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A Smart Decision-Support System: Evaluating Cost-Effectiveness of Agri-Tech Investments

Md Obydullah Sarder[1*], Na Daeyoung[2]

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ABSTRACT

This study outlines an intelligent decision support system that would be used to determine the cost-effectiveness of agri-tech investments. The problem it addresses is simple but widespread, since farmers, cooperatives, lenders and policymakers often do not have clear, consistent, financially prepared appraisals to understand whether an investment is worth pursuing or investing in. The system sums up the simple inputs about the benefits, costs, yields, prices and operating assumptions, such as initial investment, the project lifetime and the discount rate and then calculates the six most common indicators, including Return on Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (BCR), Payback Period, and Discounted Payback Period (DPP). It also carries out the scenario analysis and one-way sensitivity analysis to show how outcomes change with major risks, including market price, yield, input cost, and interest rate. Outputs are provided in the form of clear visualization and two types of reports: a plain-language summary suitable for farmers and a report for lenders, which is consistent with common appraisal practice. It is multilingual and produces short and explainable narratives to allow users who are not specialists to understand the logic behind each recommendation. The standardization of indicators, explicit risk, and exposure of results to concrete financing conditions make the tool useful to conduct comparative evaluation of options, cash-flow planning, and give transparent and evidence-based decisions. The key contribution is an actively useful, expandable structure, which is a combination of divergent approaches into a unified agri-finance support instrument that is suitable for adoption, lending decisions, and policy targeting.

INTRODUCTION

The agricultural sector is one of the most significant sectors that guarantee food security, economic growth and rural development worldwide. Nevertheless, conventional agricultural systems are often confronted with issues of poor resource utilization, low productivity, and vulnerability to climate change (FAO, 2019). These limitations are especially critical in developing countries, where smallholder farmers depend heavily on agriculture for their livelihoods but often lack access to modern technologies and reliable data (FAO, 2019).

In recent years, smart farming—the integration of ICT, IoT, and data analytics—has emerged as a promising solution for making agriculture more efficient and sustainable (Wolfert *et al.,* 2017). Farming technologies help farmers monitor soil conditions, weather, and crop health in real time, enabling data-driven decisions that improve yields and reduce costs (Liakos *et al.,* 2018). These innovations also support environmental sustainability by minimizing fertilizer and pesticide use, conserving water, and reducing greenhouse gas emissions (Klerkx *et al.,* 2019).

Despite these potential benefits, the adoption of smart farming in many developing countries remains limited due to high investment costs, lack of infrastructure, and low digital literacy (Basso & Antle, 2020). Therefore, it is crucial to assess whether these technologies are economically viable and provide measurable returns over time. Evaluating indicators such as Return on Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR) can help determine their cost-effectiveness and long-term sustainability (Shruthi *et al.,* 2017).

This study aims to evaluate the cost-effectiveness of agri-tech investments in achieving sustainability from a financial perspective. By analyzing real farm-level data and applying standard financial metrics, this research seeks to provide a scientific basis for policymakers and practitioners to promote smart farming as a sustainable agricultural strategy in developing regions.

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[1] Graduate School of Global Development and Entrepreneurship, Handong Global University, Pohang, South Korea & Bangladesh Academy for Rural Development (BARD), Cumilla, Bangladesh

[2] Global Leadership School, Handong Global University, Pohang, South Korea

[*] Corresponding author's e-mail: obydullah.bard@gmail.com

LITERATURE REVIEW

Precision and digital agriculture, referred to as smart farming, are expected to bring greater productivity, lower input spending, and improved risk management, however, adoption and profitability outcomes are highly heterogeneous across environments. Meta-analytical studies show that adoption of technology depends on the factors of farm size, access to capital, and the density of information networks and that empirical evidence on the average increases in profits after considering the costs involved is inconclusive (Ruzzante *et al.,* 2021; Schimmelpfennig, 2016). Furthermore, the efficacy of the implementation, which has been observed in pilot studies, is warned against in a critical review as not always being transferred to the economic benefits, which are expected to be long-term in commercial farms (Lowenberg-DeBoer & Erickson, 2019; Ruzzante *et al.,* 2021).

The resultant effect is that economic appraisal takes on a critical role. The analytical foundation of investment decision-making in the agriculture sector is comprised of conventional capital-budgeting indicators such as Net Present Value (NPV), Internal Rate of return (IRR), Benefit-Cost Ratio (BCR), Return on Investment (ROI), Payback, and Discounted Payback, which take into account the time value of money and cash-flow structure explicitly (Boardman *et al.,* 2018). Empirical studies applying these metrics to precision technologies yields positive but context-dependent results. As an example, whole-farm analysis of precision applications shows a financial advantage in the case of site-specific response and realistic cost estimation, and national-scale findings reveal that the introduction of precision agriculture is linked to an increase in profits after adjusting for farm characteristics (Schimmelpfennig, 2016). However, deterministic NPV/IRR methodologies do not perform well in cases of agricultural uncertainty; yield and price volatility introduce option value in determining when adoption should occur that such measures do not take into account (Tozer, 2009).

The purpose of decision-support systems (DSS) is meant to fill the evidence-practice gap with the purpose of converting data and models into practical decisions. Nonetheless, the historical adoption of agricultural DSS has been rather low, due to the issues of usability, credibility, insufficient alignment with the workflow of farmers, and insufficient localization (Rose et al., 2016). The reviews on irrigation and farm-planning DSS are convergent, as the instruments often focus on technical optimisation but pay limited attention to strategic investment problems, risk analysis, and end-user co-design (Aar *et al.,* 2021; Rose *et al.,* 2016).

These strands of literature expose three gaps this study addresses. To start with, it lacks the availability of tools that are oriented towards farmers and can be used to compute the entire range of investment indicators (ROI, NPV, IRR, BCR, Payback, Discounted Payback) in an open and reproducible way and yet are consistent with published case data (Schimmelpfennig, 2016). Second, uncertainty and sensitivity analysis as well as such indicators are rarely integrated into mainstream DSS in spite of the transparent guidelines provided by investment theory (Tozer, 2009). Third, adoption research emphasizes the need of readily available interfaces as well as locally pertinent outputs such as plain-language reporting and multilingual explanation, which contribute to building confidence and making consistent choices of lenders, farmers, and policymakers (Rose *et al.,* 2016; Ruzzante *et al.,* 2021). The current work is directly responsive to the stated needs through the combination of the established financial measures with user-centered design principles, as well as the evidence-replication strategies based on the previous research.

MATERIALS AND METHODS

Research Design

This study follows a quantitative and analytical research design to evaluate the cost-effectiveness of agri-tech investments in promoting agricultural sustainability. The research integrates secondary data to analyze and validate the financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (BCR), Return on Investment (ROI), and Payback Period. These metrics were used to determine the profitability and long-term viability as a decision support system (DSS) of agri-tech investments compared to conventional practices (Shruthi *et al.,* 2017).

Data Sources

The analysis is based on farm-level data collected from peer-reviewed research papers, field experiments, and project reports related to farming technologies. The dataset includes real values on initial investment cost, project lifetime, annual benefits, annual costs, and discount rates. These data points were extracted from studies conducted in developing regions with similar agro-climatic and socio-economic conditions (FAO, 2019; Wolfert *et al.,* 2017). For validation, three case studies, Case A (Precision Farming in Paddy, Raichur/Koppal, India) and Case B (Precision Farming Services Firm, Kentucky, USA), and Case C (Business Sustainability of Medicinal Plant Production, Bangladesh) were selected to assess financial outcomes under varying investment and benefit conditions (Shruthi *et al.,* 2017; Logsdon, 2006; Saiyem *et al.,* 2025).

Financial Evaluation Framework

The six metrics that are well established to analyze the financial results of the investments in smart farming are Return on Investment (ROI), Net Present Value (NPV), (undiscounted) Payback Period, Discounted Payback Period (DPP), Internal rate of Return (IRR), and Benefit Cost Ratio (BCR) which is used to analyze the financial results of the investments in farming technology in the current paper. They are the common tools used when analyzing agricultural economics and investment. They help to estimate the profitability, recovery periods and longevity of the technologies in question.

Notation and Timing

For consistency, the following notation is used:

i. $t = 0,1,\ldots,n$: the project years (with $t = 0$ as the starting year)
ii. Bt: benefits in year t; Ct: costs in year t; C_0: initial investment cost; r: discount rate (decimal)
iii. NCFt = Bt − Ct : Net cash flow in year t

Financial Metrics

Return on Investment (ROI)

ROI measures the profitability of an investment relative to its cost. It shows how much gain is achieved for each unit of cost incurred. It is expressed as a percentage. So,

ROI= ((Gain from Investment-Maintenance Cost)/(Initial Investment Cost)) x 100 %

For mathematical analysis,

$\text{ROI} = (\sum_{t=0}^{n}(Bt-Ct))/C0 \times 100\ \%$

The ROI calculation expresses net benefits as a percentage of total costs, giving a clear measure of profitability. The calculator displays ROI both numerically and in percentage form. For example, when sample data with total costs of USD 10,000 and net benefits of USD 3,000 was entered, the system calculated an ROI of 30%. This aligns with existing literature that highlights ROI as a farmer-friendly measure of profitability because of its simplicity (Duangpakdee *et al.,* 2024). A positive ROI indicates that the investment generates profit beyond its initial cost, while a negative ROI suggests financial loss.

Net Present Value (NPV)

NPV calculates the present value of future net benefits after accounting for the time value of money. It discounts future cash flows back to their value at the start of the project (Poudel *et al.,* 2024).

$\text{NPV} = (\sum_{t=0}^{n}(Bt-Ct)/(1+r)^{t}$

The calculator computes NPV by discounting future cash inflows and subtracting the initial investment. Using sample data, the calculator produced an NPV of USD 33.06 at a 10% discount rate (Table 1). This output demonstrates how the calculator makes advanced financial measures accessible, as NPV is often overlooked by farmers despite being widely recognised in economic research (Poudel *et al.,* 2024).

If $\text{NPV} > 0$, the investment adds value and is financially viable. If $\text{NPV} < 0$, it reduces value.

Table 1: Sample NPV Output

Year	Benefits (B)	Costs (C)	Net Cash Flow (B – C)	Discount Factor (1 / (1+r)^t)	Present Value (USD)
0	–	1,000	–1,000	1.0000	–1,000.00
1	800	300	500	0.9091	454.55
2	1,100	400	700	0.8264	578.51
Total	—	—	—	—	33.06

Payback Period (Undiscounted)

The payback period is the number of years required for the cumulative net cash inflows to equal the initial investment. It does not consider the time value of money. A shorter payback period indicates faster recovery of the initial cost.

Averaging method (even cash flows):

Payback = (Initial Investment Cost)/(Average Annual Cash Flow)

Subtracting or interpolation method: Let, cumulative net cash flow be $\text{Cumt} = \sum_{t=0}^{n}(Bt-Ct)$.

If $\text{Cumt}-1 < 0 \leq \text{Cumt}$,

$\text{Payback} = (t-1) + (-\text{Cum}_{t-1})/(Bt-Ct)$

It can be written in a simplified format, like:

Payback=A+ (B/C)

where, A = full years before recovery, B = remaining amount at start of recovery year, C = cash inflow in recovery year (Poudel *et al.,* 2024).

Discounted Payback Period (DPP)

The DPP modifies the payback measure by discounting yearly net cash flows. This ensures the time value of money is reflected. The DPP is generally longer than the undiscounted payback, but it gives a more realistic picture of investment recovery. Let,

$\text{DiscNet}_t = (Bt-Ct)/(1+r)^{t}$, $\text{DiscCum}_t = \sum_{t=0}^{n}\text{DiscNet}_t$

$\text{Disc. Payback} = (t-1) + (-\text{DiscCum}_{t-1})/\text{DiscNet}_t$ if $\text{DiscCum}_{t-1} < 0 \leq \text{DiscCum}_t$

It can also be written in a simplified format, like:

Disc. Payback=A+ B/C

where, A = full years before the discounted cumulative turns positive, B = remaining discounted balance at the start of the recovery year, C = discounted inflow in the recovery year (Bhandari, 1989).

The calculator computes both the Undiscounted Payback Period and the Discounted Payback Period (DPP). The Undiscounted PBP in the sample case was 3.5 years (Table 2), while the DPP extended to 3.85 years (Table 3). This difference highlights the value of incorporating DPP, which accounts for the time value of money and provides a more realistic timeline for investment recovery

Table 2: Sample Payback Period Outputs (Undiscounted)

Year	Cash Inflows (USD)	Cumulative Inflows (USD)	Remaining Balance (USD)
0	–3,500	–3,500	3,500
1	1,000	–2,500	2,500
2	1,000	–1,500	1,500
3	1,000	-500	500
4	1,000	+500	—
5	1,000	+1,500	—

Undiscounted Payback Period = 3 + (500/1000) = 3.5 years

Table 3: Sample Payback Period Outputs (Discounted)

Year	Cash Inflows (USD)	Discount Factor (4%)	Discounted Inflows (USD)	Cumulative Discounted (USD)	Remaining Balance (USD)
0	–3,500	1.0000	–3,500.00	–3,500.00	3,500.00
1	1,000	0.9615	961.54	–2,538.46	2,538.46
2	1,000	0.9246	924.56	–1,613.90	1,613.90
3	1,000	0.8890	889.00	–724.90	724.90
4	1,000	0.8548	854.80	129.90	—
5	1,000	0.8219	821.93	951.83	—

(Bazaluk *et al.,* 2022).

Observation: The cumulative discounted total crosses zero between Year 3 (−724.90) and Year 4 (+129.90).

DPP = 3 + (724.90 / 854.80) = 3.85 years

So, the undiscounted payback period = 3.5 years and discounted payback period = 3.85 years as it counts the discount factor over the time period. This clearly shows the effect of considering the time value of money.

Internal Rate of Return (IRR)

IRR is the discount rate at which the NPV of an investment becomes zero. It represents the annualized effective return on the investment. So,

$\sum_{t=0}^{n}(Bt-Ct)/(1+IRR)^{t}=0$

The calculator also solves for IRR, which represents the discount rate at which NPV becomes zero. In the sample scenario, the system produced an IRR of 18%, indicating that the investment remains profitable up to that rate. This aligns with earlier findings from Ghana, where IRR proved to be a reliable measure of profitability in integrated nutrient systems (Kpenekuu *et al.,* 2025).

Let, Initial Investment = 1,000 USD, Cash Inflows: year 1 = 500 USD and year 2 = 700 USD

Formula: $-1000+500/((1+IRR))+700/(1+IRR)^{2}=0$.

So, IRR ≈ 12.3%. So, Estimated IRR = 12.3%

An investment is considered profitable if the IRR is greater than the cost of capital or prevailing interest rate (Poudel *et al.,* 2024).

Benefit–Cost Ratio (BCR)

BCR measures the relationship between the discounted value of benefits and the discounted value of costs: So, (Poudel *et al.,* 2024)

$BCR=\sum_{t=0}^{n}(Bt/(1+r)^{t})/(\sum_{t=0}^{n}Ct/(1+r)^{t})$

The BCR, calculated by dividing discounted benefits by discounted costs, provides a simple ratio for evaluating investment attractiveness. The calculator displayed a BCR of 2.71 in the sample case, meaning that every dollar invested returns USD 2.71 in profits (Table 4). Ratios above 1 indicate profitable ventures, consistent with outcomes reported in studies on hydroponic farming in Thailand (Duangpakdee *et al.,* 2024).

Table 4: Sample BCR Output

Year	Benefits (B)	Costs (C)	Discount Factor	PV of Benefits (USD)	PV of Costs (USD)
1	800	300	0.9091	727.27	272.73
2	1100	400	0.8264	909.09	330.58
Total	—	—	—	1636.36	603.31
BCR	—	—	—	1636.36 / 603.31 = 2.71	

If BCR > 1, the investment produces more benefits than costs, indicating financial feasibility. If BCR < 1, the project is not viable.

A combination of the six indicators is a holistic opinion of the financial performance. ROI and NPV assess profitability, Payback and DPP assess recovery time, IRR assesses how profitable the project is each year and BCR assesses a balance between the benefits and costs.

By applying all six measures, this study will ensure that the study of investments in smart farming in different technologies and regions is strong and complete.

RESULTS AND DISCUSSION

System Development Overview

This system is a decision-support tool designed to automate the economic analysis of farming technologies. The system integrates financial analytics, AI-powered reporting, and interactive documentation into a single platform. The main idea behind it is to make the process of evaluating farm-level investments easier, and in this respect, compute all significant financial indicators automatically and generate professional feasibility reports in real time.

The computational engine, developed in JavaScript, applies standard financial formulas to compute Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR), Return on Investment (ROI), Payback Period (Undiscounted), and Discounted Payback Period (DPP). Users provide basic input parameters, such as project lifetime, initial investment cost, discount rate, and annual benefits, annual costs, through a clean graphical user interface. The backend then processes these values to produce both numerical outputs and automated textual interpretations, bridging the gap between data and decision-making.

Functional Architecture and Workflow

The system is built upon a single architecture that considers the data entered, financial calculation, AI-based reporting, and documentation as a continuous process. At the front end, key parameters required by the user include project life, the initial investment, the discount rate, and the annual cost and benefit values by using structured input form.

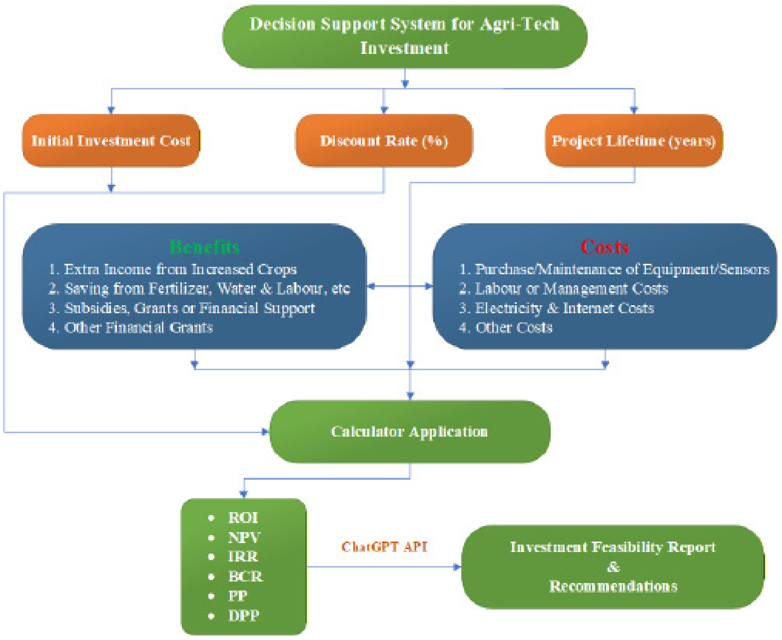


Figure 1: System Flow Diagram

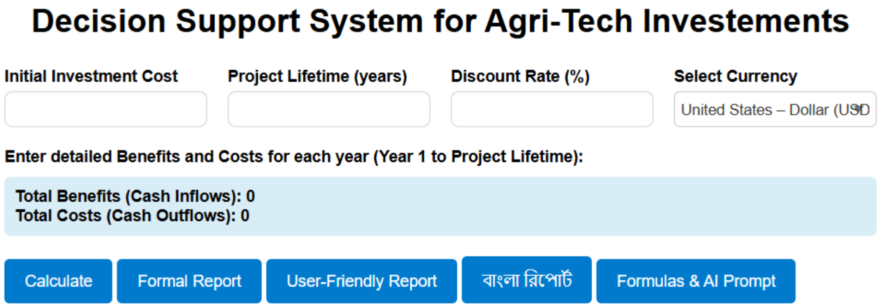
These data are then processed by the built-in computation engine, which applies verified mathematical formulas to calculate six key financial indicators, Net Present Value, Benefit-Cost Ratio, Internal Rate of Return, Return on Investment, Payback Period, and Discounted Payback Period. Once calculations are completed, the system connects to the ChatGPT API to generate an automated feasibility report tailored to the user's needs (Figure 1).

It has three output options including a Formal Report that utilizes professional research language that is readable by academics or other institutions, a User-Friendly Report that simplifies technical findings to be readable by farmers and other non-experts, and a Bengali Report that makes the same information readable by the local population. The last part, which includes documentation and visualization, shows the whole system flow, the formulas that lie behind it, and structured prompts of ChatGPT that facilitate the creation of reports. This smooth combination of the concept of computational integrity, multi-lingual report creation, and the creation of clear documentation allows implementing the system as a financial evaluation device and an educational tool of a wide range of stakeholders within the agricultural industry.

System Interface

The system interface (Figure 2) provides a streamlined layout where users can input key financial parameters such as initial investment, project lifetime, discount rate, and currency selection. The design emphasizes simplicity, accessibility, and accuracy, ensuring that both researchers and farmers can easily perform financial analysis.

Once the user proceeds, the detailed input section (Figure 3) appears, enabling entry of yearly benefits and costs.



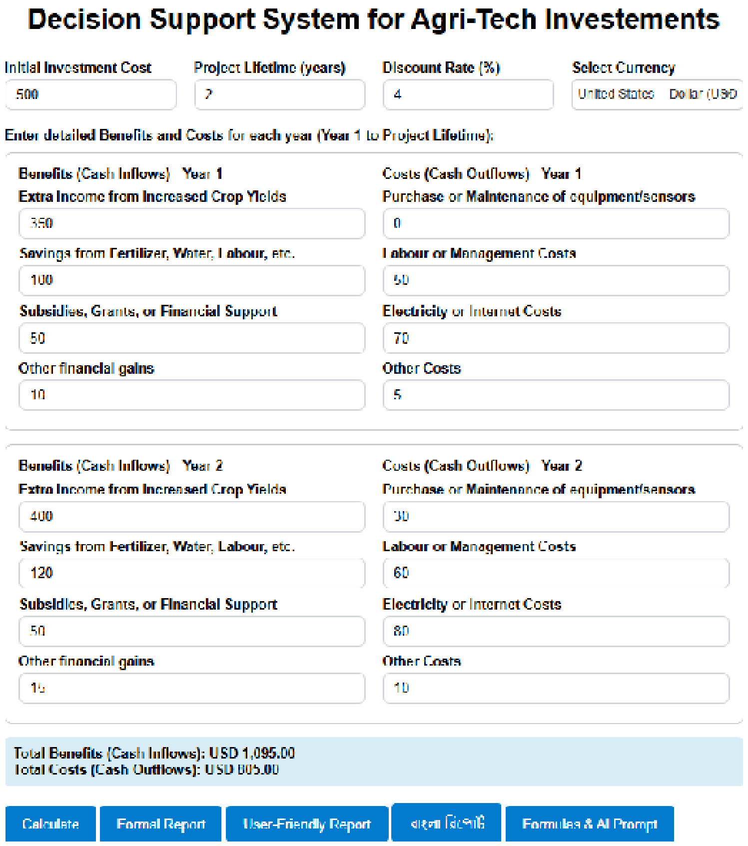
Decision Support System for Agri-Tech Investements

Initial Investment Cost:
Project Lifetime (years):
Discount Rate (%):
Select Currency: United States – Dollar (USD

Enter detailed Benefits and Costs for each year (Year 1 to Project Lifetime):

Total Benefits (Cash Inflows): 0
Total Costs (Cash Outflows): 0

Figure 2: Initial user interface of the decision support system showing input fields for investment cost, project lifetime, discount rate, and currency selection



Decision Support System for Agri-Tech Investements

Initial Investment Cost: 500
Project Lifetime (years): 2
Discount Rate (%): 4
Select Currency: United States – Dollar (USD

Enter detailed Benefits and Costs for each year (Year 1 to Project Lifetime):

Benefits (Cash Inflows) – Year 1		Costs (Cash Outflows) – Year 1	
Extra Income from Increased Crop Yields	350	Purchase or Maintenance of equipment/sensors	0
Savings from Fertilizer, Water, Labour, etc.	100	Labour or Management Costs	50
Subsidies, Grants, or Financial Support	50	Electricity or Internet Costs	70
Other financial gains	10	Other Costs	5

Benefits (Cash Inflows) – Year 2		Costs (Cash Outflows) – Year 2	
Extra Income from Increased Crop Yields	400	Purchase or Maintenance of equipment/sensors	30
Savings from Fertilizer, Water, Labour, etc.	120	Labour or Management Costs	60
Subsidies, Grants, or Financial Support	50	Electricity or Internet Costs	80
Other financial gains	15	Other Costs	10

Total Benefits (Cash Inflows): USD 1,095.00
Total Costs (Cash Outflows): USD 305.00

Figure 3: Input data fields showing annual breakdown of benefits and costs used to evaluate farming projects

Each row corresponds to a project year, where users specify income from increased crop yields, savings from input use (fertilizer, labor, or water), and operational expenses such as energy, equipment, or management costs. These inputs form the core dataset for subsequent financial computation. The system is live at https://smart-farming-mkqd.onrender.com

After the computation process, the system generates the financial metrics dashboard (Figure 4), displaying six essential indicators: Return on Investment (ROI), Undiscounted Payback Period, Discounted Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit–Cost Ratio (BCR). On the test case, the results indicated ROI = 158, IRR =36.39, NPV = USD 244.64, BCR=1.31, Undiscounted Payback = 1.28 years, and Discounted Payback = 1.35 years. These results indicate that the simulated investment is profitable, meets the standard economic feasibility requirements.

The system also plots the annual trend of cash flow (Figure 5) as compared to benefits and costs of the years and the cumulative net cash flow. The chart indicates blue benefit bars, red cost bars and an orange cumulative line that shows capital recovery with time. Intersections between the cumulative line and the discounted and undiscounted payback periods are shown, which indicate the point at which the total inflows are equal to or exceed the initial investment.

Return on Investment (ROI)
158.00 %

Undiscounted Payback Period
1.28 Years

Discounted Payback Period
1.35 Years

Net Present Value (NPV)
USD 244.64

Internal Rate of Return (IRR)
36.39 %

Benefit-Cost Ratio (BCR)
1.31

Result
Profitable

Figure 4: Computed financial indicators demonstrating system output for a two-year farming project

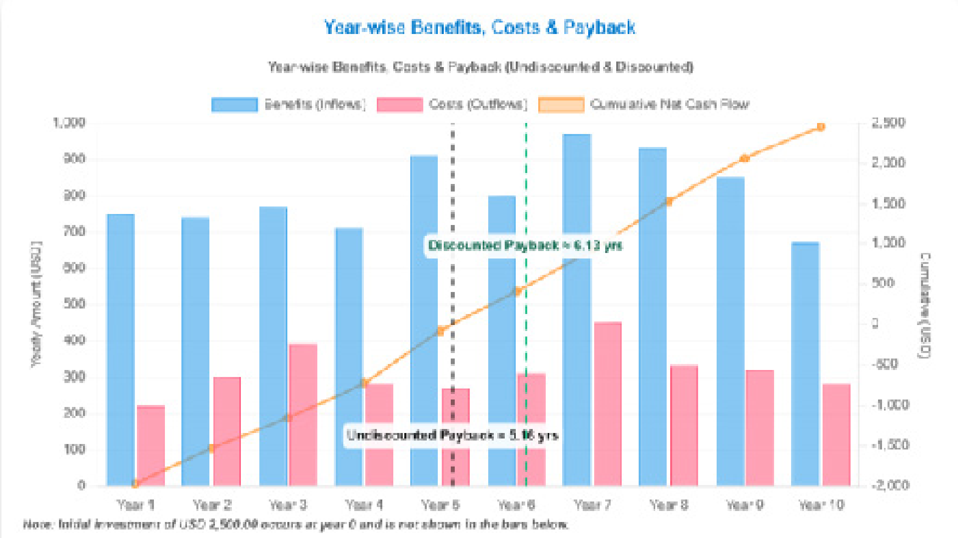
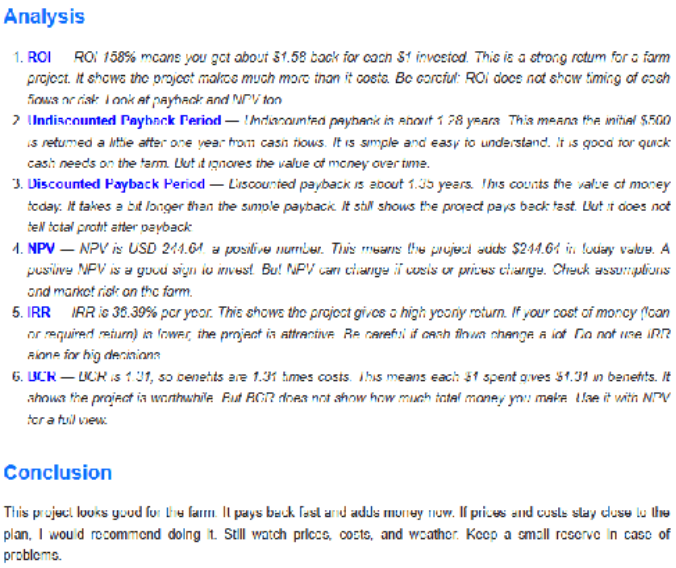


Figure 5: Year-wise benefits, costs, and cumulative cash flow chart indicating payback periods (10 years)

Automated Feasibility Report and AI Integration

Following computation, the system connects to the ChatGPT API, which generates an automated feasibility report (Figure 6). This report interprets numerical results into descriptive insights and draws a conclusion. Users can choose among three modes of report generation:

a. Formal Report: Written in professional academic style for research or policy use,



Analysis

1. **ROI** — *ROI 158% means you get about $1.58 back for each $1 invested. This is a strong return for a farm project. It shows the project makes much more than it costs. Be careful: ROI does not show timing of cash flows or risk. Look at payback and NPV too.*
2. **Undiscounted Payback Period** — *Undiscounted payback is about 1.28 years. This means the initial $500 is returned a little after one year from cash flows. It is simple and easy to understand. It is good for quick cash needs on the farm. But it ignores the value of money over time.*
3. **Discounted Payback Period** — *Discounted payback is about 1.35 years. This counts the value of money today. It takes a bit longer than the simple payback. It still shows the project pays back fast. But it does not tell total profit after payback.*
4. **NPV** — *NPV is USD 244.64, a positive number. This means the project adds $244.64 in today value. A positive NPV is a good sign to invest. But NPV can change if costs or prices change. Check assumptions and market risk on the farm.*
5. **IRR** — *IRR is 36.39% per year. This shows the project gives a high yearly return. If your cost of money (loan or required return) is lower, the project is attractive. Be careful if cash flows change a lot. Do not use IRR alone for big decisions.*
6. **BCR** — *BCR is 1.31, so benefits are 1.31 times costs. This means each $1 spent gives $1.31 in benefits. It shows the project is worthwhile. But BCR does not show how much total money you make. Use it with NPV for a full view.*

Conclusion

This project looks good for the farm. It pays back fast and adds money now. If prices and costs stay close to the plan, I would recommend doing it. Still watch prices, costs, and weather. Keep a small reserve in case of problems.

Figure 6: Automatically generated feasibility report (user-friendly) explaining financial results in structured analytical format

b. User-Friendly Report: Simplified explanations for non-technical readers, and

c. Bengali Report: Translated version for local farmers and community stakeholders.

Each generated report includes project overview, financial summary, yearly benefits and costs, financial metrics table and narrative analysis of the six metrics, investment interpretation, and final recommendations.

Validation And Case Studies

Validation Approach

We validated the Smart-Farm Investment Calculator by (i) mapping parameters from published farm-level studies into the tool (project life, initial outlay, annual costs and benefits, discount rate), (ii) recomputing Net Present Value (NPV), Benefit–Cost Ratio (BCR), Internal Rate of Return (IRR), Payback Period, Discounted Payback Period (DPP), and Return on Investment (ROI), and (iii) checking these against the sources' reported results. Definitions and calculation procedures follow Iowa State University's Ag Decision Maker guidance (including DPP) and the Millennium Challenge Corporation's agriculture CBA guidance.

Acceptance Thresholds

We accept a replication when $|\Delta NPV| \leq 0.01$, $|\Delta BCR| \leq 0.01$, $|\Delta IRR| \leq 0.1$ percentage points, and $|\Delta PBP| \leq 0.1$ year. When cash-flow conventions differ (e.g., timing of capital charges), we report both the source figure and the calculator figure with the convention used, consistent with applied CBA practice.

Benchmarks Used

1. Paddy (India): 10-year farm-level feasibility at a 12% discount rate (the paper explicitly applies NPV, BCR, IRR and payback) (Shruthi *et al.,* 2017).
2. Precision-farming services firm (Kentucky, USA): Five-year start-up model at 5.5% cost of capital, with year-by-year cash flows (Logsdon, 2006).
3. Business Sustainability of Medicinal Plant Production (Bangladesh): A 2025 PLOS One simulation study examined high-value crop, Withania somnifera (per ha). Assuming an 8% discount over 10 years, was profitable (Saiyem *et al.,* 2025).

Case Study A: Precision Farming In Paddy (Raichur/Koppal, India)

Source and Data: The study reports: annual cultivation cost ₹75,825.35/ha, gross return ₹122,656.30/ha, a 10-year project life, 12% discount rate, and a Year-0 establishment cost of ₹26,906.55/ha. The paper's feasibility measures include NPV, BCR, IRR, and payback (Shruthi *et al.,* 2017).

Cash-flow Construction (per ha)

Year 0 is the initial outlay (₹26,906.55); Years 1–10 are equal net benefits of ₹122,656.30 − ₹75,825.35 = ₹46,830.95, discounted at 12% (Shruthi *et al.,* 2017).

Metric Outputs (Calculator vs. Paper)

a. NPV (12%): ₹237,698.76 — matches the paper.

b. BCR (12%): 1.52 — matches the paper.

c. IRR: calculator ≈ 174% from the tabled net-benefit stream; the paper reports 70.54%. See "IRR discrepancy" below.

d. Payback: 6.84 months (undiscounted), consistent with the paper's 6.84 months; Discounted payback is 7.68 months at 12% (not reported in the paper).

e. ROI (system metric, not reported in the paper): positive and large given the short payback; we report ROI alongside NPV/BCR to improve interpretability for farm managers.

IRR Discrepancy and Author Contact

The article lists IRR = 70.54% yet modelling its own table as one up-front outlay followed by ten equal net-benefit years implies ≈174%. This gap likely reflects a different internal convention (e.g., additional capital charges or a different net-benefit stream). We emailed the corresponding author to clarify; as of 11 November 2025 (KST), no reply has been received. For transparency, we reproduce the paper's headline NPV/BCR exactly and state the calculator's IRR under explicit assumptions (and add DPP and ROI, which the paper does not provide).

Case Study B: Precision Farming Services Firm (Kentucky, USA)

Source and Context: A University of Kentucky thesis models a start-up precision-ag services firm over five years with 5.5% cost of capital; the associated conference paper documents the decision factors used (payback, NPV, BCR, IRR), with year-by-year cash flows (Table 5) (Logsdon, 2006).

Table 6: Net Cash Flow (USD) from year 0 to 5

Year	Net cash flow	Discounted net cash flow @5.5%
0	−139,725	−139,725
1	−38,357.67	−36,357.98
2	15,997.31	14,372.82
3	53,024.81 (incl. $350 salvage)	45,156.65
4	89,352.31	72,126.68
5	107,691.06	82,398.13

Metric Outputs (Calculator vs. Paper)

a. NPV (5.5%): $37,971.29 — matches.

b. BCR (5.5%): 1.27 — matches.

c. IRR: 11.04% — matches and exceeds the 5.5% hurdle.

d. Payback: 3.07 years (as reported), Discounted payback 4.54 years at 5.5% (our system adds DPP; not in the source's reported decision set).

e. ROI: reported by our system alongside NPV/BCR to aid managerial interpretation; not provided in the source.

Case Study C: Business Sustainability of Medicinal Plant Production (Bangladesh)

Source and Context: Year 1 cost (BDT 3,35,236.25); Years 2–10 are equal net benefits of BDT 5,24,408.09 – BDT 3,80,950.29 = BDT 1,43,457.80, discounted at 8% (Saiyem *et al.,* 2025).

Metric Outputs (Calculator vs. Paper)

a. NPV (8%): BDT 5,19,378.28 — matches the paper.

b. BCR (8%): 1.21 — matches the paper.

c. IRR: 40.83% — matches the paper.

d. Payback: 3.34 years (undiscounted); Discounted payback is 3.70 years at 8% (not reported in the paper).

Why Our Output Set Is Richer

The benchmark sources do not report ROI or Discounted Payback Period. Our system adds both by default. DPP, in particular, explicitly incorporates the time value of money and is often longer than simple payback, important for agricultural projects with long or back-loaded cash-flow streams, while ROI offers a familiar, ratio-style summary many farm managers actively seek.

Discussion

The system represents a major advancement in the digital assessment of agricultural investments. As opposed to the traditional spreadsheets-based analyses, it incorporates financial modeling, visual analytics, and artificial intelligence to provide valid and real-time feasibility assessments. The six main financial measures included, ROI, IRR, NPV, BCR, Payback Period and Discounted Payback Period, make sure that any project is analyzed through multiple economic evaluation approaches, which makes the process of decision making that of researchers and practitioners more reliable.

The most outstanding characteristic of the system is a built-in AI-based feasibility reporting engine, which is based on the ChatGPT API, which automatically converts numerical data into context-specific narratives. This will enable users to derive comprehensive analyses in real-time in Formal, User-Friendly, or Bengali form, thereby enabling the process of multilingualism and inclusivity. It is a reliable way to bridge the gap between academic knowledge and practice by putting complicated financial information into a simple language.

In addition, the built-in documentation interface improves the transparency of the computational workflow through the visualization of mathematical formulas, transparency of the ChatGPT prompt structure. This provides confidence to the users as well as enhancing reproducibility and sharing of knowledge. The platform will provide the opportunity of using modern technologies in the field of farming to implement an evidence-based policy creation and on-farm investment planning, which will be enabled by automation, visual charting, and AI reporting.

CONCLUSION

The system shows that automation and artificial intelligence can transform the financial evaluation of technologies in agriculture. It is an all-in-one system where it offers a financial calculation engine, which is driven by the artificial intelligence, and a reporting system that is able to determine the economic viability of any farming investment project. It calculates six key indicators: ROI, IRR, NPV, BCR, Payback Period, and Discounted Payback Period which are automatically interpreted to give descriptive feasibility reports in Formal, User-Friendly, and Bengali. The tool is multilingual, and the flexible reporting feature enables the tool to be accessible to a wide range of users, such as policymakers, researchers, and smallholder farmers.

The outcome of the system demonstrates reliability and accuracy as the results align with the validated financial models and available literature. The capacity of visualizing payback schedules and offering narrative knowledge transforms technical data into actionable knowledge. In addition, the built-in documentation page provides a higher degree of transparency, as the system flow, financial formulae, and ChatGPT prompt logic are described, which guarantees both reproducibility and learning usefulness. Finally, the system reduces a big gap in analysis complexity and comprehension by users. It is an example of digital decision support tools within the field of sustainable agriculture, and a base of future development based on the combination of IoT-based data collection, real-time dashboards, and farm analytics on the cloud to enhance data-driven planning of agricultural investments.

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