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Trends and drivers of change of cattle systems in the Western Balkans

E. Sedić[1], M. Brka[2,*] and P. D'Ottavio[1]

[1]Department of Agricultural, Food and Environmental Sciences (D3A) – Università Politecnica delle Marche, Via Brecce Bianche 10, 60131 – Ancona (Italy)
[2]Faculty of Agricultural and Food Sciences – University of Sarajevo, Ulica Zmaja od Bosne 8, 71000 – Sarajevo (Bosnia and Herzegovina)
*e-mail: m.brka@ppf.unsa.ba

Abstract. The paper presents the analysis of the changes of the cattle systems in the former Yugoslav republics which are now independent nations. It is assumed that cattle systems in former Yugoslavia gained in intensity of production but suffered from a decrease in the number of animals and in the number of farms over the last few decades, with a continuous negative trend. Development differences among the countries were present both before and after the split, but development gaps have widened even further since then. The aim of our study was to analyse the cattle trends and their drivers of change in the newly formed republics before and after the breakup. Therefore, we made a comparison of the evolution of cattle numbers in the Western Balkan countries so as to expose the results of our research to a wider public so that they can be used in priority setting and as a basis for a general foundation on livestock development. The analysis provides information about the intensity and influence of the main drivers of change affecting the dynamics of cattle numbers, taking into account the social conditions of the different countries.

Keywords. Cattle systems – Trends – Drivers of change – Western Balkans.

Dynamique des systèmes d'élevage bovin dans les Balkans occidentaux

Résumé. *Ce papier présente l'analyse des évolutions tendancielles des cheptels bovins dans l'ancienne république Yougoslave, qui est aujourd'hui composée de nations indépendantes. On suppose que les systèmes d'élevage dans l'ancienne Yougoslavie ont gagné en intensité de production mais ont diminué en nombre d'animaux et en nombre de fermes au cours des dernières décennies, avec une décroissance continue. Les niveaux de développement différents dans les pays étaient présents à la fois avant et après la séparation, mais les écarts de développement se sont creusés depuis lors. L'objectif de notre étude était d'analyser les évolutions tendancielles des cheptels bovins et les moteurs de ces changements dans les nouvelles républiques, avant et après la scission. Par conséquent, une comparaison de l'évolution du nombre de bovins dans les pays des Balkans occidentaux a été faite, en vue d'exposer les résultats de la recherche à un large public et de servir comme base pour définir des priorités pour le développement du bétail. L'analyse fournit des informations sur l'intensité et l'influence des moteurs des changements affectant la dynamique des systèmes d'élevage bovins, en tenant compte des conditions sociales des différents pays.*

Mots-clés. *Systèmes d'élevage bovin – Tendances – Moteurs de changement – Balkans occidentaux.*

I – Introduction

Given the complexity of agro ecosystems 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 (Liu, 2001; Taillefumier and Pie´gay, 2003). There is a considerable literature from a development perspective on how farming systems may change in response to key drivers (see the review of 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 an 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 by Mac Donald *et al.* (2000).

This study aims to provide information about the influence of the main drivers of change in the cattle sector of the former Yugoslav republics, taking into account their different conditions. Our assumption is that, despite having similar bio-geographic and climate conditions, the countries had different trends in terms of livestock system evolution which resulted in creating a difference in socio-economic development.

II – Materials and methods

For the purpose of this study, a database for six countries was compiled. The database contained nineteen variables grouped according to the type of information we obtained: (i) land use; (ii) livestock; (iii) social (Table 1). Variables were chosen in order to determine the trends of cattle numbers and the related drivers of changes.

Table 1. List of collected variables used for the statistical analysis

Land Use	Livestock	Social
Total agricultural area (TAA, ha)†	Stocking density†	Total population†
Arable land (ha)†	Total livestock units (LU)†	Population density (person/km²)†
Area under cereal production (ha)†	% Cattle in total LU†	Total rural population††
% Grassland in TAA†	LU per TAA†	% rural population of total population††
Area used for fodder crops (ha)†	Cattle number†	Rural population growth (%)††
	Grassland (ha)†	% of population between 15 and 64 years of age††
		Independency (0-no, 1-yes)
		Social turbulence (0-peace, 1-turbulence, 2-war)

† Statistical yearbooks; †† World Bank and FAO-stat.

The data used for the analysis were obtained from various statistical services and sources from the analysed countries (Table 2).

Cattle number was the only variable used for the trend analysis and served as dependent variable in the discriminant analysis. A Student's *t*-test was used for the trend analysis of cattle numbers between six decades within each country.

In order to reduce the number of explanatory variables, facilitate the interpretation of discriminant functions, ensure the requirements of normality and to reduce multi-colinearity among the independent variables, a Principal Factor Analysis (PFA) on the collected variables was performed (Table 1). The PFA with varimax rotation was performed to obtain the main factors (eigenvalue > 1) that summarized the observed changes.

The relationships between the evolution of cattle numbers through decades (dependent variable) and other explanatory variables were analysed using a discriminant analysis. A forward stepwise discriminant analysis using the *stepdisc* function in SAS 9.1 was carried out on the new variables (factors) resulting from the previously performed PFA. The method involves inserting the independent variables into the discriminant function one at a time on the basis of their discriminant

power, determining the optimal combination of variables so that the first function provides the highest total discrimination between groups, the second provides the second most, and so on (Hair *et al.*, 2006). The *discrim* function in SAS 9.1 was used to obtain variances explained by each discriminant function per country analysed.

Table 2. Sources of the collected data

Country	Source	Reference period
B&H	National First Release reports for agriculture and livestock of the Federation of Bosnia and Herzegovina	2005 to 2013
RS	Jovanović Z., 1998, Agriculture of Serbia 1947-1966 providing 50 annual series of statistical data	1947 to 1966
	SYB of the Republic of Serbia	1998 to 2012
RS, MNE	SYB of Serbia and Montenegro	2003 and 2004
	SYB of Yugoslavia	2001 and 2002
MNE	SYB of Montenegro	2006 to 2012
	Online data from the Statistical Office of Montenegro	2004 to 2011
CRO	SYB of the Republic of Croatia	2010 to 2012
	Statistical Information of the Republic of Croatia	2005 to 2013
MC	SYB of the Republic of Macedonia	1999 to 2002, 2005, 2008 to 2013
	Livestock statistical reviews of the State Statistical Office of Republic of Macedonia	2007 to 2012
SLO	SYB of the Republic of Slovenia	1990 to 2012
B&H, RS, MNE, CRO, MC	SYB of Yugoslavia	1950 to 1991
	FAO stat online database	1950 to 2012
	World Bank online database	1950 to 2012

B&H: Bosnia and Herzegovina, RS: Serbia, MNE: Montenegro, CRO: Croatia, MC: Macedonia, SLO: Slovenia, SYB: Statistical Yearbook.

III – Results and discussion

The analysis of the evolution of cattle numbers per country (Table 3) showed that the trends of the cattle population did not occur with the same intensity and with the same sign between the Western Balkan countries. In B&H, a continuous decrease in cattle number has occurred since 1960s, in CRO since 1970s, and in MC and RS since 1980s. A total decrease by 41% of the cattle population of all the countries has been recorded over the last sixty years. The highest total decrease occurred in B&H (-55%) and MNE (-52%). A relatively high decrease occurred in Montenegro in the 2000s (-44%) which was responsible for the total decrease recorded in this country (-41%). Serbia's cattle population increased until the 80s, then a steep decrease followed until now. Slovenia so far is characterized by the smallest decrease in cattle number, although a significant negative trend can be observed during the 90s ($P<0.001$).

A total of twelve factors with eigenvalues greater than one were obtained from the PFA. The number of factors obtained per country ranges from five (CRO) to seven (RS). The stepwise discriminant analysis resulted in the incorporation of factors that showed significant differences between decades ($P<0.05$) and therefore had discriminatory power.

Rural population turned out to be a good discriminant factor for five of the six countries. Social turbulence scored second to rural population with three significant cases. Also independence discriminated cattle evolution with three significant cases. Most factors with no significant effects

included the types of land use, concluding that they did not properly discriminate cattle trends in the analysed countries over the last few decades. Social factors had the most frequent and significant discriminatory power. Intensification (area for fodder crop and cereal production) and extensification (grassland, % grassland in TAA, stocking density) had significant discriminatory power just in two countries (B&H and MC).

Table 3. Changes of cattle numbers in the former Yugoslav republics over the last six decades

Country	1950s†	Changes of cattle numbers (% difference)					
		1960s	1970s	1980s	1990s	2000s	Total diff.††
B&H	1,099,296	-0.96	-5.57*	-5.67*	-8.34	-34.58**	-55.13**
Croatia	1,006,936	+8.18**	-7.96**	-8.13**	-34.26**	-9.7**	-51.87**
Macedonia	375,821	-14.26**	+4.37	-3.43	-10.8*	-6.37	-30.51**
Montenegro	183,918	-8.61**	+4.14*	+5.34*	+1.83	-43.97**	-41.28**
Serbia	1,859,300	+20.15**	+7.19	-7.22	-24.50**	-35.06**	-39.44**
Slovenia	505,780	+9.56**	-3.51	+5.23	-14.45**	-4.39	-7.57**
Total	5,031,051	12.46*	-0.03	-7.86	-33.87**	-12.08*	41.38**

† Average cattle number in the first decade is used as reference; †† Diff.: difference; *P<0.05; **P<0.001.

Socio-economic indicators were the most significant drivers of change for cattle numbers in most of the analysed countries. In B&H, four discriminant functions, explaining 83, 13, 3 and 1% of the total variance were obtained: social turbulence and an increased senility of the population resulted in a decline in rural population, extensification and lower stocking density. For Croatia 77, 18, 4 and 1% of variance were explained by the four following discriminant functions: rural population decline, land use and total population changes. Macedonia's drivers resulted in four discriminant functions which explained 76, 18, 4 and 2% of variance: social turbulence, independence declaration, change in the number of rural population and farming intensification. Montenegro's drivers of change generated four discriminant functions explaining 90, 7, 2 and 1% of variance: independence declaration, abandonment, decreased stocking density and migration of the population led to a decrease in cattle numbers. For Serbia, all variance was explained by one discriminant function: despite orienting towards cattle breeding, the decline in rural population and abandonment of rural areas led to a decrease in cattle numbers. Drivers of change in Slovenia resulted in four discriminant functions explaining 71, 18, 9 and 2% of the variance: abandonment of rural areas, land use changes and the decline in rural population had the most discriminant power explaining the cattle changes over the analysed decades.

IV – Conclusions

For all the six countries analysed, cattle evolution resulted in negative values concerning the number of animals. Most of the decrease took place over the last two decades which were mainly characterised by social turbulences. Rural population had such high discriminant power for most of the countries that depopulation of rural areas by emigration affected cattle systems the most. Further investigations on some other different factors affecting cattle trends could provide deeper insight into their way of functioning and path of evolution. The direct and indirect effects and constrains of legislation and policies have to be analysed and addressed additionally. On-farm analyses could provide the needed information to identify the needs and options for the development of livestock systems in different environmental conditions.

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