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Comparative analysis of circular agriculture development in selected Western Balkan countries based on sustainable performance indicators

Abstract
Modern agriculture rapidly improves productivity, yet it also pays high price for overconsumption of natural resources and energy use which is not environmentally friendly. To shape a sustainable agricultural future, the Western Balkans countries (WBC) need to tackle key challenges such as pollution, climate change and biodiversity threats. Circular agriculture is a concept that promotes the sustainable use of existing agricultural inputs and products, thus representing a driver of the future agri-food system. The paper considers basic drivers, moving from linear to circular agriculture, and summarises the implications of various performance indicators that drive circular agriculture development in Albania, Macedonia and Serbia. Based on the performance indicators, selected WBC have favourable conditions for switching from linear to circular agriculture and approach the EU level. Besides the indicators relevant to the northern part of Serbia, where «agrokombinats» are changing the general picture of input consumption, all other indicators illustrate favourable conditions for circularity.
Technologically, Macedonia is leading in its use of ICTs for circular agriculture. The adoption of sustainable technologies for precision agriculture in the region will optimise the input use and increase productivity. The promotion of smart farming, based on the ongoing debate on the future design of the national agriculture policy to CAP harmonisation and use of EU funds to support farmers who have already taken steps towards digitalisation for circular agriculture, is a must for the region.
Serbia has positive trends in organic agriculture, which is a wider accepted concept of the circular approach. However, there is still a need for an integrated farming system to minimise the use of direct energy from harmful resources, as well as fertilisers and pesticides for crop production.
Albania shows the best performance in terms of circular agriculture, yet there is a space for improvement regarding socio-economic aspects. Shifting from extensive labour to autonomous force is needed.
Keywords: Performance Indicators; Circular Agriculture; Sustainability; Albania; Serbia; Macedonia
JEL Classification: Q01; Q51; Q57
DOI: https://doi.org/10.21003/ea.V168-09

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Порівняльний аналіз розвитку циркулярного сільського господарства окремих країн Західних Балкан на основі показників сталого розвитку
Анотація. У сучасному сільському господарстві швидкими темпами зростає продуктивність праці. Разом із цим воно несе великі витрати через надмірне споживання природних та енергетичних ресурсів, яке шкодить навколишньому середовищу. Для того, щоб забезпечити сталий розвиток сільського господарства в майбутньому, країнам Західних Балкан необхідно вирішити ряд ключових питань, пов'язаних із забрудненням навколишнього середовища, змінами клімату та загрозами для біорізноманітності. Концепція циркулярного сільського господарства сприяє сталому використанню існуючих ресурсів і продуктів сільськогосподарського призначення, даючи нам уявлення про те, який вигляд матиме агропродовольча система в майбутньому. У статті розглядаються основні чинники переходу від системи лінійного до системи циркулярного сільського господарства, а також узагальнено показники ефективності, що сприяють стійкому розвитку циркулярного сільського господарства в Албанії, Македонії та Сербії. З огляду на показники ефективності, зазначені країни Західних Балкан мають сприятливі умови для переходу від лінійного до циркулярного сільського господарства, наближеного до рівня та стандартів ЄС.
Ключові слова: показники ефективності; циркулярне сільське господарство; сталий розвиток; Албанія; Сербія; Македонія.

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Сравнительный анализ развития циркулярного сельского хозяйства
в некоторых странах Западных Балкан на основе показателей устойчивого развития

Аннотация. В современном сельском хозяйстве быстрыми темпами растет производительность труда. Вместе с тем оно несет большие расходы из-за чрезмерного потребления природных и энергетических ресурсов, которое вредит окружающей среде. Для того, чтобы обеспечить устойчивое развитие сельского хозяйства в будущем, странам Западных Балкан необходимо решить ряд ключевых проблем, связанных с загрязнением окружающей среды, изменением климата и угрозами биоразнообразию. Концепция циркулярного сельского хозяйства способствует устойчивому использованию существующих ресурсов и продуктов сельскохозяйственного назначения, давая нам представление о том, как будет выглядеть агропродовольственная система в будущем. В статье рассматриваются основные факторы перехода от системы линейного к системе циркулярного сельского хозяйства, а также обобщены показатели эффективности, способствующие устойчивому развитию циркулярного сельского хозяйства в Албании, Македонии и Сербии. Принимая во внимание показатели эффективности, можно утверждать, что обозначенные страны Западных Балкан имеют благоприятные условия для перехода от линейного к циркулярному сельскому хозяйству, приближенному к уровню и стандартам ЕС.
Ключевые слова: показатели эффективности; циркулярное сельское хозяйство; устойчивое развитие; Албания; Сербия; Македония.

1. Introduction and Brief Literature Review

The agriculture sector is relatively unique and relies on natural resources and cycles as its primary inputs. Resources such as water, soils, nutrients and biodiversity underpin the functioning of ecosystems and the land that provides the space in which we work. We therefore need to be more resource-efficient in the way we use and re-use resources, improving feedback loops and integrating circular economy principles. The circular economy is a system which promotes the reuse, repair, refurbishing, remanufacture and recycling of existing materials and products. At its heart is the idea that growth can be decoupled from resource extraction, and waste can be utilised for both economic benefit and environmental good (World Economic Forum [WEF], 2014). Today, we have a real opportunity, especially with the circular economy so high on the political agenda, to try and make our approach to resource use more sustainable from the beginning because countries that are proactive in moving to a circular economy will get larger economic benefits (Haaranen, 2015).

To benefit in the transition to a circular economy, the European Commission (EC) has brought together a series of existing policies and tools within the «Circular Economy Package» that includes a range of actions covering the whole value chain, a revised legislative proposal on waste recycling and a review of the fertilisers regulation (European Innovation Partnership [EIP], 2015). In addition, it includes the Biodiversity Strategy (EC, 2011b), the main aim of which is to refer to the maintenance of the natural capital and resources as a critical economic asset (Mazza and ten Brink, 2012).

The concept of circular economy approach can raise the cost-effectiveness not only in developed economies but also in developing economies, as their industries are more material sensitive, which means that they could realise even more relative savings by implementing circular business model (WEF, 2014). Nowadays, the economic development in the WBC is putting additional strains on the environment, affecting primarily resource use, waste and biodiversity that are crucial for circular agriculture (European Environmental Agency [EEA], 2010).

The EEA report (2010) stated that the outcomes of the current economic development trends in the Western Balkans are not inevitable and implementing appropriate policies could minimise their adverse effects on biodiversity. Abandonment of agricultural land, together with the increased agricultural production and use of fertilisers, indicates that farming in the region has become more intensive.

According to the research by R. Nikolić, A. Fedajev, V. Stefanović and S. Ilić (2017), the agricultural sector in all the WB countries faces many obstacles, namely «disclosure of large agricultural enterprises, demesne fragmentation and insufficient cooperation and integration of small farmers, unstable and non-regulated internal markets, strengthening of monopoles and occurrence of illegal trade, import of cheap agricultural products due to liberalization of foreign trade, inadequate and insufficient financial and credit support from the government». As a result, the GVA share of agriculture in GDP in the Western Balkan countries was steadily decreasing in 2001-2012.

To shape a sustainable agricultural future, all the actors in the region need to cooperate with each other and with the neighbouring countries to tackle key challenges such as pollution and health issues, climate change impacts and ecosystem threats. Today's choices will influence not only the region's agriculture in the coming decades, but also that of other EU and neighbouring countries. This paper summarises the implications of various performance indicators that drive the future trend of the circular agriculture development in Albania, Macedonia and Serbia.

2. Methodology

All goal-oriented concepts assume single indicators or performance indicator sets to properly interpret previously settled principles. Performance indicators represent a powerful tool both to ease the complexity of system depiction and to integrate complex system information (Giampietro, 1997). If the entire agricultural value chain system is considered as one compartment of a whole landscape, indicator sets have to provide information not only on imbalances of the system itself, but also on the external deposition and offsite effects such as CO_2 emission, energy use, food insecurity and resource inefficiency resulting from the agri-food system. The paper considers basic drivers moving from linear to circular agriculture and the demand for related performance indicators. Due to the novel holistic approach, the parameters of circularity can be determined for either the given product or the system in its entirety, and excavating the system insufficiencies causing non-sustainability becomes possible (Fogarassy, Orosz & Ozsvári, 2016). Therefore, such basic concepts do not capture the agricultural impact of resources extraction and use as well as the objective of using agricultural inputs such fertilisers or energy more efficiently.

According to three components of sustainability, Fogarassy and Bakosné (2014) proposed economic, ecological and technological performance indicators, whereas authors additionally choose input, energy use, productivity and a social indicator for measuring agricultural circularity. Therefore, the authors have developed five sub-indicators per each indicator of specific performance characterising single parts of the system of concern (Bockstaller, Girardin & van der Werf, 1997) to have a balance between the different aspects, since they have the same significance for circularity. Considering sustainable agriculture in the global context, performance sub-indicators were developed for assessing the circular agriculture concept (Nambiar, Gupta, Fu, & Li, 2001) based on social and policy relevance which is suitable for different scales and sensitive to variations in management, and acceptability.

Taking into consideration the lack of data and the fact that the selected countries' agricultural censuses were in different

years, data availability and reliability was difficult to structure. The analysed data for the 2002-2015 period was partly adjusted for the research needs by using a linear trend between the earliest and latest available data for a given year.

AHP Method and similar approach to Zhang, Wang, & Chen (2003) has been used to assign weight to the composed indicators system. Standardisation of the raw data was made by the following method:

Performance indicator:

Positive

$$X`ij = Xij / Xi\ , \qquad (1)$$

Negative

$$X`ij = Xi / Xij\ , \qquad (2)$$

where:

Xij - the original value of the indicator;

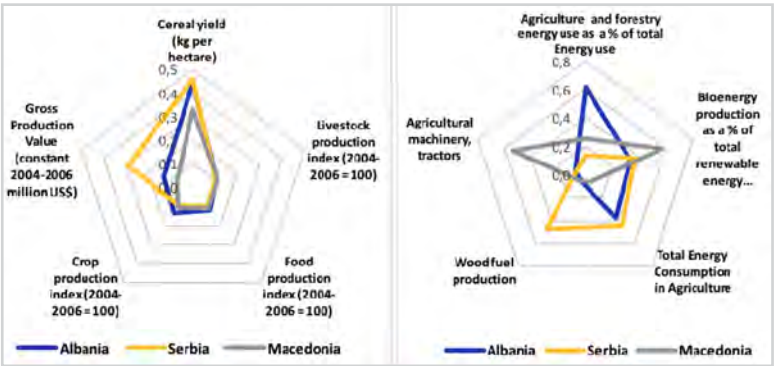
$X`ij$ - the standardised value of the indicator;

Xi - the original value of Cn indices of circular economy development in a given country.

3. Results

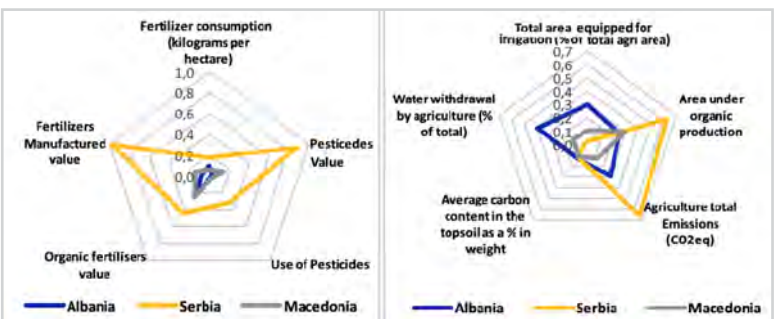
Modern agriculture not only rapidly improves productivity, but also pays its high price for overconsumption of natural resources and energy use which is not environmentally friendly.

As can be seen from the findings (Figure 1a), only Serbia's farms produce products at a lower opportunity cost than the other two countries as their Gross Production Value is significantly higher. Production indices are low in the three countries. They need changes in utilisation and demands for resources. This means that the selected countries have to implement measures to increase the productivity of their farms, and at the same time find ways to ensure that future generations will also have full access and enough resources to continue.



a) Productivity b) Direct energy use

Fig. 1: **Productivity and direct energy use as sub-indicators for circular agriculture development in selected Western Balkan countries**
Source: Compiled by the authors based on data from FAOSTAT, WEF, World Bank



a) Inputs b) Ecology

Fig. 2: **Inputs and ecology as sub-indicators for circular agriculture development in selected Western Balkan countries**
Source: Compiled by the authors based on data from FAOSTAT, WEF, World Bank

As can be seen from the findings (Figure 1b), current practices applied by the selected countries are not sustainable. Even though Serbia's Production Value is high, the energy consumption and wood fuel production for agriculture purposes is high, too. Macedonia is the only one among the selected countries which mostly relies on mechanisation power instead of direct energy use for agriculture production with the highest percentage of bioenergy production. Albania's direct energy consumption for agriculture is the highest among the selected countries. A low level of mechanisation, as well as a lack of technology and alternative sources of energy followed by inefficient subsidy systems, makes the selected countries' agriculture sector unsustainable energy user which needs fast changes to provide sustainable production.

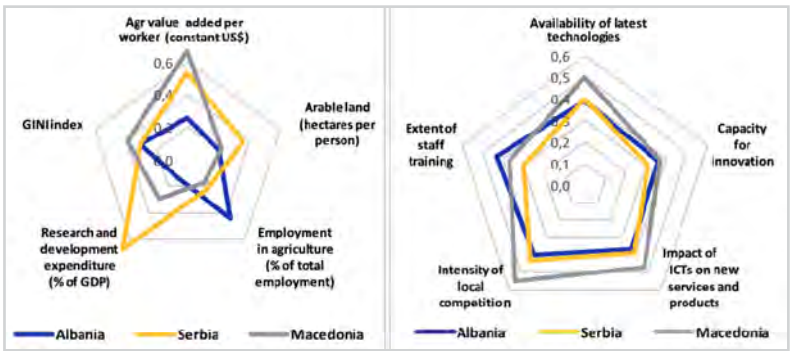
Taking into consideration low GDP per capita and PPP in the Western Balkans, inputs application on the farms is based on a minimum level and is only relevant the given crop production. The lack of information and knowledge on production shows that Albania and Macedonia have pre-conditions for circular agriculture (Figure 2a). Based on the region's surface, diversified landscape and current trends on organic production, these two countries are efficiently managing input use on their farms. Serbia is showing differently, but this may disturb the general picture because of the lowland they have in the northern part, while agriculture production is most developed and intensified in its central and southern parts where landscape is mostly hilly and mountainous.

Climate changes are more than visible in the region. During the previous decade, there were several drought seasons, floods and cold winters that changed the agricultural sector, especially in terms of irrigation and soil management. Albania has the most developed irrigation system the planning and management of which comes from the previous political system. Transition from one system to another, which was determined by rapid changes, also affects the irrigation systems in Serbia and Macedonia, thus leading to privatisation of water management companies and collapse of the irrigation networks. However, by using appropriate technologies, Serbia and Macedonia are showing positive results in circular water management. In addition, Serbia has a significant increase in area under organic production, which is mostly in the central and southern part of the country. In the northern part, where under socialism agricultural value chains were dominated by large vertically integrated «agrokombinats», there were output-driven leads to higher CO_2 emissions from the sector, if compared to Albania and Macedonia (Figure 2b).

Due to the lack of effective socio-economic long-term strategies, rural inhabitants often end up poor in the absence of any frequent remittance flows (Trendov & Vasa, 2015). Based on the findings (Figure 3a), Serbia and Albania belong to the group of the countries with a low level of inequality, while Macedonia has a medium level of inequality.

In the era of Yugoslavia, Serbia had the most developed R&D centres, many of which today remain the most powerful and influential in the region. From this point, Serbia's R&D expenditures are expected to be higher than those of Albania and Macedonia together. In Albania, labour force involved in agriculture represents the backbone of rural economy. Characterised by poor road infrastructure and a lack of agricultural mechanisation Albania is still lagging behind in the modernisation process. In general, the socio-economic sub-indicators are a week precondition for circular agriculture in the selected countries.

There are noticeable technological deficiencies in the selected countries (Figure 3b) and ICT for agriculture remains a non-developed sector. There are two reasons for that. Firstly, the average size of farms is relatively small, with 1.2 ha in Albania, 2.5 ha in Serbia and 1.4 ha in Macedonia (Arcotrass, 2006). Secondly, the arable land is divided into several small parcels. In such conditions, introduction of technologies



a) Socio-economic b) Technology

Fig. 3: **Socio-economic and technology indicators as sub-indicators for circular agriculture development in selected Western Balkan countries**
Source: Compiled by the authors based on data from FAOSTAT, WEF, World Bank

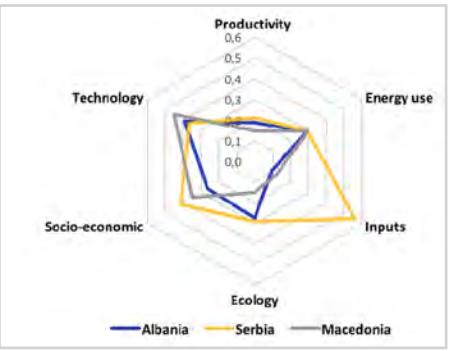


Fig. 4: **Performance indicators for circular agriculture in selected Western Balkan countries**
Source: Compiled by the authors based on data from FAOSTAT, WEF, World Bank

becomes more difficult, which requires special solutions. On one hand, the presence of young people in the agricultural sector is limited, and the tendency of the youth leaving farms and country is evident in the region. On the other hand, the growth of IT companies and the number of students enrolled in IT science education is huge potential in terms of introducing ICTs. This applies especially to innovations in ICTs for circular agriculture.

4. Conclusion

Based on the performance indicators, the selected countries have good preconditions for shifting from linear to circular agriculture (Figure 4). Taking into consideration its diversified landscape, traditional production methods and climate conditions, Western Balkans have a pathway to their full integration into circular agriculture. Besides the indicators relevant to the northern part of Serbia, where «agrokombinats» are changing the general picture of input consumption, all other indicators illustrate favourable conditions for circularity. Technologically, Macedonia is leading in its use of ICTs for circular agriculture. The adoption of sustainable technologies for precision agriculture in the region will optimise the input use and increase productivity. The promotion of smart farming, based on the ongoing debate on the future design of the national agriculture policy to CAP harmonisation and use of EU funds to support farmers who have already taken steps towards digitalisation for circular agriculture, is a must for the region. Effective energy use, through investments in alternative resources for farming purposes, as most EU countries have nowadays, especially Denmark and the Netherlands, is to be emphasised. Macedonia has to focus more on responsible use of natural resources and water management, thus increasing its environmental performance and enabling a circular approach through sustainable practices.

Serbia has positive trends in organic agriculture, which is a wider accepted concept of the circular approach. However, there is still a need for an integrated farming system to minimise the use of direct energy from harmful resources, as well as fertilisers and pesticides for crop production. Increased use of renewable energy sources, organic fertilisers and pesticides may significantly change farming in Serbia from linear to circular. Albania shows the best performance in terms of circular agriculture, yet there is a space for improvement regarding socio-economic aspects. Shifting from extensive labour to autonomous force is needed. Also, increased socio-economic benefits for rural community in terms of training and support for the implementation of circular agriculture on their farms, followed by subsides for innovations and technologies, are the very components that have to be prioritised by policy-makers.

Introducing laws on circular agriculture, supported by financial and knowledgeable experience from the EU28, will boost WBC's integration and harmonisation with the EU CAP strategy on bio-based economy and circular agriculture as well. However, to achieve this, a re-evaluation of the national agricultural policies has to be tackled, enabling a shift towards circular agriculture.

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Received 20.08.2017