From Sun to Sustainability: Project Management Strategies for Solar Energy in Baluchistan’s Agriculture


Abstract

This study explores the incorporation of solar energy and project management in sustainable agriculture in Baluchistan, Pakistan. A 10-acre farm with a solar-powered water reservoir supports up to 10 irrigation sets, illustrating a tactical synthesis of reserve management and environmental stewardship. The economic scrutiny confirmations that the agronomy of onions, potatoes, and spinach on this farm might harvest a profit oscillating from 1.537 to 1.62 million Rupees, with a breakeven point valued at 1.76 years. This model serves as a beacon for profitable, eco-friendly agronomic practices, leveraging solar power to overwhelmed water insufficiency challenges. Despite the global dependence on fossil fuels, solar energy’s interest has been regular, expressly in agriculture. The findings reveal a stark variance in the practicality of solar energy across diverse sectors due to Pakistan’s inconsistent national grid. The research underlines the critical need for particular project management to harness the full latent of solar power and set a usual for future activities in lucrative and ecologically cognizant agronomy.

INTRODUCTION

Pakistan is at a crossroads in its history, with its economic and social progress long overshadowed by the energy issue. The country is turning to alternate energy sources for comfort as a result of the ongoing power disruptions and the intensifying demand for electricity. This change in direction is not only a question of policy; it is also an example of the nation’s persistence as it uses the force of flora to illuminate the future. With projects like the Quaid-e-Azam solar power plant gleaming as a sign of enthusiasm to renewable energy, the government has played a vital role. This cutting-edge capability is more than simply a power originator; it’s an inductee of a Pakistan that is more justifiable and greener, but the journey doesn’t end here. The call for achievement resonances in every home, every farm, and every corporate, urging every resident to partake in this energy insurgency. This comprehensive outline
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Naqvi, S. H.A., et al. (2024) explores Pakistan’s energy condition in further detail, highlighting both its prospects and problems. It examines the restraints of hydropower, wind, and solar technologies and analyses how they can change the country’s electricity supply. It scrutinizes the problematic of fossil fuels, where finding oil and gas has turned into an exclusive and ecologically harmful activity. The story then moves to the sun-drenched and wind-swept plains, where the possibility of solar and wind energy is attractive. This outline recognizes the areas of potential where aerogenerators could ultimately turn steadily and provide electricity for towns, despite the scarcity of wind energy possessions. It presents a more cheerful visualisation of solar energy, with Pakistan’s plenteous sunshine providing a prompt and well-organized solution to the country’s energy discrepancy. However, this argument goes elsewhere the production of power. It also includes the impending danger of climate change, which hangs over Pakistan’s diverse ecosystems. A sobering valuation of the agricultural trade is given in the primer, where meagre management techniques and a non-existence of water supply have a momentous adverse impact on food sanctuary. It focuses on Baluchistan, a ethnically rich up till now water-starved region where the future is hazardous.

The introduction argues for a holistic approach, one that integrates solar power with water conservation techniques to breathe life into the arid fields of Baluchistan. It envisions a future where solar-powered pumps and drip irrigation systems become the norm, where every drop of water is treasured, and every ray of sunshine is captured. As the word count builds, so does the momentum of the argument. The introduction lays out a roadmap for sustainable development, highlighting the economic, environmental, and social benefits of renewable energy. It calls for a collective effort, a synergy between government policies and grassroots initiatives, to turn the tide of the energy crisis.

In conclusion, this expanded introduction is a clarion call to the people of Pakistan and their leaders. It’s an invitation to embark on a journey of transformation, to embrace renewable energy not just as a necessity but as an opportunity. It’s a blueprint for a future where the lights never go out, where the air is clean, and where the energy flows as freely as the aspirations of its people. The remaining paper is structured as follows, after the intro of our prospects the related work section incorporates the similar dimensions work in Pakistan’s agriculture sector, afterward the section analysis of work is done to showcase the entire flow of work with the methodologies and cost benefit analysis of project and the solar design for the required system. At last, the conclusion is coined to summarize the findings and propagation of work flow.

LITERATURE REVIEW

This research (Hussain, et al, 2023; Salman et al, 2024; Iqbal et al, 2024) examines Pakistan’s solar energy potential with an emphasis on Baluchistan’s agriculture industry. The technical, financial, social, and environmental aspects of solar energy system installation are among the main concerns and difficulties covered by the writers. The report also offers suggestions for resolving these issues and realising the area’s solar energy potential. Similarly, in (Mustafa, et al, 2023; Bakhsh et al, 2024) presents a project management agenda for the implementation of solar energy structures in the agronomic sector in Pakistan. The authors discuss the key factors that need to be considered in the project management process, including technical, economic, social, and ecological factors. The paper also provides a case study of a solar-powered irrigation system implemented in the region and discusses the lessons learned from the project. The viability of solar-powered irrigation systems in Pakistan’s Baluchistan is evaluated in this research (Mitchell, et al, 2021 : Aziz et al, 2024), where the authors gauge the probable of solar energy for irrigation and identify the critical
fundamentals persuading the practicability of solar-powered irrigation organizations using a techno-economic framework. The advantages and disadvantages of installing solar-powered irrigation systems in the area are also covered in the article. Also, the impact of solar-powered irrigation systems (SPIS) on the technical efficiency (TE) of wheat production in rural Baluchistan, Pakistan, is examined in the study (Khan, et al, 2023; Aziz et al, 2024). To estimate the TE of wheat production, the scholars used data from 1080 wheat growers and a stochastic frontier production function. In addition, they working an endogenous switching regression model to counteract the possibility of self-selectivity bias. According to the data, 13.7% of wheat farmers employed SPIs, and using SPIs raises wheat cultivators’ TE by 6.657%. The study also reveals that when employing SPIs, wheat farmers with large farms and farming experience have greater favourable effects on TE. The results emphasise the need for more investigation into evidence-based best practices for SPI solutions to encourage sustainable agronomy and reduce reliance on non-renewable energy sources.

Using a Bayesian spatial modelling approach, the study (Hussain et al, 2023 ; Manzoor, et al (2023) investigates the association between dengue disease geographical distribution in China and climate change. The researchers analysed climatic data from the China Meteorological Data Service Centre and monthly dengue fever case data from 2005 to 2019 in 31 Chinese provinces. The findings indicate that the incidence of dengue fever in China is significantly influenced by the average temperature, the diurnal temperature range, and the relative humidity. The study also discovers that the temperature and relative humidity in adjacent provinces have an impact on the spatial dispersion of dengue disease in China. The findings suggest that climate change has a significant impact on the spatial distribution of dengue fever in China, and that public health policies should take into account the effects of climate change on the spread of infectious diseases (Hussain et al, 2023 ; Manzoor, et al 2023). The study also highlights the need for further research on the relationship between climate change and the spread of infectious diseases in other regions of the world.

The link between nutrition, food security, and climate change is examined in this paper (Khan et al, 2024; Farooq, et al, 2023) The study draws attention to how poverty and social inequality worsen the detrimental consequences of climate change on food and nutrition security. Access, production, nutritional quality, and price volatility are the primary effects of climate change on food and nutrition security. In order to address how climate change affects the security of food and nutrition, the report also makes recommendations for mitigation and adaptation measures. The concentration on Africa and Asia, two continents known for their social inequality and poverty, is seen in the geographic distribution of publications on the subject. The results highlight the pressing need for increased global spending in public policies, studies, and research on the topic.

DATA ANALYSIS

The supply and demand of energy have never been balanced. In 2015, Pakistan’s energy deficit amounted to 5500 MW, or about 45% of the country’s total demand (Haq, et al, 2023; Uddin, et al, 2023). In order to maintain a balance between supply and demand, load shedding is often implemented for 8 to 10 hours every day. Ten to fourteen hours have passed since last year.

Synopsis of Technologies

China is now the world’s top producer of PV modules, and the photovoltaic sector is expanding at a rate of up to 30% worldwide. China exported 23,000 MW of consumable power in solar panel form in 2010. Of all solar transactions worldwide in
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2010, only those from China accounted for 75% (Haq, et al, 2023 ; Uddin, et al, 2023) Owing to the rising demand for solar modules, a large number of domestic and international businesses are founded every year. Prices for PV modules are falling daily due to heightened market competition (Haq, et al, 2023; Uddin, et al, 2023). In a brief four years, the average cost per watt of PV modules has dropped from $1.61 to $0.8, according to recent surveys and studies. This is nearly the exact opposite of the country’s rising electricity rates over that same time period (Haq, et al, 2023; Uddin, et al, 2023).

Table 1.
Top 10 countries by solar installed capacity 2024 [13]

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>609,920.8</td>
</tr>
<tr>
<td>2</td>
<td>USA</td>
<td>139,205.3</td>
</tr>
<tr>
<td>3</td>
<td>Japan</td>
<td>87,068.0</td>
</tr>
<tr>
<td>4</td>
<td>Germany</td>
<td>81,739.0</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>73,109.3</td>
</tr>
<tr>
<td>6</td>
<td>Brazil</td>
<td>37,449.2</td>
</tr>
<tr>
<td>7</td>
<td>Australia</td>
<td>33,683.0</td>
</tr>
<tr>
<td>8</td>
<td>Spain</td>
<td>31,016.3</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>29,795.3</td>
</tr>
<tr>
<td>10</td>
<td>Republic of Korea</td>
<td>27,0462.2</td>
</tr>
</tbody>
</table>

China is the global leader in the installation of PV. Pakistan now holds the 23rd position on the list with a meagre 1000 MW of solar energy installed. Pakistan is located in a very solar-power-friendly area, with an average of 10–11 hours of sunshine each day in the summer and 6–7 hours in the winter. The sun provides the world with an average of 1.259 KW/m2 of energy, and on a clear day, up to 80% of that energy is transferred to the planet. The sun is typically obscured by clouds, fog, and dampness, which reduces solar radiation (Kong et al, 2020; Uddin , et al, 2023). Pakistan is ideally located to receive the most solar radiation possible all year round, giving it a unique geographic location (Lee, 2021; Raza, Frooghi, Aziz, 2020). The largest amount of solar radiation is received year-round in several parts of southern Pakistan, such as Quetta, and parts of central and southern Punjab, such as Lahore, Faisalabad, Multan, Bahawalpur, and Rahimyar Khan. Pakistan typically receives 6.8 to 8.3 KMJ/m2 annually, with around 7-9 hours of sunshine per day on average (Kalogirou, 2023; Zafar, Aziz, Hainf, 2020).
Pakistan direct normal solar radiation.

Pakistan is ideally situated to transform solar energy into advantageous and practical uses. Pakistan’s energy crisis can be resolved by using this solar energy to generate power. Energy Book Pakistan 2004-2005 states that the 0.25 percent solar irradiation that falls on the region of Baluchistan alone will be adequate to cover the nation’s present energy needs (Asghar, 2023; Aziz & Pangil, 2017).

Prospects for the Market

Pakistan is a market with shifting trends because it is a growing nation. The local market is eager to use new technology and adjust to them. As a result, Pakistan has a lot of promise for alternative energy sources in general and solar energy in particular because it is inexpensive simple to install, and quick to harvest (Kalogirou, 2023; Zafar, Aziz, Hainf, 2020). Given their high rate of return and short payback periods, solar systems are probably more suited for the commercial, industrial, and agricultural sectors than for Residential, Commercial and agricultural sectors. It’s a lengthy payback time for households. The table below shows the cost per watt of solar PV modules for the national and international modules. Factors that determine the solar cost per watt and the installation cost are: solar companies and the dimensions of solar frame. The cost of solar panels is dependent on the solar panel company you choose. From the solar equipment system itself to installation costs and add-ons, the price will vary from company to company, and the first step is to consider your options for the best solar companies. Similarly, the dimension of panels is dependent on the size, weight and numbers of panels. Your home’s size, the efficiency of the panels and the amount of sunlight can play a role in determining just how many solar panels you’ll need (Kalogirou, 2023; Zafar, Aziz, Hainf, 2020).

Table 2:
National and International cost per watt of solar panel types.

<table>
<thead>
<tr>
<th>Solar Technology</th>
<th>International Cost per Watt $</th>
<th>Local Cost per Watt Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocrystalline</td>
<td>1 to 1.50</td>
<td>45 to 58</td>
</tr>
<tr>
<td>Polycrystalline</td>
<td>0.90 to 1.50</td>
<td>37 to 50</td>
</tr>
<tr>
<td>Thin-film</td>
<td>0.50 to 1.50</td>
<td>39 to 45</td>
</tr>
</tbody>
</table>

In a country with abundant sunlight like Pakistan, opting for higher-efficiency panels to maximize energy generation from limited rooftop space is more beneficial. However, thin-film panels can find practical applications in large-scale commercial installations or projects where space is not a constraint, such as solar farms or industrial installations table 3 shows the potential comparison of different solar panel type.

Table 3. the comparison of solar panel types

<table>
<thead>
<tr>
<th>Factors</th>
<th>Monocrystalline</th>
<th>Polycrystalline</th>
<th>Thin-Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life span</td>
<td>25+ years</td>
<td>25+ years</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Cost</td>
<td>Comparatively Expensive</td>
<td>Average</td>
<td>Cheap</td>
</tr>
<tr>
<td>Advantages</td>
<td>Highest Efficiency</td>
<td>Good Efficiency</td>
<td>Lower Efficiency than Monocrystalline</td>
</tr>
<tr>
<td>Drawbacks</td>
<td>Expensive</td>
<td>Occupy more Space</td>
<td>Lower Efficiency</td>
</tr>
<tr>
<td></td>
<td>Heavy</td>
<td></td>
<td>Require more Space</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shorter Lifespan</td>
</tr>
</tbody>
</table>

It is evident from the above table that solar modules wouldn’t be costly for the local market, particularly for the middle-class people. For organizations looking to employ
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Solar energy for industrial and commercial applications, it is far more practical. Figure 2 shows the solar electricity generation cost in comparison with the other power sources according to National Electric Power Regulatory Authority (NEPRA) report 2022-23.

Figure 2. Solar generation cost comparison with other fuels.
During FY22, power consumption in the country grew ~9.9% YoY, whereas installed capacity increased ~10.0% YoY. This supply demand gap is one of the contributing factors of increasing consumer-end tariffs. In terms of Sectors, Commercial and Industrial consumers are charged the highest average tariffs, while agricultural and domestic sectors are charged the lowest, due to different subsidies provided for the end consumers as well as low base effect of hydel fuel charges. The societal average rate per unit in PKR/kWh for the diverse area of residential, commercial, industrial, agricultural, and other sectors is displayed statistically in Figure 3.

Figure 3. Sectoral average tariff per unit.
Figure 4 shows the Over a 5-year period (FY19–23), Pakistan's GDP growth and power generation show a substantial link with a Pearson coefficient of ~0.83, suggesting a strong positive correlation between the two variables. Globally, during CY18–22, this was measured at approximately 0.9, suggesting an almost perfect positive correlation between GDP and power generation.

Figure 4. Power generation with respect to GDP growth.

Figure 5 shows the for each year, the table displays the percentage of power generated from each source. For example, in FY19, 2.7% of the power was generated from solar sources, 0.15% from coal, 14.15% from gas/RLNG, 25.20% from hydel, 5.70% from nuclear, 37.50% from oil, and 7.70% from other sources. Similarly, you can observe the breakdown of power generation for other years. The table shows that the percentage of power generated from solar sources has been increasing over the years, while the percentage of power generated from oil has been decreasing. Additionally, the percentage of power generated from coal and gas/RLNG has also been decreasing, while the percentage of power generated from hydel and nuclear has been increasing. Overall, the figure provides valuable insights into the power generation landscape in Pakistan and the shift towards renewable energy sources.

Figure 5. Distributive analysis of multiple source generation per year.

Problem Synopsis
In order to reduce system costs and payback times, power requirements must be met while taking power outages and other limitations into consideration. Variables in Decision-Making is Power Plant Capacity

Agricultural Case Study

Since agriculture has historically been the foundation of our nation, about 90% of pumping units are situated in isolated locations or in places without access to the grid. Farmers are forced to adopt costly energy production methods to power their water pumps due to unreliable grid conditions and voltage fluctuations. A solar energy system that uses just solar energy as its primary source and only runs during the day is a standalone solar energy system for water pumping. Our farmers will benefit from knowing how long a system will take to pay for itself. The constraints are still as described in the section on technique. Because there is no grid electricity, grid purchases, generator sizing, and fuel consumption of generator choice variables are not relevant in this situation. Instead, the decision variables are solar array size. Outcomes for this project, 27 plates of 1000W Canadian solar module are employed.

• Economic Analysis

This type of analysis discusses the payback period, replacement costs, and system costs. As an off-grid system, solar panels are the only power source; and pump is used to drilled water for the irrigation system. The approximately profit for the 10-acer land of thesees entire crops production would be 1.537 million to 1.62 million Rupees, whereas the entire project cost with the panel installation, tank construction and land cost is around 2.7 million. The Breakeven occurs at the duration of approx. 1.76 years, the real profit generation would begin after the Breakeven duration.

• Solar Panel

As we know, the solar panel produces its power from the sun, which is calculated as follows:

\[
P_{pv}(t) = \eta_{pv} \times A_{pv} \times I_{rr}(t) \times (1 - 0.005(T_{mp}(t) - 25))
\]

where \( P_{pv} \) indicates the hourly produced energy by solar panel. The efficiency and area of the solar panel are represented as \( \eta_{pv} \) and \( A_{pv} \), respectively. The terms \( I_{rr}(t) \) and \( T_{mp}(t) \) denotes the solar irradiance and outside temperature respectively, for time interval \( t \).

• Electricity COST

To define the electricity pricing of a day, many electricity tariffs are available, like DAP, TOUP, PP, and RTP [9]. In our model, we used RTP. In RTP, the electricity price changes every hour and remains constant for an hour. \( T_{EcP} \) and \( EdP \) shows the daily electricity bill of shiftable and non-shiftable appliances, these are calculated by respectively.

\[
EcP = EdP = \Sigma t = 124(\Sigma M = 1m(Ecm \in M(t) \times Xcm \in M(t) \times PRTP(t))) \Sigma t = 124(\Sigma N = 1n(Edn \in N(t) \times Xdn \in N(t) \times PRTP(t))) \times EcP + EdP
\]

where \( Xcm \in M(t) \) and \( Xdn \in N(t) \) represents the on/off states of shiftable and non-shiftable appliances. \( M \) represent shiftable appliances, while \( N \) represent non-shiftable appliances in a particular time slot \( t \). (19) is used to calculate the total electricity cost. Where \( EtoIP \) denotes the total electricity cost. \( EP(t) \) at any time slot \( t \) represents the electricity bill after taking RESSs and ESS into consideration. It is calculated as:

\[
EP(t) = (Ec(t) + Eb(t) - EPV(t) - SE(t)) \times PRTP(t).
\]
where, \( \tau \) represents the time slot between \( t_{20} \) to \( t_{24} \) having the highest electricity bill. The ESS is discharged because the PV is not available in those slots.

- **Solar System Design**

  The pivot to renewable energy is exemplified by the operational requirements of this irrigation infrastructure, necessitating approximately 22.5KW of power. This demand is seamlessly met by an array of 26 to 27 solar panels, each rated at 1000W, thereby underscoring the project’s commitment to green energy. The financial outlay for this solar installation ranges from Rs900,000 to Rs1,150,000, reflecting a strategic investment in long-term sustainability. The project’s 25-year lifespan is derived from the solar panels’ lifespan. Solar panels do not require maintenance; nevertheless, system charger must be changed periodically based on their lifespan. Since the system charger only lasts 15 years, it must be replaced twice over the project’s 25-year lifespan.

- **Cost-Benefit Analysis of Potato, Onion, and spinach Crops in Baluchistan:**

  Baluchistan, with its arid climate and water scarcity, presents unique challenges for agriculture. However, by meticulously evaluating costs and benefits, we can make informed decisions to maximize profitability and sustainability. Our analysis focuses on the cultivation of four essential crops: potatoes, onions, garlic, and tomatoes.

  **Fixed Costs (FC)**

  - **Land Lease or Mortgage Payments**: The cost associated with securing the 10-acre land. 100,000/ac

  - **Infrastructure Maintenance**: Expenses for maintaining irrigation channels, fencing, and other infrastructure. 5-10k/ac

  - **Depreciation of Machinery and Equipment**: Calculating the wear and tear on tractors, plows, and other farm equipment. 15k/ac

  **Variable Costs (VC)**

  - **Seeds**: The cost of high-quality seeds for each crop.
  - **Fertilizers and Pesticides**: Necessary inputs for healthy crop growth.
  - **Labor**: Wages paid to workers for planting, weeding, and harvesting.
  - **Watering**: Includes electricity costs for pumping water from wells or other sources.

  **Total Cost (TC)**

  The total cost of production (TC) is the sum of fixed costs (FC) and variable costs (VC): \( TC = FC + VC \)

  **Benefit**

  Yield: Estimate the expected yield (in 40 kilograms) for each crop per acre.
  Market Price (P): Determine the prevailing market price for each crop.
  Revenue: Calculate the total revenue from selling all crops:
  \[ R = P \times \text{Yield} \]

  **Net Benefit (NB)**

  28
The net benefit (NB) is the difference between revenue and total cost:
\[ \text{NB} = R - TC \]

Costs and benefits Investment costs for the crop farming consist of costs for equipment, infrastructure and building which are used for the sustainable farming. The fixed costs occur regardless of farming and will generally be the depreciation and interest. The depreciation is calculated by the straight-line method. Operating costs are related to the daily activities of farming and vary depend on the frequency of irrigation, amount of water applied per irrigation, consumption of fuel and number of area irrigated. The most important variable cost is labor cost which is used for cultivation the land, irrigation, maintenance and harvesting. Material costs include the costs of seeds and fertilizer. Annual repair and maintenance costs would be 6% of the initial investment for the irrigation system. Water is a limited resource. Water loss is measured by the amount of water applied for irrigation using the irrigation norm of crops and water ecological and economic evaluation. The benefits of the irrigated farming are the crop revenue, increased yields using the irrigation system, land rent, water and labor savings and social insurance. The table 4 shows the entire cost flow for the crop’s expenses per acre.

Table 4.
Cost benefit Analysis of entire project.

<table>
<thead>
<tr>
<th>Cost Variable Cost</th>
<th>Production per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Onion</td>
</tr>
<tr>
<td>Cost of Land Preparation</td>
<td>12364</td>
</tr>
<tr>
<td>Cost of Seeding &amp; Sowing</td>
<td>20904</td>
</tr>
<tr>
<td>Cost of Irrigation</td>
<td>20890</td>
</tr>
<tr>
<td>Cost of Fertilizer</td>
<td>20163</td>
</tr>
<tr>
<td>Cost of Drug</td>
<td>1673</td>
</tr>
<tr>
<td>Cost of Pesticides</td>
<td>4716</td>
</tr>
<tr>
<td>Cost of Weedicides</td>
<td>5342</td>
</tr>
<tr>
<td>Cost of Harvesting</td>
<td>9805</td>
</tr>
<tr>
<td>Cost of Transport</td>
<td>9675</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Land (100,000)</td>
</tr>
<tr>
<td>Cost of Motor Pump with Tank construction 700,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Benefit Analysis</th>
<th>Onion</th>
<th>Potato</th>
<th>Spinach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Cost</td>
<td>95,857</td>
<td>220,943</td>
<td>98471</td>
</tr>
<tr>
<td>Revenue Expected</td>
<td>142,641</td>
<td>287,274</td>
<td>139,338</td>
</tr>
<tr>
<td>Profit</td>
<td>46,784</td>
<td>66,331</td>
<td>40867</td>
</tr>
<tr>
<td>Indicative price per 40kg</td>
<td>1450</td>
<td>1278</td>
<td>991</td>
</tr>
</tbody>
</table>

In the realm of project management and solar energy generation, the integration of a meticulously designed water tank tailored for a 10-acre tract of land stands as a testament to sustainable agricultural practices. This reservoir, with its capacity to irrigate the land up to 10 times, embodies the synergy between resource planning and environmental stewardship. The deployment of four submersible water pumps expedites the irrigation process, entailing an investment of approximately Rs700,000. From an economic perspective, the cultivation of onions on this land yields a profit of Rs 46,784 per acre, while spinach and potatoes generate profits of 40867 and 66,331 per acre respectively. These figures not only highlight the financial viability of the project but also the potential for scalable growth. The seasonal cycles, with potato harvesting from January to March, and onion and spinach cultivation from April to June and October to December, align with the agronomic calendar, ensuring a continuous production flow. The approximately profit for the 10-acer land of theses entire crops production would be 1.537 million to 1.62
million Rupees, whereas the entire project cost with the panel installation, tank construction and land cost is around 2.7 million. The Breakeven occurs at the duration of approx. 1.76 years, the real profit generation would begin after the Breakeven duration.

CONCLUSION

In summary, the use of solar-powered power systems in Pakistan’s agriculture industry offers a revolutionary chance with numerous advantages. For these solar-powered structures to be implemented successfully and continue to operate sustainably, project management is essential. Agronomists can reduce their reliance on vestige fuels and operating expenses by using solar energy to offset the problems begun by wobbly electrical grids. In addition, solar-powered irrigation systems improve water efficiency, which is important in resolving Pakistan’s problems with water scarcity. The implementation of efficient project management performances guarantees that solar solutions are tailored to the specific requirements of Pakistan’s agricultural terrain, hence optimizing resource provision and make the most of impact. Solar know-how implementation also encourages ecological sustainability, which is consistent with international efforts to mitigate climate change. Project management indorses cooperation amongst investors, including local communities, government officialdoms, and private investors. This helps solar-enabled power systems become widely adopted, empowering farmers and increasing agricultural output. In the end, project management facilitates the achievement of a resilient, energy-independent, and ecologically conscious agricultural sector in Pakistan through strategic planning, effective execution, and ongoing monitoring.

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Consent to Participate: Yes
Consent for publication and Ethical approval: Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent.

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