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MEASUREMENT OF INVESTMENT EFFICIENCY IN THE GREEN AGRO-INDUSTRY VALUE CHAIN

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Abstract: Measurement of investment policy efficiency in the green agribusiness value chain is currently highly valued in connection with sustainable development goals. The return on investment is no longer assessed solely by economic indicators, as responsible investments also require the implementation of opportunities for environmental protection, innovative agriculture, and the organization of a circular economy in food processing. The study proposes a methodology for measuring investment efficiency in the green agro-industrial value chain, based on key indicators of progress.

Keywords: agro-industry, food processing value chain, key performance indicators, investment efficiency, innovative agriculture, environmental protection.

JEL code: O 013

Research aims: to present the features of assessing the effectiveness of investments in the green agro-industrial chain.

Research novelty: a methodology for assessing the effectiveness of investments in the green agro-industrial value chain based on key performance indicators is proposed.

Introduction

Measurements of the effectiveness of green investments at the microeconomic level differ from those at the supranational or macro level. As a rule, in the professional literature, it is proposed to correlate the effectiveness of green investments at the micro-level with the results of green management recorded in organizations. In particular, these measurements are distinguished by their nature in agro-industrial, since here the value chain of management clearly operates: agriculture - food processing - final consumption (Bastan et al., 2018).

In the agro-industrial sector, "green investments" are targeted at the ecosystem functions of effective sustainable development, since entrepreneurship, consuming the products of nature, seeks reasonable ways of compensation. If they are limited exclusively to environmental taxes and nature use fees, then the "green investment policy" cannot be considered effective, since it is not aimed at ensuring environmental sustainability and only performs preventive operations against the use of natural resources. And in food redistribution activities, resources are used, that are not the product of the organization's own activities, and therefore need to be restored by entrepreneurs themselves after their consumption. And if there is no restoration of exhausted resources in entrepreneurial activities, then the sustainable course of green business is already in doubt in the foreseeable future (Martirosyan et al., 2025).

Therefore, currently, within the framework of entrepreneurship, the issue of responsible consumption of ecosystem services is being raised, which to a certain extent

requires “green investments” in the context of sustainable business development. In the last decade, the culture of responsible investments has gradually become more active, when shareholders avoid buying securities from organizations that do not pursue a sustainable development strategy, do not create resilient infrastructure, are indifferent to the development of inclusive and sustainable industry, and are not particularly motivated in the field of promoting innovation.

Litrature review

Currently, in international practice, serious attention is paid to the organization of circular production in the green agro-industrial system, when effective waste management is implemented (PricewaterhouseCoopers, 2023). Moreover, circular production is organized using both open and closed approaches. However, in both cases, waste is collected and re-routed into the production cycle. In the case of a linear economy, waste accumulation occurs. Even in the case of half-recycling, plastic waste is increasing at such a rate that, according to the Ellen MacArthur Foundation, by 2050 there will be more waste in the water than fish. All plastic waste that is thrown into trash cans or into the bosom of nature returns in the form of contaminated food, water and air. Plastic and all household and economic waste can cause serious ecological problems, and on the other hand, harm human health. In order to prevent these dangers, "green investments" aimed at organizing circular production are gradually being put into action.

In the agro-industrial value chain, “green supplies” also play a decisive role in sustainable development processes. They target the

acquisition of environmentally friendly raw materials, the formation of green logistics networks within the agro-industrial framework, when optimal transport operations are designed and implemented, and the possibilities of using electric vehicles (Ziadat et al., 2025). Here, cooperation with suppliers who have already voluntarily undertaken "green entrepreneurship" is also important. Therefore, green logistics is also part of the sustainable agro-industrial system. In this case, entrepreneurial activity, based on market research, reveals such business model value chains, the logistical links of which are characterized by the optimization of freight transportation and energy saving (Ellen Macarthur Foundation, 2026).

In the programs for the sustainable development of agro-industry, "green innovations" are also emphasized, the main goal of which is to support environmental protection. In general, innovation in business is the generation of creative ideas in such a way as to create a new product or type of service for sale, with the aim of strengthening the competitiveness of the organization in the market, increasing productivity, and improving the quality of output. In the case of "green innovations", business objectives change significantly, since in this case the main target becomes ensuring sustainable development and environmental protection (Khachatryan et al., 2026). In this regard, potential investors first of all assess how much potential the business has for the implementation of green innovations. And this potential can have multi-vector directions, such as the use of alternative energy, the exploitation of resource-saving technologies, the reduction of harmful emissions, the organization of a circular economy, etc. In

agro-industrial organizations, "green innovations" may not be localized and not be directly manifested, but may play a stimulating role in the formation of a sustainable development value chain (ClimateShot Investor Coalition, 2025).

Research results

Green investments are implemented in three sectors of the agro-industrial value chain, and therefore different approaches to assessing their effectiveness can be taken into account. However, the possibilities of their chain interactions should be taken into account (Martin and Moser, 2016). Thus, when implemented in the agricultural sector, their impact can have a chain effect on food processing and final food consumption, and vice versa. Therefore, the effectiveness of "green investments" should be assessed with a comprehensive approach, taking into account the aggregate impact of their results in the agro-industrial value chain (Galbiati et al., 2023).

From the point of view of interaction with investments, it is easier to apply in practice the assessment of "green progress" from the point of view of performance. In this case, we propose key performance indicators (KPIs) for the implemented "green investments" and sustainable development functions accompanied by entrepreneurship, measuring the degree of their availability. In addition, it is more expedient to carry out the assessment of green entrepreneurship performance using factorial measurement, since the performance indicators are expressed in different units of measurement (tons, hectares, drams, percent, etc.), and thus,

opportunities for their comparability and comparative analysis are created.

The comparison of key performance indicators with investment volumes creates an opportunity to assess the degree of implementation of an effective investment policy in the green agro-industry sector. Therefore, it is important to clarify what the scope of KPIs for green entrepreneurship will be in the agro-industry value chain.

We consider it necessary to separately present the manifestations of green progress in the "agriculture-food processing-final food consumption" value chain with KPIs (see tables 1-3). Moreover, KPI_0 and KPI_1 indicators are presented as targeted and actually achievable criteria, respectively, and the KPI_1/KPI_0 ratio is presented as the magnitude of the achievement of key indicators of progress, which are expressed as coefficients.

For a comprehensive assessment of green progress in each sector of agro-industry, we propose averaged performance values of the relevant sectoral KPIs (Sm, Sn, Sq), the components of which can be expanded or reduced based on the changing requirements for the green development of agro-industry in a specific situation.

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Table 1. KPIs for demonstrating green progress in the agricultural sector

Source: *Author's own work.*

KPI_0	KPI_1	KPI_1/ KPI_0	**KPIs**
KPI_{11}	KPI_{10}	$S_{m1} = KPI_{10}/ KPI_{11}$	Share of drip irrigation in the whole irrigation system (%)
KPI_{21}	KPI_{20}	$S_{m2} = KPI_{20}/ KPI_{21}$	Share of inorganic agricultural products in agrobusiness (%)
KPI_{31}	KPI_{30}	$S_{m3} = KPI_{30}/ KPI_{31}$	Greenhouse gas emissions (CO2 t)
KPI_{41}	KPI_{40}	$S_{m4} = KPI_{40}/ KPI_{41}$	Share of green innovations in the total operational field (%)
KPI_{51}	KPI_{50}	$S_{m5} = KPI_{50}/ KPI_{51}$	Soil erosion prevention (ha)
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KPI_{m1}	KPI_{m0}	$S_m = KPI_{m0}/ KPI_{m1}$	Share of smart barns among total barns (%)
		∑Sm/(m)	Green progress in agriculture

The scope of indicators for assessing "green growth" can be expanded based on the specifics of entrepreneurship, or revised in terms of defining key indicators.

However, entrepreneurship should always strive for 100% performance of "green growth". Therefore, it is important to use a sound methodology for measuring and assessing "productive growth of green entrepreneurship", based on the directions of sustainable entrepreneurship.

Table 2. KPIs for demonstrating green progress in the food processing sector

Source: *Author's own work.*

KPI_0	KPI_1	KPI_1/ KPI_0	**KPIs**
KPI_{11}	KPI_{10}	$S_{n1} = KPI_{10}/ KPI_{11}$	Share of circular economy products in total output (%)
KPI_{21}	KPI_{20}	$S_{n2} = KPI_{20}/ KPI_{21}$	Share of alternative energy use in electricity consumption (%)
KPI_{31}	KPI_{30}	$S_{n3} = KPI_{30}/ KPI_{31}$	Energy-saving technologies output share (%)
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KPI_{n1}	KPI_{n0}	$S_n = KPI_{n0}/ KPI_{n1}$	Reduction of harmful emissions (t)
		$\sum Sn/(n)$	Green progress in food processing

Table 3. KPIs for demonstrating green progress in the final food consumption sector

Source: *Author's own work.*

KPI_0	KPI_1	KPI_1/ KPI_0	**KPIs**
KPI_{11}	KPI_{10}	$S_{q1} = KPI_{10}/ KPI_{11}$	Share of green supplies in total supplies (%)
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KPI_{q1}	KPI_{q0}	$S_q = KPI_{q0}/ KPI_{q1}$	Recycling of household food waste (t)
		$\sum Sq/(q)$	Green progress in final food consumption

However, only the green progress of agro-industry cannot characterize the effectiveness of implementing sectoral green

investments. To achieve this goal, we also propose to assess the manifestations of progress in green investments in the "production-processing-final sale of agricultural products" value chain. And if, in the long term, the green progress of agro-industry is more progressive than the sectoral progress of green investments being implemented, then in that situation, a successful investment policy is recorded in the agro-industry value chain.

Table 4. KPIs for demonstrating progress in green investments in the agribusiness value chain
Source: *Author's own work.*

KPI_0	KPI_1	KPI_1/ KPI_0	**KPIs**
KPI_{m1}	KPI_{m0}	$R_m = KPI_{n0}/ KPI_1$	Investments in Agriculture
KPI_{n1}	KPI_{n0}	$R_n = KPI_{m0}/ KPI_{n1}$	Investments in Food Processing
KPI_{q1}	KPI_{q0}	$R_q = KPI_{q0}/ KPI_{q1}$	Investments in Food End-Use
		∑R/3	Advancement of Green Investments

Thus, Table 4 presents our proposed green investment KPIs (Rn, Rm, Rnq), which act separately in different links of the agro-industrial value chain, their average value (∑R/3) can assess the activity of the investment policy implemented in the agro-industrial complex. However, assessing the effectiveness of investments requires making comparisons between the KPIs characterizing the green progress of agro-industrial complex and the KPIs of the progress of green investments. In the event that green growth

progress is recorded in relation to green investments, the investment policy pursued will be considered successful.

$$(\sum Sm/m + \sum Sn/nq + \sum Sq/qQ)/ \sum R > 1.0$$

In addition to general assessments, the proposed KPIs create an opportunity to conduct sectoral assessments, and if the situation presented below is formed, that is, a sectoral systematic progression of green business results in relation to investments, then the green investment policy in agro-industry is considered successful:

$[\sum Sm/(m)] : Rm > 1,0$ agricultural sector
$[\sum Sn/(n)] : Rn > 1,0$ food processing industry
$[\sum Sq/(q)] : Rq > 1,0$ food final consumption sector

Conclusion

The methodological approach to measuring the effectiveness of investments in the green agro-industrial value chain proposed by us creates an opportunity:

- ✓ to make the green growth formed in the agro-industrial value chain measurable by defining appropriate KPIs for each of its components,
- ✓ to carry out sectoral assessments of the green progress of the agro-industrial value chain, creating an opportunity to identify the weaknesses and strengths of sustainable development,
- ✓ to make decisions on the effectiveness of green investments, making comparisons of the green investment results implemented in the agro-industrial value chain and the

directions of progress of the sustainable development indicators derived from them.

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ՆԵՐԴՐՈՒՄՆԵՐԻ ԱՐԴՅՈՒՆԱՎԵՏՈՒԹՅԱՆ ՉԱՓՈՒՄՆԵՐԸ ԿԱՆԱՉ ԱԳՐՈԱՐԴՅՈՒՆԱԲԵՐՈՒԹՅԱՆ ԱՐԺԵՔՂԹԱՅՈՒՄ

Հայկ Մելքումյան
Հայաստանի պետական տնտեսագիտական համալսարան
ասպիրանտ

Բանալի բառեր - ագրոարդյունաբերություն, սննդի վերամշակման արժեշղթա, առաջընթացի առանցքային ցուցիչներ, ներդրումների արդյունավետություն, նորարարական գյուղատնտեսություն, շրջակա միջավայրի պաշտպանություն:

Ներդրումային քաղաքականության արդյունավետության չափումները կանաչ ագրոբիզնեսի արժեշղթայում ներկայումս խիստ կարևորվում են՝ կապված կայուն զարգացման նպատակադրումների հետ: Այլևս ներդրումների հատույցը չի գնահատվում սոսկ տնտեսական ցուցանիշներով, քանի որ պատասխանատվությամբ ներդրումները պահանջում են նաև

շրջակա միջավայրի պաշտպանության, ինովացիոն գյուղատնտեսության, սննդի վերամշակման շրջանաձև տնտեսավարման կազմակերպման հնարավորությունների իրագործում:

Հետազոտությունում առաջարկվում է կանաչ ագրոարդյունաբերության արժեշղթայում ներդրումների արդյունավետության չափումների մեթոդաբանություն՝ հիմնված առաջընթացի առանցքային ցուցիչների վրա:

Այս դեպքում, հնարավորություն է ստեղծվում իրականացնել ագրոարդյունաբերական արժեշղթայի կանաչ առաջընթացի ոլորտային գնահատումներ, բացահայտելով կայուն զարգացման թույլ և ուժեղ կողմերը, որոշումներ կայացնել կանաչ ներդրումների արդյունավետության գծով, համադրումներ կատարել ագրոարդյունաբերության արժեշղթայում իրականացվող կանաչ ներդրումային արդյունքների, և դրանցից բխող, կայուն զարգացման ցուցիչների առաջանցիկության ուղղություններով:

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