (mean difference 0.41, P<0.05) and goats (0.92, P<0.05). Depending on the size of holdings (FV8) mean differences were obtained for all groups for which an estimation on the size of the operation could be obtained, compared to case studies with no response on this question (mean differences S, M, L>NA P<0.05). Ownership of the grazing resources (FV9) in regard to the delivery of local products (C3) led to significant differences between group means. It was shown that systems performing grazing activities on both private and public resources have higher means than systems grazing on private resources (0.8, P<0.05) and systems without any grazing activities (0.60, P<0.05). Reponses on the awareness of consumers (C6) showed dependence on the experts affiliation (FV1), for which higher group means were found in responses from researchers and university professors compared to management experts (mean differences 2.33 and 2.03 respectively P<0.05). Environmental criteria C6 showed dependence on FV4 (species), for which significantly higher group means were obtained for sheep systems compared to cattle systems (difference of means 0.65, P<0.05) highlighting better consumer awareness for sheep systems and their products than for cattle systems.

All social criteria variables showed dependency on at least one factor of variation. Social criteria variable D1 (husbandry is the main economic activity assuring the presence of population in the territory and the social cohesion of the area) was dependent on FV1 (experts affiliation), for which the group means of the score given by researchers and university professors was higher than the mean score of management experts (mean difference of 1.77 and 1.51 respectively, P<0.05). Dependency of D1 on FV2 (biogeographical region) was reflected in the difference of means between the alpine region with the Mediterranean and Pannonian region (mean difference of AL>MED 0.56 and AL>PAN 1.09, P<0.05) and between the continental region with the latter two regions (mean difference of CO>MED 0.63 and CO>PAN 1.16, P<0.05). Criteria variable D1 exposed dependence on FV3 (country), for which seven differences between group means showed significance (mean difference of BA>RS 0.91, BA>MK 1.24, BA>SI 1.18, MN>CR 1.77, RS>CR 1.29, SI>CR 1.03, MK>CR 0.96, P<0.05). For the production intensity (FV7), mean differences were significant for the comparison of extensive and intensive systems. Extensive LPs had a mean higher by 0.66 (P<0.05) than intensive systems putting accent on the importance on those extensive systems for the social cohesion in rural areas of the alpine and continental biogeographical regions. The interest of young farmers in the livestock operation (D2) had a higher mean for systems in the mediterranean region compared to the continental and alpine region (mean difference of MED>CO 0.65 and MED>AL 1.15, $P<0.05$). The social criteria variable D3 showed dependence on FV1 (experts affiliation). The experts from the group of researchers had a higher mean compared to university professors (mean difference of 0.82, $P>0.05$) and management experts (1.87, $P>0.05$). Social criteria variable D4 showed dependence on FV1 (experts affiliation), FV3 (country) and FV8 (size of holdings). Experts affiliated to research and university professors had both higher group means for social criteria variable D4 compared to management related experts (mean difference of 1.93 for the former and 1.78 the latter, $P<0.05$). The social criteria variable D5 (Potential external disturbances are more important than internal ones for the continuity of the livestock operation) showed dependence on FV1 (experts affiliation) (mean difference of M>U 1.44, M>R 2.53 and U>R 1.09, $P<0.05$). The second factor of variation on which D5 showed dependence was FV3 (country) for which SI had lower group means compared to ME and MK (mean difference of ME>SI 1.36, MK>SI 1.61, $P<0.05$). The social criteria variable D6 (Land allocation and accessibility is based on legal and normative rules and not in informal regulations and diffuse claims of land use) showed dependence on FV3 (mean difference of RS>BA 1.04, RS>ME 1.99, MK>ME 1.64, SI>ME 1.56 and CR>ME 1.23, $P<0.05$), and FV10 (mean difference of S>M 0.72, $P<0.05$). The aggregate score for the social criteria (ΣD) showed mean difference dependence on the experts affiliation (FV1), for which research affiliated experts provided higher aggregate scores for LPS than management affiliated experts (mean difference of 5.00, $P<0.05$) university affiliated experts also provided higher aggregate scores than management affiliated experts (mean difference of 4.16, $P<0.05$).

Finally, the aggregate total score of the four criteria showed dependency on FV1 and FV2 with experts on systems of the MED bioregion scoring higher than those of the AL bioregion (mean difference of 4.28, $P<0.05$) and CO bioregion (MED>CO 4.48, $P<0.05$). For FV1 research affiliated experts and university affiliated experts scored higher than those experts affiliated to management (mean difference of R>M 18.8 and U>M 17.12, $P<0.05$).

Regarding the influence of factors of variation on the current constraints (CC) variables (Table III-5), we found 25 cases with significance of the mean differences out of 270 cases analysed (27 constraints×10 factors).

For the whole sample of case studies, CC1 (ecological constraints) was a less concerning constraint. However, the response of experts to this constraint was influenced by FV10 (mobility). For systems which adopt movements, either horizontal or vertical, higher scores regarding the importance of this constraint were obtained comparing mobile with sedentary grazing systems (difference of means M>S 0.36, $P<0.05$) and mobile with non-grazing systems (mean difference of M>NA 0.31, $P>0.05$). Responses to insensitive policies and inadequate normative system (CC2) showed dependence on both FV3 (country) and FV9 (ownership of the grazing resources). The experts in RS and partly CR provided a response rating this constraint higher than the experts from other countries. Differences of means for RS with BA, MK, ME and SI ranged from 0.32 to 0.51 (mean difference of RS>BA 0.32, RS>MK 0.34, RS>ME 0.42, RS>SI 0.51, $P<0.05$) and for CR with BA, ME and SI from 0.23 to 0.41 (mean difference of CR>BA 0.23, CR>ME 0.33, CR>SI 0.41, $P<0.05$). Experts' responses on CC2 showed dependence towards FV9, for which the mean comparison of the group of systems operating in a public governed grassland towards those operating on private, mixed and non-grazing systems has higher importance (mean difference of PU>NG 0.36, PU>M 0.39, PU>PR 0.48, $P<0.05$). Absence of supporting policies/regulations (CC3) showed dependence on the country (mean difference of MK>CR 0.27, MK>ME 0.35, MK>BA 0.39, $P<0.05$). Lack of sufficient income generation from the livestock operation (CC6) showed dependence on FV8 (size of holdings), for which a higher score was obtained for systems with medium sized holdings in comparison to large and small holdings (mean difference of M>L 0.21, M>S 0.21, P<0.05). Context and socio-economic dynamics (CC7) was the constraint with most dependence exposed towards the factors of variation. Regarding experts' affiliation (FV1) CC7 showed mean differences of 0.28, 0.55 and 0.27 for R>U, R>M and U>M respectively (P<0.05). For FV3 (country), MA, RS and CR had higher group means than the other countries indicating the higher importance of this constraint in the mentioned countries (mean difference of ME>SI 0.46, ME>BA 0.51, ME>MK 0.66, RS>SI 0.44, RS>BA 0.49, RS>MK 0.64, CR>SI 0.39, CR>BA 0.44, CR>MK 0.59, P<0.05). Among other constraints context and socio-economic dynamics (CC7) was the only constraint to depend on the species (mean difference of G>S 0.29, G>C 0.42, S>C 0.13, P<0.05). Lack of family business turnover reached a high consensus of the experts and showed dependence on two of the ten factors of variation. For the biogeographical region experts in the alpine region provided a higher score to this constraint comparing it with the response from those taken in the continental region (mean difference of AL>CO 0.16, P<0.05). Second FV for which CC10 showed dependence was mobility, hence, sedentary systems have a higher score compared to systems which include movements (mean difference of S>M 0.21, P<0.05). Deficient or inappropriate training services (CC12) showed dependency on the biogeographical region (FV2) for which a higher score was obtained inside the continental region compared to the mediterranean and pannonian (mean difference of CO>PAN 0.26, CO>MED 0.33, P<0.05). For FV3 (country) deficient or inappropriate training services had a higher score in BA and MK compared to CR (mean difference of 0.38 and 0.37 respectively, P<0.05). The third factor of variation CC12 showed dependence was the size of holdings for which a higher score was obtained for systems with large holdings compared to system with medium sized holdings (mean difference of 0.32, P<0.05). Constraints in access to capital for sustainable investments (CC13) despite being one of the highest scoring constraint with a consensus of over 50% showed dependence only to FV2 for which a difference between the mean of MED towards the other three biogeographical region was found (mean difference of MED>CO 0.17, MED>AL 0.20, MED>PAN 0.23, P<0.05). It could mean that the high consensus was mostly supported by systems located in the mediterranean region rather than the other regions. The response rate and scoring for CC16 (unsatisfactory infrastructures) showed dependence towards FV2 (biogeographical region), FV3 (country), FV8 (size of holdings) and FV10 (mobility). The pannonian biogeographical region showed the lowest score among the four groups, scoring 0.41 lower than MED, 0.38 lower than CO and 0.19 lower than AL (P<0.05). The alpine region had a lower mean compared to MED (0.21) and CO (0.18), and no significant difference between the scores for MED and CO were found. Like FV2 a unique result comparing the group means for FV3 were found. RS showed a significantly lower group mean comparing it to BA, MK and CR (mean difference of 0.35, 0.26 and 0.23 respectively, P<0.05). Other dependence was found for FV8 for which a higher group mean was obtained for small comparing them to large holdings (mean difference of NA>L 0.32, S>L 0.27, P<0.05) and for FV10 (mobility) for which mobile systems had a higher mean than sedentary and non-grazing systems (mean difference of M>NA 0.15, M>S 0.21, P<0.05). The last constraint variable showing dependence on the factors of variations with significant mead differences between groups was CC18 (lack of participative management planning). Significant differences between group means for FV1 (experts affiliation) were found between the scores provided by researchers and university professors (R>U 0.22, P<0.05). For FV3 (country) a higher score was shown for RS compared to BA, CR and MK (mean difference of RS>BA 0.18, RS>CR 0.24, RS>MK 0.35, P<0.05).

3.4 Future trends

Section four of the identity questionnaire elicited data on the experts' opinion on the direction towards which the LPS would evolve in the future. The responses were afterwards grouped based on the criteria used for section one in general identity, environmental, economic and social. Upon grouping, the number of responses was transformed into a score of 0 to 1 based on the proportional frequency of each response in the total number of responses taken for each case study (Table III-7). Rather than each response individually. The partial score for each group was used for statistical analysis, including the number of total responses per case study (TG, TE, TX, TS and TT).

Table III-7. Future trends based on experts' opinion.

Nº	Type	Σ	Frequency (Σ=1) [b]Mean ± SD	[a]Consensus (%)	[b]Mean ± SD
TG	General	84	0.28 ± 0.19	71	1.38 ± 0.58
TE	Environmental	54	0.17 ± 0.19	50	1.26 ± 0.61
TX	Economic	82	0.25 ± 0.19	59	1.61 ± 0.74
TS	Social	85	0.29 ± 0.20	63	1.57 ± 0.60
TT	Total	305	1		3.55 ± 1.60

[a]Consensus based on providing at least one future trend for the corresponding group.
[b]All means of proposed trends per expert showed asymmetrical distribution (Shaphiro-Wilk test).

No limit was set regarding the number of possible responses per respondent, which yielded from 1 to seven worded responses, and accounted for 305 total responses taken. In average 3.55±1.60 response per person were taken.

Inter-correlating the four group variables and the total of all groups yielded no correlations between the groups (±0.40), leading to the conclusion that the frequencies of reported trends for the case studies were independent.

Correlating the trend frequency variables with the identity and constraint variables yielded 24 correlations higher than ±0.40 for the 280 correlated pairs. Two individual criteria variables (B6, D4) showed correlations above ±0.40 with the total number of future trends provided. Constraint variables were highly correlated with the groups of trend variables provided. Experts which provided a higher number of general future trends had also provided a higher importance to constraint variables CC1, CC14 and CC19, but fewer importance to CC18. Environmentally oriented responses were positive correlated to constraints CC5, CC12 and CC19, but negatively to CC7, CC8 and CC9. For higher attention to economic related trends positive correlation towards constraint variables CC1 and CC19 were found, but negative correlations towards CC4, CC14 and CC17. Experts which provided a higher number of social related trends showed high positive correlations towards constraint variables CC14 and CC15, but negative towards CC19.

Experts, who provided a larger number of possible future outcomes for individual case studies, shared the opinion that common constraints are seen through the lack of livestock farmers' affection towards farming (CC9) and put an emphasis on the lack of family business turnover (CC10).

3.5 Cluster and discriminant analysis

In order to assess whether there experts share similar perceptions and concerns on LPS in different environment and management conditions the discriminant and cluster analysis were performed on the sustainability criteria variables and most relevant constrain variables (score over 0.6 with a consensus of over 50%). The cluster analysis was performed separately for the sustainability criteria variables, for which the aggregate score of the four groups were used (ΣA, ΣB, ΣC and ΣD), and for the most relevant constraints (CC3, CC5, CC6 and CC13).The clustering analysis revealed three group centroids for the case studies, with cluster group statistic shown in Table III-8.

Table III-8. Cluster group statistics for the criteria and current constraint variables in the sample of case studies.

[a,c]Cluster Nº	Variable	[d]Mean ± SD	[b,c]Cluster Nº	Variable	[d]Mean ± SD
1(19)	A	17.11 ± 2.87	1(26)	CC3	0.75 ± 0.24
	B	18.47 ± 1.12		CC5	0.47 ± 0.19
	C	20.53 ± 1.81		CC6	0.57 ± 0.28
	D	17.84 ± 2.36		CC13	0.59 ± 0.24
2(45)	A	19.36 ± 1.49	2(39)	CC3	0.55 ± 0.16
	B	23.07 ± 1.68		CC5	0.77 ± 0.23
	C	20.76 ± 2.09		CC6	0.86 ± 0.11
	D	18.93 ± 1.96		CC13	0.66 ± 0.19
3(22)	A	23.86 ± 2.05	3(21)	CC3	0.50 ± 0.30
	B	20.86 ± 1.64		CC5	0.55 ± 0.27
	C	22.50 ± 2.70		CC6	0.20 ± 0.12
	D	20.77 ± 2.49		CC13	0.61 ± 0.22

[a]Criteria-variables A, B, C and D general group scores are provided in Table III-4 for the 86 case studies. Clustering of case studies in Figure III-1.

[b]Current constraint variables CC3, CC5, CC6 and CC13 and general group scores are in Table III-5 for 86 case studies. Clustering of case studies in Figure III-2.

[c]In parenthesis, number of case studies within clusters.

[d]ANOVA of any variable between clusters ($P<0.001$).

The cluster analysis resulted in three clusters with a higher proportion of case studies in Cluster 2 compared to Cluster 1 and 3 (22%, 53% and 25% of case studies by Cluster 1, 2 and 3). Cluster 1 grouped LPS of experts scoring higher for the aggregate score of criteria variable C, cluster 2 for aggregate B and Cluster 3 for aggregate A. Cluster 1 had the lowest mean aggregate scores for all criteria variables among the three clusters. The mean differences of the clustering groups were significant ($P<0.001$). Grouping the case studies around the three centroids is presented in Figure III-1. The relevant point is that each of the three clusters grouped case studies disregarding their relationship towards factors of variation. As example, near the centroid of Cluster 1 were found case studies Nº 12 (meat cattle system in the alpine region), 15 (meat sheep system in the alpine region), 19 (dairy sheep system in the alpine region) and 85 (dairy goat system in the pannonian region). The results indicate that experts share a similar perception on aggregate criteria for systems with a different structure and location.

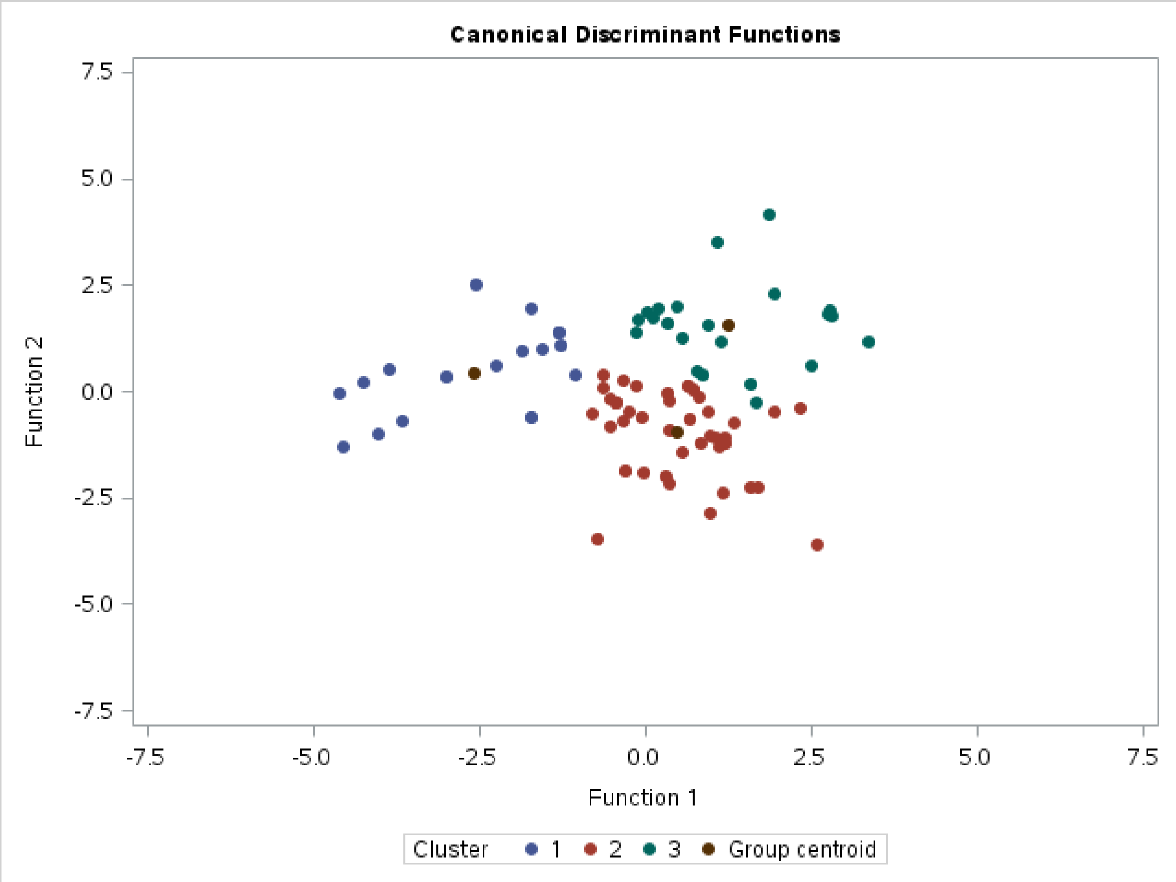

Figure III-1. Clustering of case study LPS by criteria-variables A (identity), B (environment), C (economic) and D (social).

Cluster 1. Case studies Nº 1, 2, 3, 12, 15, 19, 38, 39, 40, 42, 43, 46, 47, 56, 63, 83, 84, 85, 86.
Cluster 2. Case studies Nº 4, 5, 6, 7, 9, 13, 14, 16, 17, 20, 21, 23, 24, 25, 32, 33, 34, 36, 37, 41, 44, 45, 49, 50, 53, 54, 55, 57, 58, 59, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 77, 79, 81, 82.
Cluster 3. Case studies Nº 8, 10, 11, 18, 22, 26, 27, 28, 29, 30, 31, 35, 48, 51, 52, 60, 61, 62, 75, 76, 78, 80.
Location of case studies in Table III-4.

The analysis of relevant constraints by clustering case studies revealed similar results. Cluster 1 grouped LPS with higher scores for CC3 and lower scores for the other constraints. Cluster 2 grouped LPS with the highest score for CC6 (0.86 ± 0.11) and CC5 (0.77 ± 0.23) and Cluster 3 grouped LPS with the lowest CC6 (0.20 ± 0.12) but higher CC13 scores (0.61 ± 0.22). Grouping the case studies around the three centroids is presented in Figure III-2. Again, unrelated LPS shared similar constraints. Case studies Nº 61 (dairy cattle breeding in the mediterranean region), 65 (meat sheep production in the mediterranean region) and 50 (dairy goat breeding in the continental region).

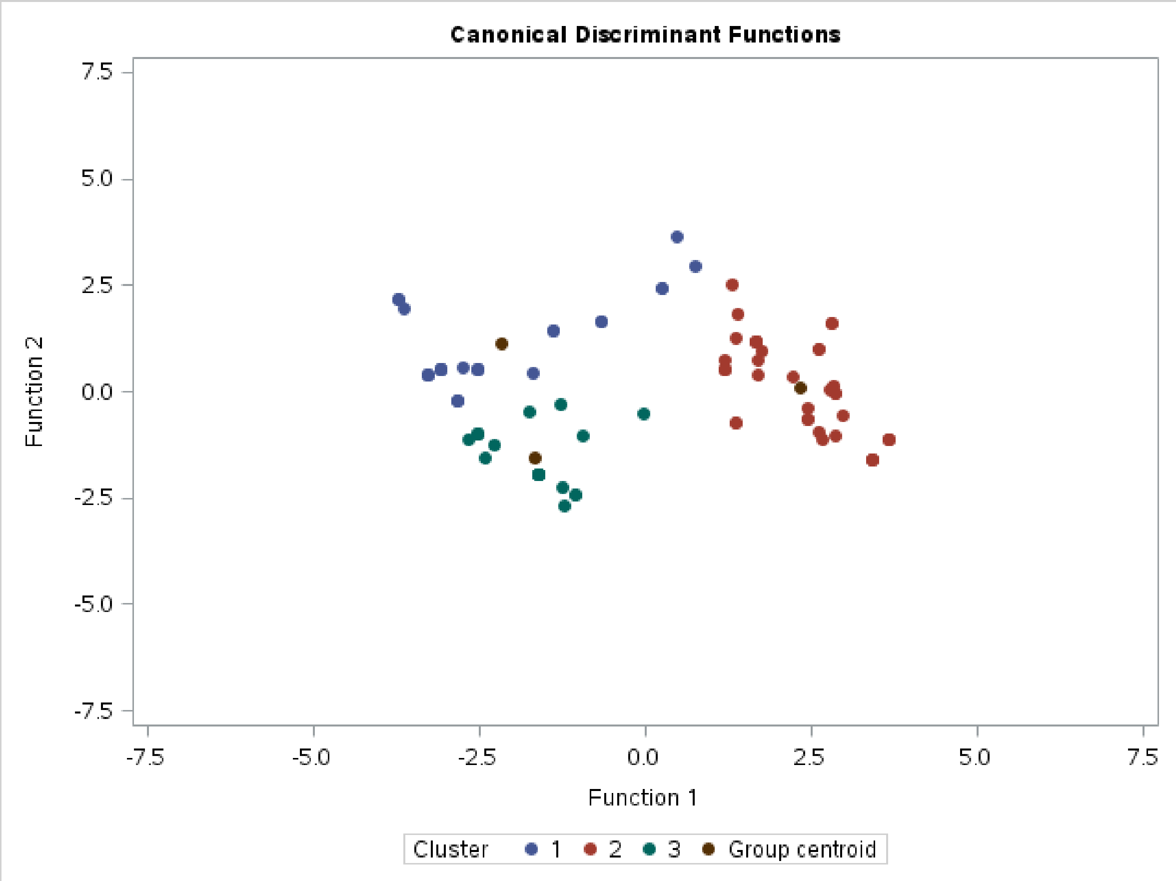

Figure III-2. Clustering of case study LPS by constraint-variables CC3, CC5, CC6 and CC13.

Cluster 1. Case studies Nº 7, 18, 23, 26, 27, 28, 29, 31, 32, 34, 36, 37, 42, 43, 46, 47, 48, 52, 54, 62, 72, 78, 79, 81, 83, 84.
Cluster 2. Case studies Nº 1, 2, 3, 4, 5, 6, 16, 17, 20, 21, 22, 24, 25, 30, 33, 38, 39, 40, 49, 50, 55, 56, 57, 58, 59, 60, 61, 64, 65, 69, 70, 71, 73, 74, 75, 80, 82, 85, 86.
Cluster 3. Case studies Nº 8, 9, 10, 11, 12, 13, 14, 15, 19, 35, 41, 44, 45, 51, 53, 63, 66, 67, 68, 76, 77.
Location of case studies in Table III-4.

The clustering analysis thus suggests that experts on environment and/or management-unrelated systems may share similar perceptions and concerns. Common and differentiating properties are a sign of regional identity. One the one hand, this may allow for the design of Regional-wide policy framework in support of LPS but, on the other beneficial management alternatives and development options should be system-specific.

3.6 Beneficial management

Respondent experts were elicited in section five of the identity questionnaire to freely word up to seven development options (DO) that they perceive of relevance to improve their systems. Eighty-six of them (100%) provided assistance with mean number of proposals of 4.01 ± 1.27. We rated the management alternatives within five tiers based on the SLIM DF by Steyaert and Jiggins (2007): Stakeholding (DO_S), Facilitation (DO_F), Ecological constraints (DO_E), Institutions & policies (DO_I) and others (DO_O). The response of experts to the five types of measures is presented in Figure III-3 with frequencies given in Table III-9.

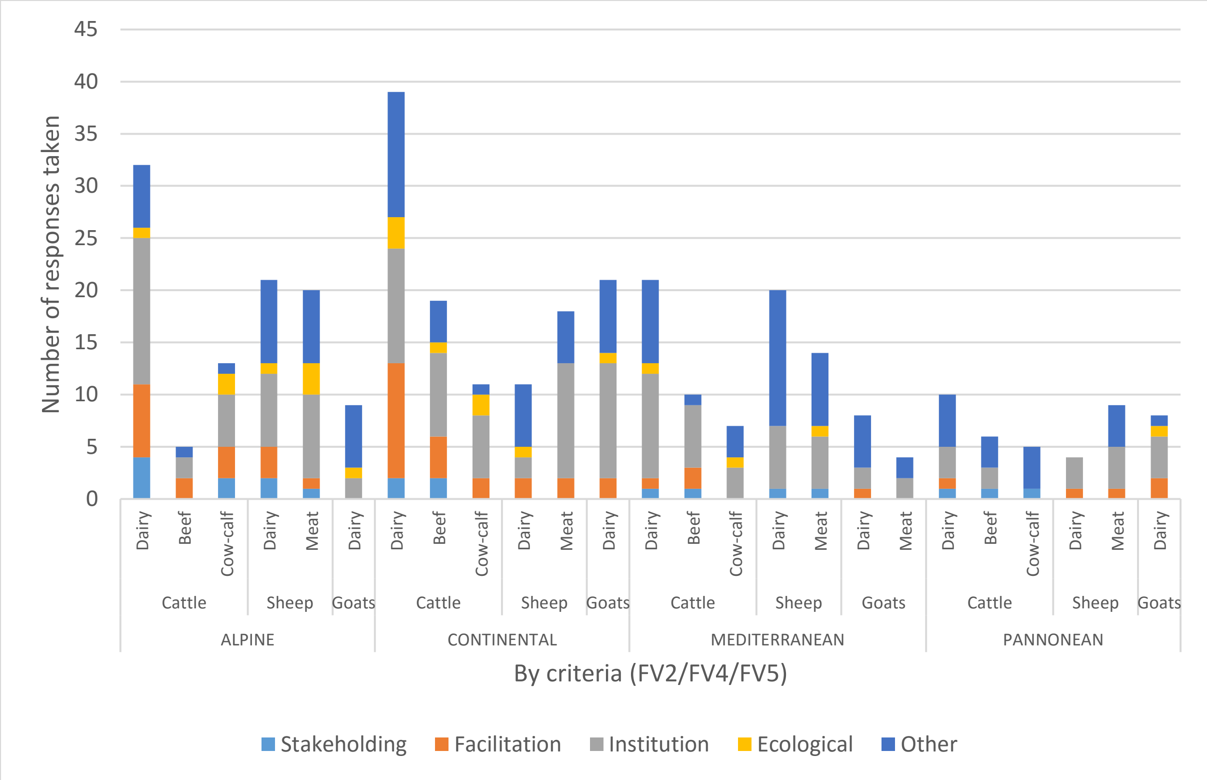

Figure III-3. Development options for LPS in the Western Balkans by FV's.

A large majority of experts (78%) highlighted the need for institutional and policy improvements (DO_I), and 37% as first option. Out of 345 development options recorded, 137 belonged to the mentioned group (40% of all taken responses).

With 120 responses (35%) and a consensus of 67% by the experts development option from the group of other (DO_O) were scored second most important. This group included most of the development options that affect the economic wellbeing of the farmers, but have to be achieved through management changes through the implementation of new, different or alternative production practices. Together with the institutional development options 75% of the total 345 responses belonged to these two groups.

Other specific measures were less cited but also of relevance. DO_F, DO_S and DO_E types of measures were cited by 41%, 22% and 22% of respondents, respectively. Most of the development options (50% of all DO_I) were addressing the rural development programmes, infrastructure related policies and farm unions. Both 15% of the DO_I were addressing the need towards the continuation, introduction or revision of subsidy schemes and direct payments by the state and the policies set regarding the marketing, advertising, protection and promotion of domestic products. By adding 8% of development options treating the revision of crediting conditions for farmers, over a third (38%) of the responses were addressing the financial issues pointed out in section three in which the highest consensus was related to the economic constraints farmers are faced with (CC6, CC5, CC3 and CC13). Similar, financing and infrastructure related, constraints were pointed out by Marković and Marković (2010). The agricultural land based policies regulating the use, ownership, inheritance and other issues were addressed by 8% of the responses taken.

Table III-9. Frequency and attribute of development options for the Western Balkan LPS.

[a]SLIM DF	Subgroup	[b]Nº	[c]Freq. (%)
Institutional & policies (DO_I)	Policy support schemes (direct payments)	21	15
	Crediting conditions	11	8
	Land based policies and schemes	16	12
	Marketing, advertising and promoting	21	15
	Rural development (e.g. programmes, public infrastructures and others)	68	50
Ecological constraints (DO_E)	Environment (climate, water and soil)	3	15
	Livestock	3	15
	Land	14	70
Facilitation (DO_F)	Education and knowledge transfer	27	56
	Introduction and implementation of new technologies	15	31
	Consumer oriented facilitation	6	13
Stakeholding (DO_S)	Farmer-farmer	14	70
	Farmer-public bodies/unions	4	20
	Farmer-other stakeholders (market, industry, …)	2	10
Other (DO_O)	Production practice and land use	38	32
	Farm infrastructures	32	27
	Breed stock (size and composition)	27	22
	Animal nutrition, reproduction and zoo-hygiene	23	19

[a]SLIM diagnostic framework as main groups for the classification + other.
[b]Number of responses taken
[c]In group frequencies (Σ=100)

Ecological constraints were divvied in three subgroups addressing development options treating issues regarding constraints related to the limitations set by the land use, species and/or breed related limitations and the general limitations or impact of the environment (climate, water, air). Most of the DO (70%) were related to the land based constraints, and both 15% for animal and environmental constraints.

Facilitation was sub grouped in three groups depending on the means of facilitation the DO were representing. Education and knowledge transfer obtained 56% of the DO inside the aggregate group. A third of the experts propose DO which address the facilitation of new technologies (31%) and 13% propose facilitation oriented towards consumers and market approaches.

Stakeholding DO were divided in groups depending on the stakeholder involved. The DO related to farmer-farmer interactions were accounting for 70% of the DO_S, 20% to the farmer-public body/union interaction and 10% to the farmer-market/industry interaction.

The DO's unlike in the previous four had a homogeneous distribution of responses between subgroups. Production practice and land use obtained 32% of the total responses, the DO's addressed mainly the use of alternative forages, or management for grazing regimes, crop rotation and better organisation of fertiliser use, but also the implementation of alternative production practises adapted to the region, or alternative production practices which divert from intensive and extensive farming and result in a higher diversity of production practices in the systems. The promotion of intensified land use through fertiliser use was besides in our research proposed by Strijker (2005). Infrastructure received 27% of responses and addressed the necessity to implement mechanical milking and proper milk and cheese storage solutions in dairy oriented systems. In extensive systems the necessity for proper winter stalling and shelter was pointed out, and in some cases the enlargement of private land by land consolidation (Caballero et al., 2009; Strijker, 2005) and installation of watersheds and fences on remote pastures. Breed stock with 22% of responses mainly contained proposals for herd and flock enlargements for better use of human labour (García-Martínez et al., 2009; Strijker, 2005), mechanisation and agricultural land, as mentioned by (Petrović et al., 2011). The breed composition was addressing the need to apply crossing in cases in which the individual farms reached the number of breeding females they can sustain but offspring for market purposes yielded lower production performances in purebred production compared to crosses. Animal nutrition, reproduction and zoo-hygiene responses accounted for 19% of DO grouped into others and included mostly new methods for nutrition and alternative feeding regimes, sanitary interventions and fertilisation changes.

4 Discussion and conclusion

The interaction of human activities in various environmental conditions with the interest of providing services for the wellbeing of a population on a wider scale, by adhering enforced laws and regulations through the past decades led to a set of livestock production systems in the analysed study area. The wide range of systems was often exposed to similar environmental and policy related drivers that shaped their level of sustainability and appearance (Pezzoli, 1997; Cabezas et al., 2003; Mayer et al., 2004). In order to set an appropriate set of policies and strategies a wide range of cases is required to identify priorities and critical points to be addressed (Caballero, 2012).

Indices can be very powerful tools for sustainability policy, but only if they are used appropriately (Mayer, 2007). One index is inadequate to fully understand the sustainability of a system, and therefore several indices used in combination are required (Hanley et al., 1999; Rees, 2002; Mayer et al., 2004; Esty et al., 2005; Wilson et al., 2007). Based on the previous, our exercise is a development of socio-ecological indicators rather than the design of a sustainability index or ranking of sampled case studies. Our interest is to identify a common base for a shared perception and concern on the values of systems as rationale for policy action in a wide range of environments.

Despite the long history sustainability concepts and indicators, sustainability has not been achieved anywhere (Millennium Ecosystem Assessment, 2005). The failure of sustainability index use is due to three issues: a lack of consensus on what sustainability is in a quantitative sense; insufficient data availability to calculate indices correctly; and an unwillingness of policymakers to follow the advice when indicators provide clear advice (Wilson et al., 2007). Sustainability index research can only shed light on how human societies can move towards sustainable conditions; political will decides whether, when, and how societies will achieve sustainability (Mayer, 2007).

The sustainability criteria variables provided information about the perception of experts on four aspects. Considering the diversity of systems addressed by this exercise, the perceptions were influenced by five of the ten factors of variation they were exposed to.

We tested the consistency of proposed measures by comparing the responses to socio-ecological indicators and constraints, particularly those reaching a higher consensus, and the amending objective of development options. We found that main perceived constraints are highly related to the economic instability (Marković and Marković, 2010). For example, over half of experts (55%) expressed disagreement with the effectiveness of current support schemes (Caballero and Fernández-Santos, 2009) and a large majority with the absence of support (64%), correspondingly, 78% included alternatives on the mentioned constraints in section five. The strongest consensus was reached on the concern on the income generated and market conditions (61% and 78% respectively), which are also in other systems and study areas outside of this research seen as main constraint to the continuity (Strijker, 2005).

The proposed development options point out the necessity for intensification inside the systems. The need for sustainable intensification that meets the three groups of indicators was encouraged by research previously conducted on other systems (Herrero et al., 2009; Quetier et al., 2005).

For the upcoming trends a common agreement on the decrease of participants to the systems is present, but simultaneously an increase of the number of animals per farm. Despite the previous, a downward trend regarding the total number of animals compared to the past decades is occurring for both cattle and sheep. The responses for abandonment were highly compatible with MacDonald et al. (2000) and Dax et al. (1995). MacDonald et al. (2000) described the process as consequence of exhaustion to generate an income flow for businesses or households and the opportunities for resource adjustment through changes in farming practices and farm structure. Dax et al. (1995) put a linkage between abandonment and the limit of systems to adjust because of traditional attitudes, inflexibility in production, fragmented structures and lack of alternative, more profitable uses of agricultural land. Unlike the previous two species, goat breeding is experiencing an upward trend considering the number of breeders and the number of animals raised, stated by the experts. Commonly, endogenous development of the management capabilities of farmers and the improvement of support schemes are expected. Few responses were taken for the changes on the market of products, the preferences of costumers, the prices of inputs and products from the systems. These statements point out the complexity to predict the future development of economic related issues the participants might face. To compensate for this lack, strong support and regional planning are necessary to prevent changes.

The gathered information on development options for a variety of LPS in different environmental conditions exposed some similar results. As shown in most aggregate statistic results similar to those provided in Table III-3 of our research, individuality and strong regional identity on a smaller scale, but representing a proportion of the aggregate may be lost. Systems can simultaneously become more sustainable in some dimensions and less sustainable in others, and it is possible for systems to become unstable even if most indicators are improving (Mayer, 2007).

Therefore, the information provided by this work should serve in a context as guideline to the proposal of regional strategies on a wider scale, but the implementation to be decided by smaller territorial units.

About the development options of LPS in the western Balkans, literature suggestions are pointing out the need to increase the overall farm size in order to achieve bigger gains per animal and higher farm incomes. We found similar results as some of the experts provided suggestions on the size of holdings represented by 20% of the development options from the group of "other development options". Experts highlighted the high diversity of the size of holdings inside the case studies for the systems that resulted in the non-existent discriminatory power of FV8 to discern case studies based on the score of economic criteria variables. The long-term concept of livestock development should be founded on efficiency in production of meat, through farmer associations and organizations (Petrović et al., 2011). The same authors state that an increase of the arable area for beef oriented breeders should be oriented towards over 8 ha in average per farm, and dual-purpose cattle breeders should increase the holding size towards 30 ha in average, for meadows and arable land. Experts in general agree that a larger number of animals has to be sustained by a household to assure its sustainability in many aspects.

We highlight the importance of rural development programmes in our research that are addressed in section five by 68 responses from the surveyed experts. Together with the devising and implementation of traditional and alternative management practices, the development on both regional and local basis is supported by a third of the total development options provided.

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Chapter IV: Technical efficiency of the beef system in the Adriatic-Ionian macro region

1 Introduction

The conventional definition of efficiency used in the literature dates back to Farrell (1957), who was the first to use frontier production functions to measure technical efficiency. The technical efficiency in a production unit refers to the achievement of the maximum potential output from given amounts of factor inputs, taking into account physical production relationships (Iráizoz et al., 2003; Ecurra et al., 2008).

Efficiency can be related to any input and output of a production function and in agriculture be referred as land use efficiency, feeding efficiency, labour efficiency and production efficiency (meat, milk, egg, wool, skin, fibre and others). The mentioned efficiencies are pure technical efficiencies if measured by quantity of consumption-production in meters, hectares, weight, length and others. Agricultural production is often influenced by external factors that influence the quantity of consumed inputs and produced outputs. Managerial decisions may also influence the perception of efficiency. Agriculture production is an economic activity whose output can be measured as financial result of the activity. Managerial decisions in this case can discriminate between farms with equal output quantities of a product but different product prices, input costs and target markets. If the economic value is added to the production function, economic efficiency emerges from the measurement of technical efficiency.

In this exercise, pure technical efficiency expressed in produced meat, of the beef system in the Adriatic-Ionian macro region was analysed. In the literature, comparing monogastric with ruminant systems, ruminant livestock generally use more land than monogastric species, this is the consequence of differences in feed conversion efficiency (de Vries and de Boer, 2010; Nijdam et al., 2012; Wirsenius et al., 2010). Much of the plant material ruminants consume comes from perennial forage crops and grazing land and their return of edible product per unit of human edible feed may actually be higher than non-ruminants (Le Cotty and Dorin, 2012; Oltjen and Beckett, 1996; Wilkinson, 2011).

The use of multiple correspondence analysis, to characterise the beef system upon their inputs and production performances in Spain was fond to be used by Milan et al. (2009). An application of the meta-regression analysis on farm technical efficiency is found in Bravo-Ureta et al. (2007).

In the literature, two main approaches have been developed over time for analysing the technical efficiency of agriculture: (i) the construction of a non-parametric piecewise linear frontier using a linear programming method known as data envelopment analysis (DEA), and (ii) the estimation of a parametric production function using stochastic frontier analysis (SFA).

Examples of the application of production frontier analysis, were found for soil tillage (Krishna and Veettil, 2014) and vegetable production (Bozoğlu and Ceyhan, 2007; Iráizoz et al., 2003). In animal production the application of frontier analysis was found for transhumant sheep farming (Galanopoulus et al., 2011), extensive livestock farming systems (Gaspar et al., 2009), pig farming (Lansink and Reinhard, 2004) and dairy farming (Fraser and Cordina, 1999; Jaforullah, and Whiteman, 1999; Latruffe et al., 2012). While for other livestock species a wide array of literature on technical efficiency assessments is available, the literature beef production enterprises is scarce (Barnes, 2008; Ceyhan and Hazneci, 2010; Fleming et al., 2010; Iráizoz et al., 2005; Otieno et al. 2012; Trestini, 2006 are exceptions).

To date, no study has analysed the technical efficiency of beef farms in the study area.

The analysis of the beef system across four countries in the Adriatic-Ionian macro region yielded information on the factor requirements per commodity of output produced. A stock and flow diagram was used to enumerate key performance metrics of the beef system. By enumerating the key performance, insight in the breeding population, mortality, animal flow and output were obtained.

2 Materials and methods

2.1 Data collecting and refining

The data for the analysis was gathered from surveys performed at farm level. This ensured the compatibility of the gathered responses within four different countries for further statistical analysis. To achieve homogeneity and preserve representativeness by the sample, farms were identified by national experts. In Marche region of Italy, the Department of Agriculture, Environment and Food Sciences - Polytechnic University of Marche (D3A-UNIVPM) and Associazione Regionale Allevatori delle Marche (ARA Marche) provided a sample of 15 farms representative for the local Marchigiana breed system. In Slovenia, a survey sample of 20 farms was provided by the Institute for Agriculture in Nova Gorica City, where all sample farms originate from the Primorska Region. In Bosnia and Herzegovina, a set of 15 sample farms was chosen with the help of the Veterinary stations from two cantons (Kanton 10 and Herzegovina-Neretva canton), all located in the Mediterranean basin of the country. In Croatia, support was provided by the Faculty of Agriculture - University of Zagreb, Croatian Agriculture Agency (HPA) and the national Advisory Service for Agriculture. A sample of 18 farms was identified in Sisak-Moslavina and Bjelovar-Bilogora County. Through the support of the mentioned institutions, a survey sample of 68 beef farms was assembled. Surveying was performed from October 2014 to April 2015. The surveys requested information structured in four segments (Table IV-1).

Table IV-1. Structure of information requested by the survey tool.

Group	Information requested	Response type
General information	Location of the farmstead	Address
	Year of establishment	Year
	Farm altitude	Meter above sea level
	Altitude range of the utilised agricultural land	Meter above sea level, Two responses (min and max)
	Cattle breeds used	Up to three breeds used
	Production type	Biologic or Conventional
Livestock	Number of animals	Number of animals (category^{-1} age group^{-1})
	Mortality	Number of animals (category^{-1}age group^{-1} year^{-1})
	Number of animals sold/slaughtered	Number of animals (category^{-1} age group^{-1} year^{-1})
	Weight	Average weight (category^{-1} age group^{-1})
	Duration of life phases	Duration in days (category^{-1} age group^{-1})
Land use and feeding	Agriculture and forest surface	Hectares
	Land in private ownership	Hectares
	Crops cultivated	Hectares (crop^{-1})
	Crop yields	Metric tonnes (hctare^{-1} crop^{-1})
	Grazed surface	Hectares
	Grazing sectors	Number of plots
	Grazing animals	Number of simultaneously grazing animals
	Grazing length	Days
	Feed bought – type	Type of fodder bought
	Feed bought – quantity	Metric tonnes (fodder type^{-1} year^{-1})
Others	Number of fully employed persons	Number equivalent to 1 annual work unit
	Number of part-time employees	Number adjusted to 1 annual work unit
	Built year of mechanisation	Year of construction (machine^{-1})
	Strength of mechanisation	Horsepower (machine^{-1})
	Fertiliser use	Metric tonnes (artificial fertiliser consumed year^{-1})
	Other farm animals present	Species of other farm animals
	Number of other farm animals	Number (species^{-1})

From the information requested by the survey tool (Table IV-1), several other indicators were calculated. The Bull per cow ratio was calculated as number of breeding cows per bull. Calving ratios were calculated by dividing the number of calves and the number of cows. The mortality rates were expressed as "long year" averages to bypass biases such as disease years, loss through intoxication due to industrial waste and other reported causes. The grazing length in days was requested as date of the beginning of the grazing and date of the return of the animals to winter shelter. The difference in number of days was used for statistical analysis. Farmers often lacked information such as yields for forages; in this case, yield per surface was calculated by dividing the total amount of produced forage and the surface occupied by the forage.

For adjustments to the reported information, the number, species and age group of other farm-animals were requested and later used to estimate the level of livestock specialisation of the surveyed farms.

The focal point was to address farms, which have a level of specialisation of at least 66% in terms of livestock units dedicated to the beef production. The remaining 33%, or less, were reserved for other farm animals such as dairy cattle, swine, poultry, equine and small ruminants. This specialisation criterion differs from the criteria used by Eurostat (Statistics explained, accessed: 2015) where farm specialisation describes the trend towards a single dominant activity in farm income, following the definition: "an agricultural holding is said to be specialised when a particular activity provides at least two thirds of the production or the business size of an agricultural holding".

Until 2007 the Farm structure survey (FSS) and the Farm accountancy data network (FADN) have used standard gross margin (SGM) to classify agricultural holdings by type of farming and by economic size (Decision 0377/1985). In the FSS 2010 and onward this classification uses standard output (SO) instead (see for more details Regulation 1242/2008). The principle of both concepts is the same; only the way they are calculated differs and therefore the results are not directly comparable (Statistics explained, accessed: 2015).

2.2 Overview of the approach

To analyse the beef system, a set of steps was necessary to elaborate the technical efficiency. First, the beef system was characterized diagrammatically as a system of stocks and flows to identify the major life phases and the relationships between them. Second, values for each stock and flow were calculated based on performance metrics (e.g. rates of reproduction, mortality, and culling of livestock). Third, feed consumption and ration composition were estimated. Fourth, the data was summarized by tabulating total intake of all component feeds per unit of output to generate aggregate ration composition. Finally, the feed needs were converted to the area of land required per unit output. Upon characterising the system, technical indicators were calculated and the technical efficiency estimation, by using the DEA, performed.

2.3 Characterising the system

The first step in the analysis was the characterization of the production as a system of stocks and flows (Figure IV-1). In this hypothetical example, a stock of breeding animals produces a stream of young animals, some of which replace the breeding herd and others that are raised for market as meat animals. Each box in the diagram represents a pool of animals that has to be fed in order to support the productive output of the system. Each arrow represents the flow of animals from one pool to the next, with premature mortality claiming a proportion of the animals in each phase of the system. The two terminal boxes indicate the pools of animals slaughtered for meat.

The stock and flow diagram clarifies what types of animals need to be enumerated in order to model the livestock system. In addition, the diagram depicts the outputs from the system. The beef system provides meat as its output, be it in the form of animals to be slaughtered directly from the system, or the selling of live animals to breeders to be fattened on feedlots.

By following the example of Peters et al. (2014) upon characterising the systems stocks and flows, key performance metrics were quantified. The collected data were used to determine the number of animals within each phase of the production system per breeding female. The system is represented in a steady state, meaning that the breeding herds are neither growing nor shrinking (Peters et al., 2014). The steady state, in this case a "hypothetical example", is a product of mathematical elaboration of the performance metrics. The information obtained through surveys represents the current state, which unlike the steady state, provides information on the dynamics of a system (egg. the surplus or lack of animals in a particular category). The difference between animals in the steady state and the current state will be reported as the dynamics of the system.

2.4 Enumerating stocks and flows

The number of animals in each life phase of the system was calculated iteratively. By definition, each system begins with one bred female and the size of the other stocks and flows depends on the performance metrics (Peters et al., 2014). The number of breeding males is a function of the male to female ratio within the typical breeding herd. Likewise, the number of young animals is a function of the reproduction rate. Since each breeding herd exists in equilibrium, the number of replacement animals entering the breeding herd equals the number exiting the herd due to culling or premature mortality. Young animals not kept as replacement are raised for market. The number of animals sold for slaughter depends on the number entering the growing (finishing) phase and the mortality rate in this phase.

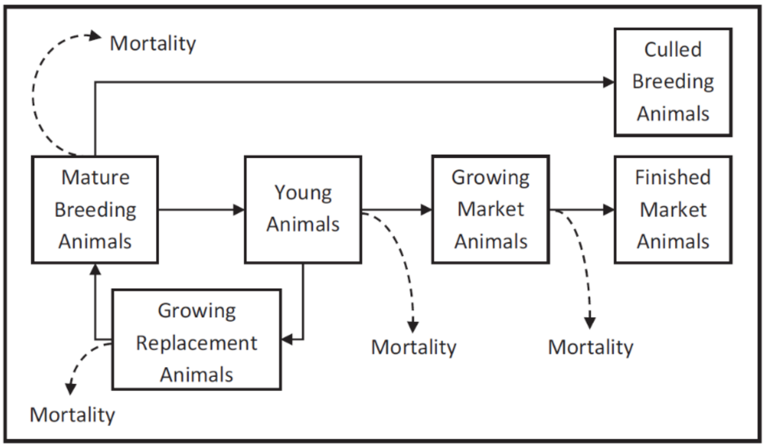

Figure IV-1. Generalized stock and flow diagram of a livestock system (Peters et al., 2014).

At every life phase, a portion of the animals dies prematurely. Consequently, the number of animals that enter a life phase exceeds the number of animals that complete the life phase. Mortality is spread over the duration of a life phase, so in reality, the size of a stock is in constant flux. Within the model, this relationship is simplified, and the size of each stock is estimated as the average of the number of animals entering a life phase and the number that complete a life phase. The average serves as a heuristic way to account for the fact that the number of animals present at the start of a production cycle is different from that at the end, due to losses from mortality. The number of animals in each pool was estimated as shown in Eq. (1) (Peters et al., 2014).

$$N_i = Average(Ninflow_i, Noutflow_i) \qquad (1)$$

The stock of animals (N) in each life phase (i) was calculated as the average of the number of animals flowing in from the previous life phase (Ninflow) and the number of animals flowing out to the next life phase (Noutflow).

Cattle take longer to reach a reproductive age than do swine or poultry and have lower reproductive rates per breeding cycle. As a result, beef and dairy systems are characterized by relatively large numbers of breeding and replacement animals compared to the number of market animals, whereas poultry systems have much smaller populations of breeding animals relative to the meat and egg production they support. Swine systems are intermediate in this regard (Peters et al., 2014).

2.5 Feed intake

The total fodder per farm per ingredient (i) was calculated on annual basis as the sum of fodder produced on farmstead and the fodder bought outside of the farm.

$$Total_i = Produced_i + Bought_i \qquad (2)$$

Grazed forage (G) was calculated as the sum of the product of the live weight (W) of grazing animals (N) per category (i), the grazing length in days (t) and the daily consumption of forage in dry matter basis. An average daily consumption of dry mater of 3% of the total live weight of the grazing animals was used (Bittante et al., 1993). The grazing length in days was adjusted to the herbage growth period to a maximum of 270 days for farms that adopt a year-round outdoor period. Farms with a grazing period shorter than 270 days were not adjusted. The total number of animals on the farm often exceeded the reported number of animals on pasture, for which animals were inserted in the formula in the following order: cows, bulls, heifers and calves, until reaching the total number of grazing animals. Finishing animals, such as bullocks and young breeding heifers were for managerial purposes excluded from the grazing herd.

$$G = \sum(N_i \times W_i) \times t \times 0.03 \qquad (3)$$

Feed intake (I) was calculated as the sum of the quantity (x) of feed ingredients (i) expressed in dry matter basis (DM) (Eq. (4)). The calculation was performed for each country separately.

$$I_i = \sum_i(x_i \times DM_i) \qquad (4)$$

2.6 Productive output

The output per farm for each country in the system was calculated on the base of the number of animals culled per cycle per each category, live weight of the culled animals, dressing weight and boneless weight. Conversion factors for determining the carcass yield and boneless meat yield from a carcass were obtained from USDA Economic Research Service (1992). Meat output for the system includes all animals sent to slaughter, both market animals and culled breeding stock (Eq. (5)).

$$O = \sum(N_i \times W_i) \qquad (5)$$

Total productive output (O) of meat for a herd of animals from a given livestock system is equal to the sum of the number of animals sent to slaughter (N) for a given category (i) times the live weight (W) of the animals in that category (Peters et al., 2014).

2.7 Data analysis

The data analysis is performed using SAS/Studio® software, Version 3.4 of the SAS System for Windows. The MEANS, CORR, UNIVARIATE and GLM procedures of the SAS program were used for the statistical analysis. The ODS GRAPH statement was used to compute the graphical output of the technical efficiency score distribution (Figure IV-4).

Characteristics of the beef system in four countries, based on 68 of the studied variables, were subjected to descriptive statistical analysis and variance analysis.

Descriptive statistics (averages and frequencies of the variables) were calculated for the farms grouped by country. Mean ± SD and Wilck test of normality Shaphiro and Wilk (1965) were used. The Levene test was used for testing the homogeneity of variances. The differences among countries regarding continuous variables were contrasted by a one-way ANOVA analysis with the Fisher's least significant difference test (LSD).

The Data Envelopment Analysis was performed in Microsoft Office Access with the MaxDEA6.6 software by using a radial measure of efficiency (Banker et al., 1984; Charnes A et al., 1978). Three model specifications were applied to the data set. One output oriented model for variable returns to scale and two input oriented models for constant and variable returns to scale. The same model specifications were used by Fraser and Cordina (1999).

3 Results

The research exposes the characteristics and technical indicators of efficiency for the beef system in four countries. A focus was set on the land use efficiency, production per breeding female, the use of feedstuff and labour.

3.1 Characterising the beef system

General characteristics of the beef system in the four analysed countries are shown in Table IV-2. The process illustrated by (Figure IV-2) shows the flow of animals through the defined life phases.

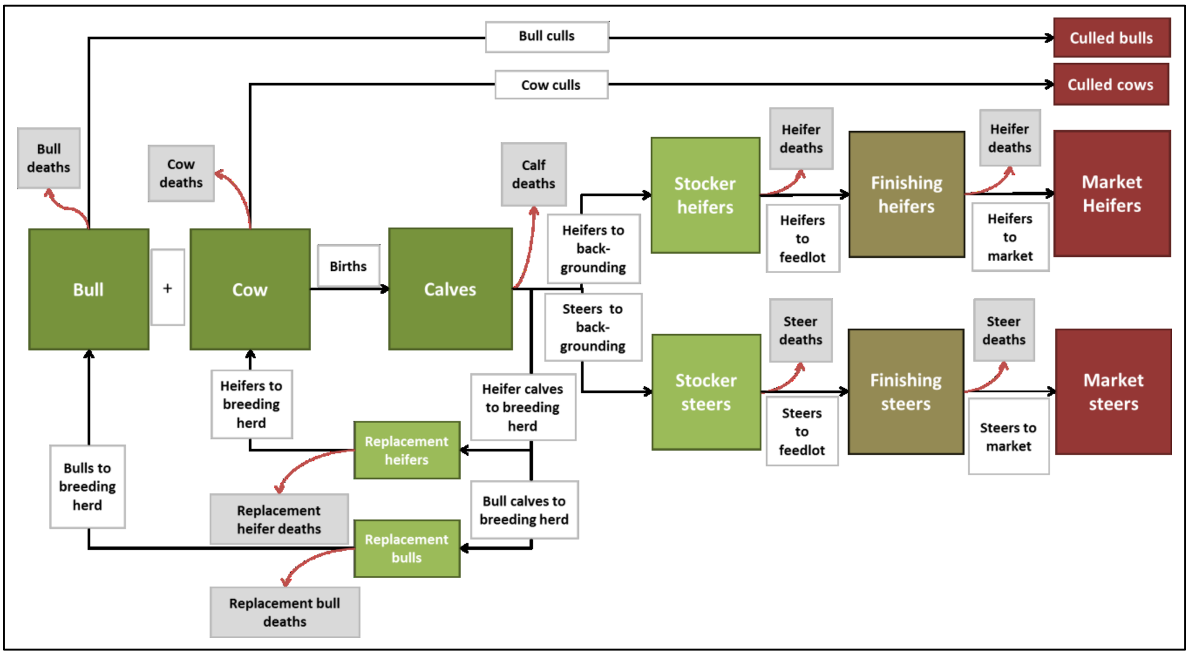

Figure IV-2. Stock and flow diagram of the beef production system (Peters et al., 2014).

A high variability is observed for the size of holdings, especially in the case of Bosnia and Herzegovina (BA). The oldest farms are located in Italy (IT), where the practice of beef breeding is passed through generations. In the Western Balkan countries, the oldest beef breeding farms were found in Slovenia (SI) then Croatia (CR) and in BA. Altitude of farmstead as shown in the table was normally distributed in three out of the four regions (Shaphiro-Wilk test). Two outliers in terms of farm altitude were found in the case of CR. One is operating at an altitude of 600 m.a.s.l. and the second in a hilly area at approximately 500. In the case of BA, despite normally distributed the highest standard deviation for the farm altitude was found in this country (±422.17). A relationship between the grazing length and the altitude of farms was expected, relating to the length of the growth period of the grazed forages. Correlating the altitude of farmstead with the grazing length for each country individually yielded just in the case of BA a significant correlation ($r=-0.756$, $P<0.002$), and for an aggregate of all analysed farms the correlation yielded a coefficient of $r=-0.186$ ($P<0.130$). This result leads us to the conclusion that, the grazing length might be influenced by site specific, rather than general environment, factors.

Table IV-2. Characteristics of the beef system in the Adriatic-Ionian macro region (mean and standard deviation).

Characteristics	Country			
	BA	CR	IT	SI
Number of sample farms	15	18	15	20
Beginning of operation[4] (year)	2009 ± 2.08	2003 ± 8.87	1955 ± 24.83	2002 ± 5.42
Level of specialisation[6] (%)	90.56 ± 17.42	87.39 ± 13.22	93.74 ± 9.82	85.49 ± 19.04
Size of holdings[2] (adult cows)	134.8 ± 345.61	63.44 ± 43.28	61.53 ± 30.38	23 ± 17.64
Altitude of farmstead[3] (m.a.s.l.)	605.33 ± 422.17	178.89 ± 161.06	603.33 ± 123.67	493.3 ± 198.81
Grazing length (days)[5]	315.13 ± 67.65	237.11 ± 62.36	209.67 ± 48.73	265.65 ± 76.85
Mechanisation (machines)	3.53 ± 2.83	3.44 ± 1.92	4.73 ± 2.11	2.95 ± 0.97
Machine strength (HP machine^{-1})	90.33 ± 60.12	83.37 ± 30.76	101.14 ± 26.00	68.39 ± 17.53
Labour (AWU)	3.77 ± 5.39	2.30 ± 1.59	2.74 ± 1.27	1.37 ± 0.48

1-Two-letter ISO code (ISO 3166 alpha-2).
2-IT has a normal distribution (Shaphiro-Wilk test).
3-Normally distributed BA, IT and SI, while CR is not normally distributed (Shaphiro-Wilk test).
4-Not normally distributed (Shaphiro-Wilk test).
5-Not normally distributed (Shaphiro-Wilk test).
6-Percentage of LU on the holding belonging to the beef breeding (all categories included); Not normally distributed (Shaphiro-Wilk test).

The comparison between countries yielded no significant differences (P>0.05) for the size of holdings. The mean farm altitude of CR farms was significantly lower compared to the means of BA, IT and SI (P<0.05). Performing a means comparison for the beginning of the farming operation, the IT farms are significantly older (P<0.05) than the farms analysed in BA, CR and SI (difference of means -53.67, -47.37 and -46.87 respectively). The grazing length discriminated between the countries and a significant difference of means was found for the farms in BA compared with means of the other three countries (difference of means 78.02, 105.47 and 49.48 for CR, IT and SI respectively, P<0.05). Further, a significant difference between the means was found between the duration of the grazing period for SI and IT (difference of means 55.98, P<0.05). No significant differences were found comparing the level of specialisation on the analysed farms for the four countries (P>0.05).

3.2 Enumerating the stocks and flows

To represent the beef system on a regional scale, rather than the arithmetic mean the weighted arithmetic mean is used as representative value for results in Table IV-3.

Table IV-3. Summary performance metrics characterizing livestock systems in the model. Values reported per breeding female in a steady state.

Country[1]	Age at first calving (days)	Breeding males (female^{-1})	Calving (year^{-1})	Market animals (cycle^{-1})	Replacement rate (cycle^{-1})	Premature mortality (cycle^{-1})	Exploitation length (years)
BA	876	0.06	0.88	0.71	0.09	0.08	15.7
CR	886	0.04	0.90	0.67	0.11	0.13	13.1
IT	1004	0.03	0.73	0.54	0.10	0.08	13.8
SI	1004	0.06	0.94	0.73	0.12	0.10	13.1
Peters et al., 2014	730	0.04	0.92	0.74	0.12	0.05	n/a

1-Two-letter ISO code (ISO 3166 alpha-2).

Despite requiring 1004 days for the rearing of a breeding female until the first calving, the metrics reveal that the male to female ratio in SI is as twice as big as in IT (Table IV-3). Premature mortality in Table IV-3 includes besides stillborn calves and early death trough natural causes loss to predators like wolfs, stray dogs and snake bits. Other premature mortality cases include suffocating by foreign bodies being stuck in the gastro-intestinal tract, poisoning and theft (treated as mortality without body as trace, similar to some predator attacks).

The beef system in the United States (US), in Table IV-3 represented by Peters et al. (2014), has the lowest age at first calving compared with the results for the Adriatic-Ionian macro region. Simultaneously, Peters et al. (2014) found lower rates for males to females, lower premature mortality and a similar value for the number of marketed animals per cycle.

As Table IV-3 shows just the steady state of the system and gives little insight in the farm dynamics, Table IV-4 provides further insight into the difference between the assumed steady state and the real conditions. Negative differences, in Table IV-4, indicate the lack of animals to preserve the system in a steady state while a positive sign indicates a surplus of animals in a given category.

Table IV-4. System metrics in a changing state (per breeding female).

Country	Metrics	Steady state	Current state	Difference
Bosnia and Herzegovina	Calf stock	0.85	0.88	0.03
	Replacement heifer stock	0.08	0.61	0.54
	Finishing heifer stock	0.36	0.02	-0.34
	Replacement bull stock	0.01	0.06	0.05
	Finishing steer stock	0.37	0.24	-0.13
Croatia	Calf stock	0.86	0.90	0.04
	Replacement heifer stock	0.09	0.26	0.16
	Finishing heifer stock	0.32	0.10	-0.22
	Replacement bull stock	0.01	0.04	0.03
	Finishing steer stock	0.38	0.13	-0.25
Italy	Calf stock	0.70	0.73	0.03
	Replacement heifer stock	0.09	0.05	-0.04
	Finishing heifer stock	0.26	0.16	-0.10
	Replacement bull stock	0.01	0.03	0.03
	Finishing steer stock	0.31	0.17	-0.14
Slovenia	Calf stock	0.90	0.94	0.04
	Replacement heifer stock	0.10	0.14	0.04
	Finishing heifer stock	0.34	0.21	-0.13
	Replacement bull stock	0.02	0.06	0.05
	Finishing steer stock	0.40	0.27	-0.13

A surplus of breeding animals, especially breeding females is observed in three of the four countries (BA, CR and SI). Considering the average year of establishment in the countries separately, an increase of the breed stock could justify the surplus. Italian farmers operate with a breeding stock whose current state is similar to the steady state of the system, leaving space for the assumption that in Italy a higher level of saturation in terms of farm capacity is achieved. Bulls and cows are states set to 1 and are therefore not reported in Table IV-4.

3.3 Productive output

The productive output per cow per breeding cycle for the analysed countries is shown in Table IV-5. The values represent the average output per cow in the form of live, dressing and boneless weight of each category. In this case, IT and CR have the highest proportion of output animals belonging to the category of calves with live weights of 229 and 191 kg respectively. For SI and BA a smaller proportion of calves was found in the output, but scoring with the highest and lowest market weights in the groups (261 and 162 kg respectively).

Table IV-5. Achieved output per cycle per commodity.

Country / reference	Commodity	Production (no. slaughtered breeding female^{-1} cycle^{-1})	Market weight (kg)	Dressing weight (kg)[1]	Boneless weight (kg)[1]
Bosnia and Herzegovina	Calves sold	0.25	162	103	71
	Bullocks sold	0.52	593	357	239
	Heifers sold	0.05	370	223	149
	Cows culled	0.05	617	371	248
	Bulls culled	0.01	788	475	318
	Total	-	411	249	167
Croatia	Calves sold	0.59	191	121	84
	Bullocks sold	0.12	561	338	226
	Heifers sold	0.10	434	261	175
	Cows culled	0.06	636	383	256
	Bulls culled	0.01	901	543	363
	Total	-	271	167	113
Italy	Calves sold	0.35	229	145	101
	Bullocks sold	0.16	713	429	287
	Heifers sold	0.16	471	283	190
	Cows culled	0.06	638	384	257
	Bulls culled	0.01	909	547	366
	Total	-	318	194	131
Slovenia	Calves sold	0.27	261	165	115
	Bullocks sold	0.33	321	193	129
	Heifers sold	0.26	319	192	129
	Cows culled	0.08	651	392	262
	Bulls culled	0.02	881	530	355
	Total	-	324	197	133
Peters et al. 2014	Calves sold	n/a	n/a	n/a	n/a
	Bullocks sold	0.42	603	363	243
	Heifers sold	0.32	530	319	214
	Cows culled	0.10	544	328	219
	Bulls culled	0.01	907	546	365
	Total	-	486	293	196

1-Conversion factors from USDA Economic Research Service (ERS), 1992.
Market weight corresponds to the live weight of animals.

The highest achieved total output per breeding female in the survey sample was obtained for BA. The output was strongly influenced by the high proportion of the number of bullocks raised per breeding female. The outputs in IT and SI are similar, despite the difference in the structure of animals composing the output. The total output was leveraged by the difference in the final weight of live animals leaving the system. The sample for CR showed the lowest achieved output per breeding female. Peters et al. (2014) report higher outputs in the US system due to its high proportion of finished animals in the output.

3.4 Aggregate ration composition

The aggregate ration composition reveals the feed ingredients used in the cow- calf system of the macro region. The farms in IT and SI adopt a feeding regime in which hay and grazed forage dominate in the dry matter composition. In IT and CR, a small portion of grass silage is used, whereas in BA and CR corn silage takes a larger part of the dry matter consumption than in IT and SI (Figure IV-3).

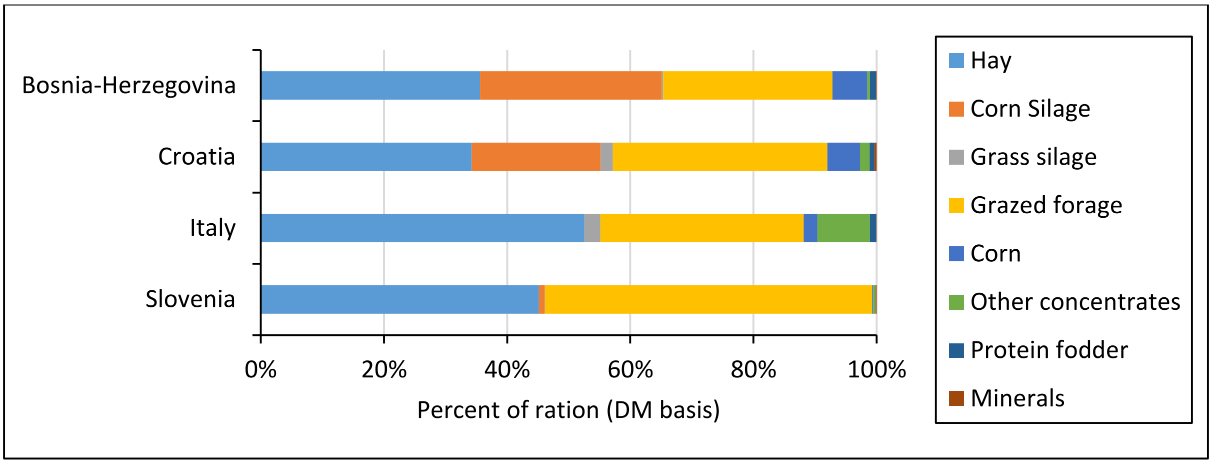

Figure IV-3. Aggregate composition of rations for beef farms per country (annual basis).

3.5 Efficiency

Efficiency indicators related to the use of inputs, on annual basis, per breeding female and surface of agriculture land are shown in Table IV-6. These indicators are provided to give an overview on the use of inputs prior to moving to the model specifications and efficiency score calculations. The indicators are shown as average per country, and are not further elaborated statistically.

Table IV-6. Efficiency indicators by country.

Efficiency type	Measure	BA	CR	IT	SI
Land use efficiency	cow UAA^{-1} (head/ha)	0.41	0.27	0.20	0.42
	LU output UAA^{-1} (kg/ha)	83.97	67.99	63.14	112.70
Labour efficiency	Human labour cow^{-1} (AWU)	0.03	0.04	0.04	0.06
	Human labour cow^{-1} year^{-1} (h)	11.65	15.08	18.50	24.81
Mechanisation utilisation	HP ha^{-1}	1.12	1.17	1.54	3.17
	HP cow^{-1}	2.75	4.29	7.55	7.50
Feeding efficiency	DM crude fodder cow^{-1} year^{-1} (t)	12.83	10.29	9.47	11.28
	DM concentrates cow^{-1} year^{-1} (t)	0.98	0.81	1.31	0.06
	Total DM cow^{-1} year^{-1} (t)	10.78	11.34	13.81	11.10
Productive output	LU output cow^{-1} (kg)	205.89	248.90	308.78	267.04

UAA: Utilised agricultural area, LU: Livestock unit, kg: kilogram, t: ton, h: hour, HP: horsepower, AWU: annual work unit, ha: hectare, DM: dry matter

The ration composition (Figure IV-3) and feeding efficiency (Table IV-6) are not adjusted for loss of fodder through weight loss, spoiling and dispersal waste.

3.6 The DEA execution and technical efficiency scores

Summary statistics of the variables used in the DEA are presented in Table IV-7. As agricultural production depends in general on land area, labour, seed, inorganic fertilizers, herbicides and pesticides, animal and mechanical traction, and soil quality (Feng 2008), five of these factors were chosen as inputs for the model (Table IV-7). Synthetic compounds such as herbicides and fertilisers were excluded due to the absence of this input on biologic/organic farms. The inclusion of this input would lead to a discrimination between organic and conventional farms, assuming higher efficiency scores for organic farms. The choice of variables was constrained by the available data and the need to avoid the "curse of dimensionality" that can affect the DEA. This occurs if too many variables are entered in the model specification and, as a result, a large proportion of the farms will be efficient. Chambers et al. (1998) have suggested that as a rule of thumb that there should always be at least three times as many data observations (i.e. farms) as variables to be included in the model specification.

Table IV-7. Variables and average values of the sample data for the data envelopment analysis.

Variable	Type	Units	Values	
Labour[1]	Input 1	Annual work unit (AWU)	Mean	2.45
			Standard deviation	2.90
			Minimum	0.75
			Maximum	23.67
Mechanisation[2]	Input 2	Horsepower (HP)	Mean	307.14
			Standard deviation	289.20
			Minimum	7.82
			Maximum	1599.96
Grassland[3]	Input 3	Hectares (ha)	Mean	188.66
			Standard deviation	240.22
			Minimum	11.36
			Maximum	1037.84
Concentrate fodder[4]	Input 4	Tonnes (t)	Mean	75.61
			Standard deviation	250.08
			Minimum	0.02
			Maximum	2013.38
Herd size[5]	Input 5	Livestock units (LU)	Mean	122.56
			Standard deviation	310.77
			Minimum	11.60
			Maximum	2556.30
Market weight of animals leaving the farm	Output	Kilograms (kg)	Mean	16299.89
			Standard deviation	36849.34
			Minimum	1170.00
			Maximum	301845.45

1-Annual work unit corresponds to 2000 hours of active labour.
2-The sum of horsepower of all machines available on farmstead.
3-The grazed surface (including pastures and grazed meadows after hay harvest).
4-Total amount of concentrate fodder (including grain, protein meal, minerals and vitamins).
5-Sum of livestock units of all categories.

Before the DEA was employed, several partial indicators of efficiency were considered to see if they yielded useful information. To facilitate this, an output to input ratio was calculated for each of the inputs for the single measure of output (market weight of live animals). To see if the various ratios provide consistent and meaningful information, sample correlation coefficients were calculated between the five partial indicators for all farms. The results of this analysis are shown in Table IV-8.

If the partial indicators are to yield consistent information in terms of benchmarking, the desired sample correlation coefficients should be close to ±1. As can be seen in Table IV-8, the sample correlation coefficients vary significantly and do not exceed ±0.38. The implication of this is as previously suggested, that different partial indicators will yield significantly different results with regard to farm level performance.

Table IV-8. Correlation coefficients of output/input ratios.

	Output/Input 1	Output/Input 2	Output/Input 3	Output/Input 4	Output/Input 5
Output/Input 1	1				
Output/Input 2	0.06537	1			
Output/Input 3	0.16035	-0.14148	1		
Output/Input 4	-0.07771	-0.06225	0.10223	1	
Output/Input 5	0.32799	0.09568	0.37243	0.09844	1

The first perceived information from the results is that, under constant returns to scale, the efficiency score derived is either less than or equal to the efficiency score derived for the variable returns to scale specification for every farm. This indicates the fact that, under variable returns to scale, inefficient farms are only compared to efficient farms of a similar size (Fraser and Cordina, 1999).

For this reason, more farms are efficient under the variable returns to scale formulation. To reduce the number of farms that are efficient would require the reduction of the number of variables in various models. However, the removal of any of the variables included would significantly undermine reliability of the analysis.

To assess if the efficiency of a farm is related to its size (measured by herd size) the correlation between efficiency score and farm size was calculated for each of the above specifications. In every case, the resulting correlation coefficient was not significantly different from 0.

The DEA yielded 20, 38 and 37 efficient farms for the various model specifications, shown in Table IV-9.

The input oriented model with a constant return to scale specification yielded four unique cases with technical efficiency scores of 100% (C13, S13, S17 and S19). The highest benchmark values were obtained for farms S9, I14, S7, S10, B14, C4, B5, B11 and C3 (benchmarks for 50, 48, 40, 32, 26, 20, 20, 18 and 14 farms respectively).

The input oriented model with a variable return to scale specification yielded ten unique cases with technical efficiency scores of 100% (B7, B8, C7, C16, C17, I13, S12, S13, S14 and S19). Farms used as benchmark for at least ten other farms were I14, S2, S9, C4, B14, B5, B11, S10, S16 and S17 (benchmarks for 32, 28, 28, 16, 14, 12, 12, 10, 10 and 10 farms respectively).

The output oriented model with a variable return to scale specification yielded 13 unique cases with technical efficiency scores of 100% (B8, C13, C17, I13, S1, S4, S5, S6, S11, S12, S13, S14 and S19). Farms used as benchmark for at least ten other farms were I14, S9, B5, B14, C4, S7, S10, B11, S2 and C3 (benchmarks for 44, 24, 16, 16, 14, 14, 14, 12, 12 and 10 farms respectively).

Table IV-9. Technical efficiency scores of beef farms.

DMU[1]	CRS[2] Input oriented	VRS[3] Output oriented	VRS[4] Input oriented	DMU[1]	CRS[2] Input oriented	VRS[3] Output oriented	VRS[4] Input oriented
B1	0.364	0.366	0.429	I2	0.472	0.472	0.593
B2	0.705	0.713	0.711	I3	1.000	1.000	1.000
B3	0.454	0.495	0.720	I4	0.781	0.925	0.915
B4	0.511	0.525	0.582	I5	1.000	1.000	1.000
B5	1.000	1.000	1.000	I6	0.641	0.655	0.654
B6	0.878	0.917	0.886	I7	0.623	0.682	0.813
B7	0.946	1.000	1.000	I8	0.932	0.933	0.934
B8	0.709	1.000	1.000	I9	0.542	0.553	0.546
B9	0.631	1.000	1.000	I10	0.493	0.560	0.919
B10	0.702	0.722	0.752	I11	0.801	0.893	0.866
B11	1.000	1.000	1.000	I12	0.856	0.871	0.857
B12	0.538	0.570	0.657	I13	1.000	1.000	1.000
B13	0.723	0.737	0.747	I14	1.000	1.000	1.000
B14	1.000	1.000	1.000	I15	0.859	0.879	0.861
B15	0.451	0.451	0.472	S1	0.533	1.000	1.000
C1	0.660	0.738	0.922	S2	0.938	1.000	1.000
C2	0.554	0.626	0.720	S3	0.662	1.000	1.000
C3	1.000	1.000	1.000	S4	0.388	1.000	1.000
C4	1.000	1.000	1.000	S5	0.573	1.000	1.000
C5	0.533	0.596	0.869	S6	0.840	1.000	1.000
C6	0.911	0.913	0.929	S7	1.000	1.000	1.000
C7	0.846	1.000	1.000	S8	0.960	1.000	1.000
C8	1.000	1.000	1.000	S9	1.000	1.000	1.000
C9	1.000	1.000	1.000	S10	1.000	1.000	1.000
C10	0.739	0.746	0.740	S11	0.396	1.000	1.000
C11	0.956	0.968	0.973	S12	0.770	1.000	1.000
C12	1.000	1.000	1.000	S13	1.000	1.000	1.000
C13	1.000	1.000	1.000	S14	1.000	1.000	1.000
C14	0.518	0.519	0.623	S15	0.953	1.000	1.000
C15	0.610	0.622	0.611	S16	1.000	1.000	1.000
C16	1.000	1.000	1.000	S17	1.000	1.000	1.000
C17	0.606	1.000	1.000	S18	0.756	0.770	0.953
C18	0.467	0.486	0.516	S19	1.000	1.000	1.000
I1	0.894	0.954	0.967	S20	0.811	1.000	1.000

1-DMU: Decision making unit; 2-CRS: Constant returns to scale, Number of efficient farms: 20 (30%); 3-VRS: Variable returns to scale, Number of efficient farms: 38 (56%); 4-VRS: Variable returns to scale, Number of efficient farms: 37 (55%).

The distribution of efficiency scores for each specification for the four countries is shown in Figure IV-4. These efficiency scores show that many of the farms in the sample are operating at near or full efficiency for all the model specifications. The scope for further improvements in efficiency, given the obvious tail for each model specification (Figure IV-4), is present in all countries.

The average value of farm technical efficiency for the Constant returns to scale input oriented model is 78.7%, ranging from a minimum of 36.4% to a maximum of 100%; 86.6% for the Constant returns to scale output oriented model, ranging from 36.6% to 100%; 89.3% for the Variable returns to scale input oriented model, ranging from 42.9% to 100%. Similar results were observed by Trestini (2006).

The radial part of improvement for inputs/outputs, shown in Table IV-10 and Table IV-11, is the proportional decrease of inputs or the proportional increase of outputs. Positive values mean increase, and negative values mean decrease.

In the input oriented model-statements, the results revealed for all countries possible savings by preserving the same amount of outputs (Table IV-10). For all countries, the proportion of savings in inputs is corresponding to the achieved efficiency score for each group of decision-making units (sample farms per country). Therefore, higher savings are reported for countries with a lower efficiency score. Farms in BA and IT are shown to operate with a waste of inputs. The interpretation of the estimated savings should be case specific. In this exercise, annual work units and concentrate consumption are inputs that depend mostly on the market price. A managerial choice would be to use free resources in excess and resort for the use of "expensive" inputs just in cases in which their use is justified by the output price gain. Concentrates are mostly related to the farms that adopt fattening processes and are an irreplaceable resource. In some cases during the research, farms reported to have unique types of support for the access to concentrates. The type of support is mostly seen as reduced grain price for large quantity purchases, the possibility to utilise arable land included in subsidy schemes for grain production, the necessity to produce grain for other purposes and use leftovers as animal fodder, or the use of grain from food industry residuals. Grassland in this case is also a site-specific resource. If available in excess, grassland management tend to be more extensive, the livestock densities are lower and therefore the farms are seen as less efficient in comparison to farms that are forced to adopt rotational stocking in an intensive grassland management regime. The grazing in BA is characterised by grazing on karst rangelands with abundant shrub growth, and stones and rocks protruding through the topsoil. The animal densities are low and the topsoil quality makes these pastures unattractive for other land uses. In CR, the grazing is organised on two locations, in the south in the natural park "Lonjsko Polje", where the annual excess water from the Sava River in spring and autumn limits the use of the fertile soil to grazing. The other location is the hilly area in the northern part of the continental region where lower population densities, abandoned villages and unsuited terrain provide sufficient surface for extensive animal production.

Table IV-10. Estimates for input oriented model statements (mean ± standard deviation).

MS	CC	TE score	Input 1 (AWU)	Input 2 (Concentrate)	Input 3 (Grassland)	Input 4 (Horsepower)	Input 5 (Herd size)
CRS IO	BA	0.71 ± 0.22	-0.73 ± 0.62	-11.12 ± 21.46	-72.71 ± 79.39	-105.50 ± 140.72	-22.41 ± 24.64
	CR	0.80 ± 0.20	-0.43 ± 0.54	-8.50 ± 17.72	-20.01 ± 27.37	-48.47 ± 68.06	-12.45 ± 12.86
	IT	0.79 ± 0.19	-0.52 ± 0.49	-17.26 ± 19.79	-72.05 ± 116.54	-83.89 ± 82.87	-23.09 ± 22.74
	SI	0.83 ± 0.21	-0.22 ± 0.27	-0.73 ± 2.09	-4.74 ± 7.47	-21.56 ± 26.74	-4.92 ± 6.78
Total		0.79 ± 0.21	-0.45 ± 0.51	-8.57 ± 17.40	-37.95 ± 73.66	-59.54 ± 89.93	-14.56 ± 18.82
VRS IO	BA	0.78 ± 0.20	-0.6 ± 0.61	-10.13 ± 20.59	-59.96 ± 72.94	-91.15 ± 132.56	-19.03 ± 24.52
	CR	0.88 ± 0.16	-0.29 ± 0.50	-7.53 ± 17.42	-10.27 ± 15.56	-32.97 ± 62.68	-7.26 ± 10.09
	IT	0.86 ± 0.15	-0.39 ± 0.46	-14.42 ± 19.32	-52.61 ± 86.11	-62.50 ± 77.30	-16.82 ± 19.30
	SI	1.00 ± 0.01	0.00 ± 0.01	0.00 ± 0.01	-0.12 ± 0.51	-0.78 ± 3.42	-0.11 ± 0.47
Total		0.89 ± 0.16	-0.29 ± 0.49	-7.26 ± 16.71	-26.70 ± 58.83	-41.51 ± 84.36	-9.58 ± 17.09

MS: Model Specification; CC: Two-letter ISO country code (ISO 3166 alpha-2).

The input oriented models (Table IV-10) revealed the input saving estimates, which are achievable without affecting the produced outputs. Rather than strive for input savings, an option for the output increase is proposed for the same amount of inputs used.

The results in Table IV-11 reveal that potential increases in all countries are possible, with the same ratio of inputs used. The output increase is linked to the achieved efficiency score of the best performing farms, and reports higher increases for farms that are reported to operate at an efficiency level further away from the best practice frontier (left tail in Figure IV-4).

Table IV-11. Estimates for the output oriented model statement (mean ± standard deviation).

Model specification	Country	Technical efficiency score	Output (Live weight)
VRS OO	Bosnia and Herzegovina	0.75 ± 0.23	4118.01 ± 5271.13
	Croatia	0.85 ± 0.19	1626.55 ± 2148.12
	Italy	0.83 ± 0.18	3717.5 ± 4376.18
	Slovenia	0.99 ± 0.05	92.84 ± 404.66
	Total	0.87 ± 0.19	2125.73 ± 3733.43

VRS OO: Variable returns to scale model, output oriented.

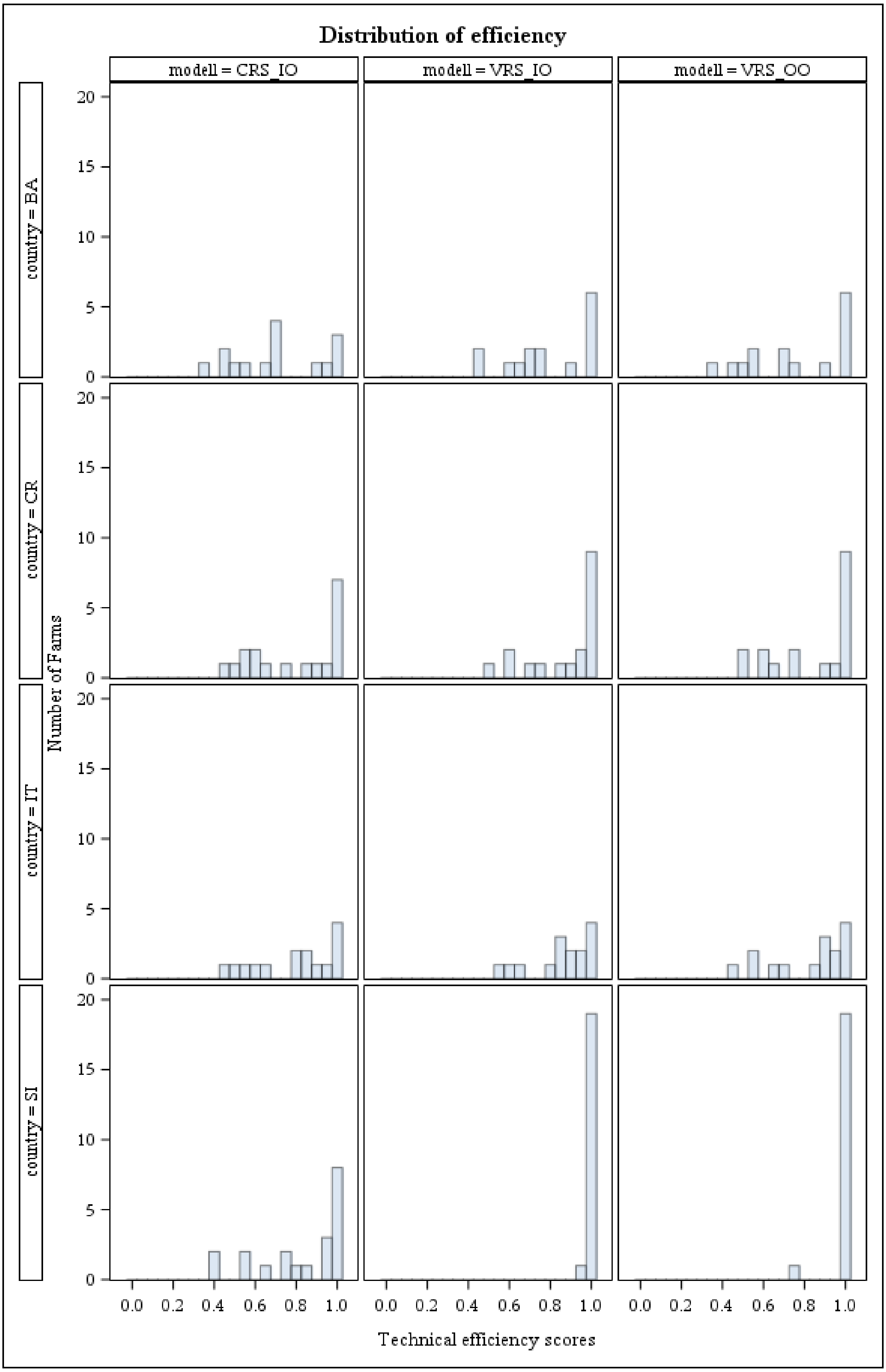

Figure IV-4. Efficiency estimate histograms (CRS: Constant returns to scale, VRS: Variable returns to scale, IO: input oriented, OO: output oriented).

Correlating the model components with the obtained technical efficiency scores yielded no strong correlations. None of the obtained coefficients were exceeding r=±0.150 (Table IV-12). This independence explains the absence of a determinant production factor upon which the efficiency scores for all countries depend.

Table IV-12. Correlation of technical efficiency scores and model components.

	CRS IO	VRS OO	VRS IO	Input 1	Input 2	Input 3	Input 4	Input 5	Output
CRS IO	1.00	-	-	0.09	0.03	-0.04	0.05	0.07	0.06
VRS OO	0.74	1.00	-	0.03	-0.03	-0.11	0.04	0.02	0.02
VRS IO	0.67	0.93	1.00	-0.02	-0.03	-0.14	0.02	-0.02	-0.01

Confronting the means of the obtained technical efficiency scores across countries yielded significant differences (Table IV-13). The model with constant returns to scale yielded no significant difference between the group means (P>0.05). The output-oriented model with variable returns to scale revealed a higher technical efficiency score for the Slovenian farms comparing their mean with the other three group means. The same result was obtained for the input oriented variable returns to scale model (Table IV-13).

Table IV-13. Comparison of the technical efficiency score means from beef farms by country.

Country[1]	CRS Input oriented			VRS Output oriented			VRS Input oriented		
	BA	CR	IT	BA	CR	IT	BA	CR	IT
CR	0.093			0.079			0.086		
IT	0.086	-0.007		0.059	-0.020		0.065	-0.022	
SI	0.122	0.029	0.036	0.222*	0.143*	0.163*	0.201*	0.114*	0.136*

1-Two-letter ISO code (ISO 3166 alpha-2); *: P<0.05; CRS-Constant returns to scale, VRS-Variable returns to scale.

4 Discussion and conclusion

Analysing the efficiency of beef farms allowed us to determine the main characteristics of this system and identify the technical efficiency under which these farms operate. The mean value for technical efficiency for the four analysed countries were 0.79, 0.89 and 0.87 for the three model specifications applied. The results imply that the average inefficiency for the use of inputs are 0.21 and 0.11, and the inefficiency of the produced output 0.13. An average saving of 21% of the inputs is possible, without affecting the quantity of produced output or, an average increase of output by 13% for the same amount of consumed inputs. Comparing the obtained results with efficiency assessments made by other authors, slightly lower efficiency was observed by Gaspar et al.(2009) analysing the dehesa system in Spain (mean efficiency of 70%), an efficiency of 69% by Otieno et al. (2012) analysing the beef system in Kenya and 78.6% by Trestini (2006) for the beef cattle production in Italy. Noteworthy, our results for the sample of Italian beef farms yielded slightly higher efficiency estimates than those observed by Trestini (2006).

The research revealed that in this survey sample Slovenian farms operate with the highest estimated efficiency. Slovenian farms have also the smallest farm size and lowest level of specialisation in the survey sample. Correlating the efficiency estimates with the single input variables yielded no significant correlations.

It is assumed that the use of inputs becomes more efficient in a diversified production. As observed by Gaspar et al. (2009) for the dehesa system that diversified farms with additional revenue achieve higher technical efficiency over specialised farms. The efficiency in our research does not include the financial result of the farming operation. We assume that higher economic gains are the primary target of the farmers.

The beef system is an extensive production system. Because of its nature and demands, the practice of cow calf breeding is often set to remote landscapes for which few interest for other agriculture production exist.

The difference in general development of the countries, the extent of the availability of natural, we dare to say freely available, resources takes also a big role in decision making and organisation. Natural conditions such as the "Lonjsko Polje" Natural Park or Italian Apennines provide sufficient fodder during the grazing season and compensate for any potential needs towards feed supplements. This may not be the case in other geographic locations. Direct payments and policy support to the farmers may also leverage the difference in the achieved scores. A case in Italy revealed the presence of farms that utilise exclusively state owned land, without any cultivated or grazed land in private ownership, no mechanisation, no production of fodder on the farmstead, and despite the need to buy all roughage and concentrates, achieve a positive economic result thanks to European subsidies and direct payments.

If means are found to include these factors in the efficiency estimation, a more accurate assessment could be applied to identify the best performing decision-making units and the possibility of applying their management to less efficient decision-making units.

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Chapter V: Synthesis

The livestock sector is now organised on the remains of the communism period, which lasted for five decades until the early 90's, and of the armed conflicts occurred after the downfall of the former Yugoslavia. The present trends indicate the need to cope with the demands of the European Union to access markets, and in the mind-set of policy makers, it takes high priority.

Due to the regionalisation based on administrative borders and differentiation in legislation adopted by the single former Yugoslav republics, livestock systems are classified based on various criteria. All systems, despite the type, location and scale, play an important role in the socio-economic context of the analysed study area. The sector serves as social buffer, provides goods and services for the domestic market and society, both formal and informal workplaces and contributes to poverty reduction.

The research revealed that both internal and external factors shape the structure and evolution of a system. Those system structures incorporate ecological, social and economic components that if misunderstood for the corresponding system could cause failure for applied interventions, downward trends and at the end abandonment. An example of this misunderstanding or misinterpretation of measures was the global banning of goat production in the study area that lasted from the mid-1950s to the breakup of the SFRJ (Socialist Federal Republic of Yugoslavia) in the early 1990s. Consequences that followed were the loss of genetic resources and variability of the goat population, a decline in the number of goats, an emerging gap in the market for goat products, abandonment of traditional breeding practises and husbandry methods, loss of knowledge on the system and land abandonment.

A common classification criterion of cattle systems prior to the application of this framework was not present in the study area. Despite, the surveyed experts were able to distinguish systems based on classification criteria such as main production purpose, husbandry practises feeding resources etc. To classify a system, quantitative data are necessary, and many times in the developing countries, these data are not available or not accessible. The success of measures for improvement can only be assessed through a measurable change of the state for which properly working mechanisms have to be set in place before applying major development strategies.

It is difficult to draw a line between systems as they tend to overlap in some cases, but policy schemes and development frameworks could contribute greatly to develop a clear distinction between systems. A pattern of mixed production on small-scale farms is dominant and farmers tend to keep more than a single animal species to diversify the production and provide diverse sources for income. This diversification on one hand provides better economic stability of the single farms, but on the other hand, it encumbers to apply classification criteria and appropriate schemes for rural development.

The sustainability criteria variables provided information about the perception of experts on four aspects of the studied livestock systems. Considering the diversity of the systems addressed by this exercise, the perceptions were influenced by five of the ten factors of variation they were exposed to.

Common issue for all the analysed systems is the lack, or slow, of knowledge supply through the advisory service, where once adhered husbandry methods, sometimes outdated, are still in use (e.g. manual milking, traditional housing and practices). These production practises reflect cultural heritage that lead to the decline of production systems due to the lack of readiness to adapt production to changing demands. The scale of operations for farmers are often constrained by issues such as small parcel sizes and land ownership dispute, just as absence of grazing rights and proper grazing infrastructures for pastoralists. Together with low competitiveness towards systems across regions, the mentioned factors just contribute to the constraints that the farmers are facing.

We tested the consistency of the proposed measures by comparing the responses to socio-ecological indicators and constraints, particularly those reaching a higher consensus, and the amending objective of development options. We found that main perceived constraints are highly related to the economic instability. For example, over half of experts (55%) expressed disagreement with the effectiveness of current support schemes and a large majority with the absence of support (64%), in correspondence, 78% of the proposed measures included alternatives on the mentioned constraints in section five. The strongest consensus was reached on the concern on the income generated and market conditions (61% and 78% respectively), which are also in other contexts seen as main constraint to the livestock systems continuity. Finally, the proposed development options point out also the necessity for intensification inside the systems.

For the upcoming trends a common agreement on the decrease of participants to the systems but a simultaneous increase of the number of animals per farm are present. Despite the previous, a downward trend regarding the total number of animals compared to the past decades is occurring for both cattle and sheep. Unlike the previous two species, goat breeding is experiencing an upward trend considering the number of breeders and the number of animals raised, as stated by the experts. Commonly, endogenous development of the management capabilities of farmers and the improvement of support schemes are expected. Few responses were taken for the changes on the market of products, the preferences of costumers, the prices of inputs and products from the systems. These statements point out the complexity to predict the future development of economic related issues the participants might face. To compensate for this lack, strong support and regional planning are necessary.

The gathered information on development options for a variety of LPS in different environmental conditions exposed some similar results. Individuality and strong regional identity on a smaller scale, but representing a proportion of the aggregate may be lost. Systems can simultaneously become more sustainable in some dimensions and less sustainable in others, and it is possible for systems to become unstable even if most indicators are improving. Therefore, the information provided by this work should serve in a context as guideline to the proposal of regional strategies on a wider scale, but the implementation to be decided by smaller territorial units.

About the development options of LPS in the western Balkans, the need to increase the overall farm size in order to achieve bigger gains per animal and higher farm incomes is represented by 20% of the development options from the group of “other development options”. Experts highlighted the high diversity of the size of holdings inside the case studies for the systems that resulted in the non-existent discriminatory power of farm size to discern case studies based on the score of economic criteria variables. The long-term concept of livestock development should be founded on efficiency in production of meat, through farmer associations and organizations. In general, a larger number of animals has to be sustained by a household to assure its sustainability in many aspects.

The importance of rural development programmes is highlighted by 68 responses from the surveyed experts. Together with the devising and implementation of traditional and alternative management practices, the development on both at biogeographical region and local basis is supported by a third of the total development options provided.

Analysing the efficiency of beef production in cow-calf farms made it possible to determine the main characteristics of this system and identify the technical efficiency under which these farms operate. The mean value for technical efficiency for the four analysed countries were 0.79, 0.89 and 0.87 for the three model specifications applied. The results imply that the average inefficiency for the use of inputs are 0.21 and 0.11, and the inefficiency of the produced output equal to 0.13. An average saving 21% of the inputs is possible, without affecting the quantity of produced output or, an average increase of output by 13% for the same amount of consumed inputs.

The research revealed that in this survey sample Slovenian farms operate with the highest estimated efficiency. Slovenian farms have also the smallest farm size and lowest level of specialisation in the survey sample. The efficiency estimates were not correlated to input variables.

It is assumed that the use of inputs becomes more efficient in a diversified production. As observed, those diversified farms with additional revenue achieve higher technical efficiency over specialised farms. The efficiency in our research does not include the financial result of the farming operation. We assume that higher economic gains are the primary target of the farmers.

The cow-calf system is an extensive production system. Because of its nature and demands, the practice of cow calf breeding is often set to remote landscapes for which few interest for other agriculture production exist.

The difference in general development of the countries, the extent of the availability of natural and freely available resources take also a big role in decision making and organisation. Natural conditions such as the “Lonjsko Polje” Natural Park or Italian Apennines provide sufficient fodder during the grazing season and compensate for any potential needs towards feed supplements. This may not be the case in other geographic locations. Direct payments and policy support to the farmers may also leverage the difference in the achieved scores. A case in Italy revealed the presence of farms that utilise exclusively state owned land, without any cultivated or grazed land in private ownership, no mechanisation, no production of fodder on the farmstead, and despite the need to buy all roughage and concentrates, achieve a positive economic result thanks to European subsidies and direct payments.