Fostering Sustainable Progress and Eco-friendly Prosperity: Elevating Investment Decision-making within the Agro-Industrial Landscape of the Kyrgyz Republic

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Abstract: The research examines how the agro-industrial complex (AIC) can be better developed and aligned with economic and environmental sustainability objectives. Playing a vital role in the nation's financial health, the AIC contributes to approximately 40% of the nation's Gross Domestic Product and offers employment to nearly a third of the working-age population. Nonetheless, the area grapples with various hindrances, including limited profit margins, soil erosion, fluctuating commodity prices, and antiquated facilities. The research also points to the pivotal nature of judicious capital allocation and the instrumental role of digital tools like decision-support systems in making well-informed decisions. These decision-support tools are especially useful for evaluating different investment opportunities, integrating various types of data, and streamlining the capital allocation process. By employing such tools and strategies, the sectors can navigate through the prevailing challenges and substantially contribute to the nation's economic and environmental sustainability objectives. The research serves as a cornerstone for future research, paving the way for innovations and strategies to bolster these sectors' resilience and sustainability.

Keywords: agro-industrial complex, green economy, sustainable development, economic and mathematical models, expert systems

JEL codes: O13, Q01, Q15, Q56, Q18

Kyrgyzstan's agro-industrial complex (AIC) serves as a cornerstone of the country's economic landscape, significantly contributing to its GDP and being a major employer, especially in rural communities (Ahmed & Rahman, 2018). However, this sector is besieged by a range of difficulties, from environmental degradation to economic resilience, which collectively endanger the country's financial stability and social well-being. The urgent call to reconcile the AIC with eco-friendly practices adds another layer of complexity, requiring an in-depth reassessment of existing operational frameworks and decision-making paradigms.

In light of these pressing challenges, this research endeavors to delve into the complex issues encountered by the AIC encounters, along with identifying actionable solutions, all under the umbrella of sustainable growth. The authors focus on the role of intelligent systems (e.g., expert systems) with the goal of ensuring long-term sectoral resilience (Alsksavov & Koshelev, 2015; Brown & Wilson, 2021).

The authors employ an array of evaluative tools, including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP), to gauge the financial robustness of proposed investment initiatives (Butsenko, 2007; Giarratano & Riley, 1998; Kumar & Sharma, 2010; Rodriguez et al., 2014).

To tackle this multi-faceted topic, this research adopts a methodologically diverse approach, blending empirical studies, real-world case analysis, and insights from industry experts. The research aims to provide stakeholders with a forward-looking action plan that can catalyze sustainable development of the Kyrgyz agro-industrial complex.

Methodology

Developing and implementing suitable software systems, including expert systems for investment design, can greatly enhance the decision-making process within the AIC. These systems enable assessing investment projects supported by multiple effective criteria, providing a more optimal approach for project selection. By incorporating various factors and expert knowledge, these systems can gather valuable information and contribute to unbiased collective decisions. Currently, computer software systems supported by intelligent information systems are being utilized. An expert system enabling specialists to research various scenarios will be a valuable tool in automating investment design.

The expert system for investment design involves selecting projects for investment through analytical assessment and determining their profitability. The selection relies on criteria that reflect the economic efficiency of investments, providing an optimal approach for project selection with multiple effective criteria.

The research indicates that intelligent information systems (e.g., expert systems) can be pivotal in aiding decision-making within the AIC. McCown (2002) emphasizes the role of technological innovations in agricultural investment decisions and suggests that these technologies can drastically improve the efficacy of various processes within the AIC (Wang & Li, 2007). Similarly, Jakku and Thorburn (2010) conducted a study that focused on enhancing decision-making in agro-industrial investments through expert systems. Applying such technology can help select viable investment projects, thereby making the overall decision-making process more robust.

Involving multiple experts with diverse approaches and data sets can reduce redundancy and cause unbiased collective decisions.

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Expert systems provide comprehensive analysis, considering hard data and subjective assessments of radical environmental changes, which will not be easily incorporated into quantitative methods.

This research aligns with Brown's and Wilson's research, which provides a comparative analysis of different approaches to evaluating investment projects in the agro-industrial complex (Brown & Wilson, 2021). Such comparative analyses can offer an analytical framework for decision-makers and provide multiple perspectives that can enhance the efficacy of the project evaluation process.

Additionally, involving multiple experts with diverse approaches and data sets can cause more informed and unbiased decision-making.

An intelligent investment planning system offers the advantage of selecting the most appropriate analytical tools to optimize project investment. This complex task aims to realize substantial economic gains. Emerging computer software technologies have enhanced the efficiency of investment decision-making in the agro-industrial complex (AIC), thereby improving essential economic and financial performance metrics.

Today's market in information technology features an expansive array of specialized software solutions designed for this sector. Many of these applications were built on the MS Excel platform. While this provides the dual benefit of adaptability and the ability to function independently of other software, it does come with limitations in terms of the scope of statistical and financial computations it can perform.

Wang and Li (2007) propose a comprehensive evaluation model for agro-industrial investment projects. This research could benefit from incorporating some of these advanced models into future iterations of the research. By doing so, decision-makers could make more informed choices that consider economic efficiency and include broader impacts like environmental sustainability.

Discussions

The agro-industrial complex (AIC) in the Kyrgyz Republic serves as a cornerstone for economic and social development. This research draws upon various datasets, intelligent information systems, and expert opinions to examine this sector's challenges and opportunities. This discussion aims to evaluate the critical aspects, limitations, and implications of the research.

The research findings confirm that there is a growing need for targeted financing, regulatory reforms, and sustainable practices within the AIC. Particularly, the impact of unstable pricing, inflated borrowing costs, and declining livestock numbers cannot be underestimated. These issues impact agricultural production and provide a broader economic impact, particularly in a country where a large portion of the population is engaged in agriculture.

This research also sheds light on the substantial environmental degradation affecting the AIC. Implementing sustainable practices, such as improving soil fertility and reducing chemical usage, seems to be in sync with the nation's shift towards a green economy. However, there is a severe lack of state funding for these initiatives. This situation calls for a multi-pronged approach, possibly involving international grants or public-private partnerships, to make strides in environmental sustainability.

One novel aspect of this research is the exploration of intelligent information systems like expert systems. While these systems show promise, their efficacy remains dependent on the quality of data input and the expertise involved. Furthermore, it is critical to examine the scalability and adaptability of these systems in a rapidly changing economic landscape.

The research has multiple implications. On a policy level, it underscores the need for targeted investments and reforms within the AIC. It also highlights the necessity for incorporating technology into traditional agricultural practices, a point reinforced by Kumar and Sharma (2010). The research also serves as a call to action for national and international stakeholders to consider sustainable practices and technology implementation as a pathway to developing the AIC in the Kyrgyz Republic.

Results

The following key metrics will be considered during the assessment of an investment initiative:

- Initial capital outlay (I_0);
- Rate of discount (r);
- Anticipated duration of the investment (number of cycles – t);
- Net present value of the project (NPV);
- Internal rate of return (IRR);
- Payback period (PP);
- Investment performance evaluation – payback period (PBP);
- Discounted yield index (DPI).

$$NPV = \Sigma_{t}^{n} \frac{CI_t}{(1+r)^t} - \Sigma_{t=0}^{n} \frac{I_t}{(1+r)^t} \quad (1)$$

where:

The cash flow during period t is CI_t;

I_t – Aggregate of expenditures (investments) in period t;

r – discount rate;

n – cumulative period (intervals, samples), with $t = 0.1, n$ (or the duration of investment applicability).

The gauge of profit or loss incurred by an investor when putting their money into a project is known as the Net Present Value (NPV). A project is deemed profitable when NPV is greater than or equal to zero.

A key metric often utilized for scrutinizing an investment venture is its Net Present Value (NPV). However, this metric has limitations, and we cannot use it for assessment (Rodriguez et al., 2014).

The internal rate of return (IRR) identifies the highest allowable discount rate for an investment where there is no loss to the investor, represented as IRR=r, with the condition that NPV equals zero.

The value of the indicator can be determined using the following equation:

$$\Sigma_{t=0}^{n} \frac{CI_t}{(1+IRR)^t} - \Sigma_{t=0}^{n} \frac{I_t}{(1+IRR)^t} = 0 \quad (2)$$

where:

CI_t – cash flow for *t* period;

I_t – investment amount (costs) for *t* period;

n – cumulative periods (intervals, samples), $t = 0.1, n$.

The IRR serves as an invaluable metric for anticipating the likely returns on investment, thus helping to gauge a project's long-term viability. When the IRR surpasses the discount rate, it suggests a more resilient project and provides a framework for eliminating those projects that are not financially viable.

One of the strong suits of the IRR is its ability to quantify the profitability level of investment and offer a comparative analysis across projects of varying scales and timeframes. However, the measure comes with its own set of limitations. First, it inherently presumes that any positive cash inflows will be reinvested at the IRR. It does not provide insights into the actual monetary gains that an investment will yield in real terms. Second, evaluating the efficacy of an investment often involves multiple metrics, including the Payback Period (PBP), which acts as a temporal gauge. This measure aims to estimate the timeframe within which an investor can expect to recoup the initial investment outlay. In this regard, PBP, along with NPV and IRR, serve as vital tools for investment assessment (Alsksavov & Koshelev, 2015).

To determine the duration required for investments to break even, the authors use the formula $PBP = n$ with $\Sigma_{t=0}^{n} CI_t > I_t$ where n represents the total number of periods; CI_t denotes the cash flow during the period; and *t* signifies the initial investment value in the starting period. I_t means the initial cost of the investment in the initial period.

A financial drain often occurs in early phases, prompting the formula to incorporate the total cash outflows rather than the initial investment sum.

An alternative approach to fine-tuning the payback metric involves summing up all time-adjusted cash inflows and then dividing that total by the time-adjusted initial investment. This yields the Adjusted Profitability Ratio (APR), expressed in present-day monetary terms.

The Profitability Ratio serves as a measure of how much revenue is generated for each unit of investment, essentially gauging the project's return on investment. A higher value for this metric signifies a more effective utilization for each investment unit.

The endeavor is seen as financially advantageous if $DPI > 1$ at the chosen rate of discount. The equation for determining the discounted yield index is as follows:

$$DPI = \frac{\sum_{t=0}^{n} \frac{CI_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{I_t}{(1+r)^t}} \quad (3)$$

where:

CI_t – cash flow in period *t*;

I_t – investment amount (expenses) in *t* period;

r – discounting rate;

n – cumulative periods (intervals, samples), $t = 0.1, n$.

The key components of an expert system include the following:

1. The knowledge base is a part of the system that stores facts and executable program code (prescriptions);
2. The output subsystem consists of a group of rules that guide the problem-solving process;
3. Explanation subsystem helps provide explanations and reasoning behind the system's decisions;
4. Knowledge acquisition subsystems facilitate the acquisition and integration of recent knowledge into the system;
5. Dialogue processor enables interaction and communication between the expert system and users.

One significant advantage of expert systems is their ability to accumulate formalized knowledge, which refers to structured information employed in logical inference, and retain it over an extended period.

Figure 1 offers a succinct visual representation of the system.

The system fundamentally comprises three essential sections:

1. A data input module enabling users to input critical initial information, including the investment's magnitude, the relevant discount rate, investment timeline, and anticipated financial returns.
2. A specialized calculation area tailored for processing vital numerical data that assesses the feasibility of an investment endeavor. This includes metrics like Net Present Value (NPV), Internal Rate of Return (IRR), payback period, and other profitability indicators.
3. A result display segment that furnishes information on existing investment opportunities and their respective performance evaluations.

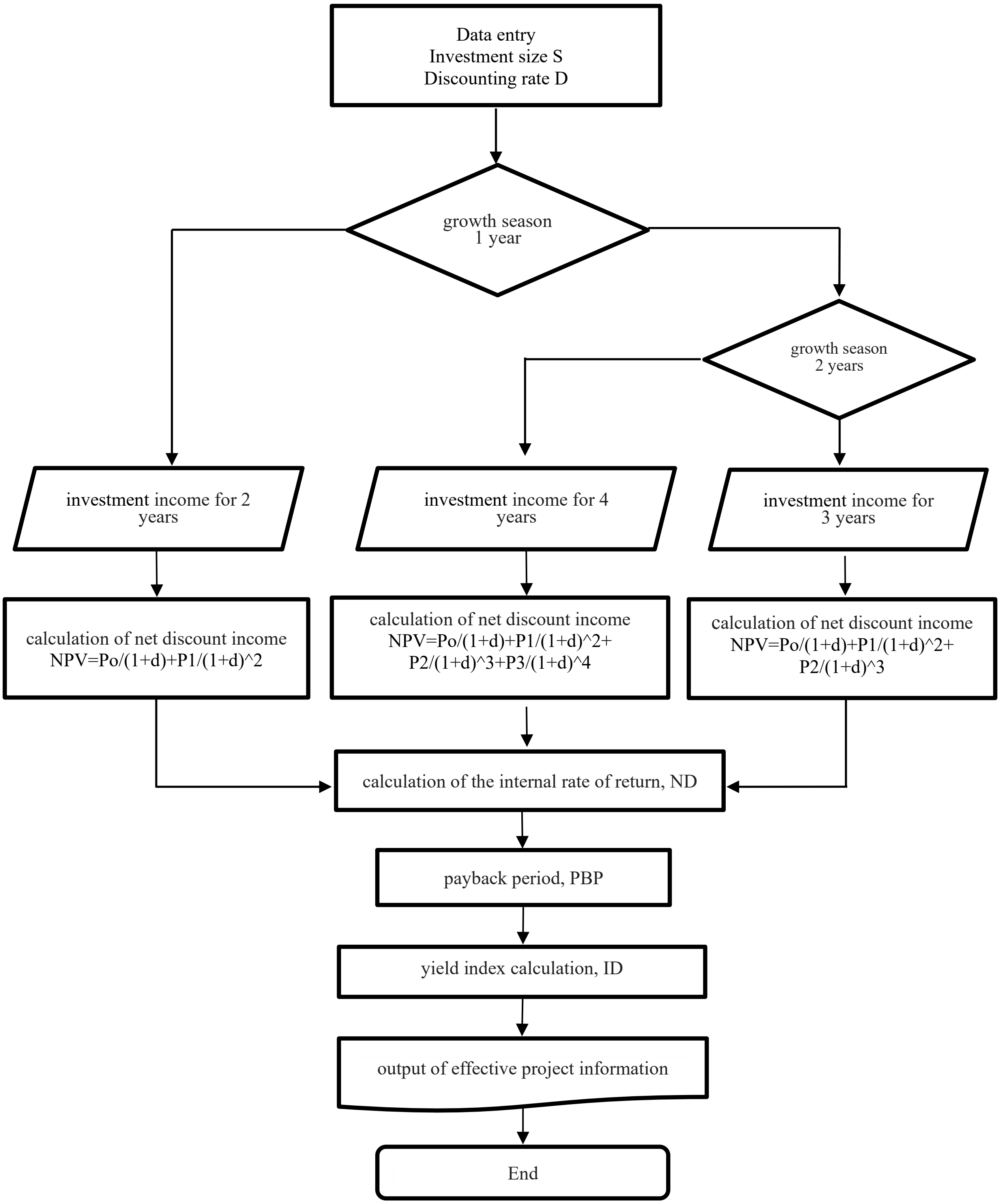

Figure 1

Schematic representation of the process for choosing investment projects

Source: Developed by the authors

Conclusion

However, the existing software products for investment evaluation in the AIC often lack comprehensive analytical functions. Many programs rely on MS Excel spreadsheets for calculations but lack sophisticated analytical capabilities. Therefore, developing specialized software systems that integrate intelligent information systems and economic and mathematical models is crucial for improving the efficiency and accuracy of solutions in a business environment.

The development of the AIC in the Kyrgyz Republic requires a comprehensive way due to economic and environmental factors. The transition to a green economy necessitates addressing the challenges faced by the AIC, such as low profitability.

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