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HARVESTING EQUALITY: UNVEILING THE POTENTIAL OF GENDER-RESPONSIVE BUDGETING IN AGRICULTURE

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In the world of policymaking, the call for inclusivity and equality has grown louder than ever. Budgets affect women and men differently because policies, programmes, and funding for them have varied and unequal effects on them. These effects consider the various groupings of women and men (aged, young, urban, rural, etc.). One avenue that holds tremendous promise in addressing these concerns is Gender-Responsive Budgeting (GRB). While it has gained significant traction across various sectors, its potential impact on agriculture policies is particularly noteworthy. In this critique, we delve into the realm of GRB and its application in shaping more equitable and effective policies in the critical domains of agriculture and climate change.

Common Issues That Women Encounter in Agriculture

Policies and programmes and the way they are funded have different and unequal impacts on women and men— taking into account that women are impacted by several enduring equity issues. Globally, women are more affected by food insecurity and malnutrition, and they also have less access to property rights and other productive resources and services. To achieve the rights to food, land, water, equal pay, and economic opportunities—all of which depend on sufficient national budget allocation, public spending, and monitoring—parliamentarians can play a significant role in promoting gender equality in agriculture.

To evaluate how each intervention meets the distinct needs of men and women as well as their access to resources and services, GRB use a variety of techniques. Reprioritizing resources and conducting an effect evaluation serve as tools for tracking the intervention's implementation.

Gender analysis is relevant and important! It addresses gender-related concerns at all stages of the budget cycle to assess inequalities in society and ensure that women and men benefit equally from government expenditure.

Gender mainstreaming is a mean to achieve gender equality' as GRB analyses how government revenue is raised and spent—who gets the most or least benefit, who has more or less expense burden, and what is the impact on inequality and women's unpaid care work.

Understanding Gender-Responsive Budgeting

Gender-Responsive Budgeting is a strategic tool designed to advance gender equality and promote the empowerment of women through the allocation of resources in public policies. It operates on the premise that budgets are not neutral and can reinforce existing gender disparities. By incorporating a gender lens into budget formulation, implementation, and evaluation, GRB aims to identify and rectify gender-based inequalities in resource distribution.

"GRB" stands for "gender-neutral budget line," which allocates government spending equally between men and women. Rather, it examines the budget from the standpoint of gender to see how it would address and cater to the various requirements of men and women. It may also entail evaluating how gender features connect with other dimensions (such age, class, or religion) to ensure that no one is left behind, particularly the most vulnerable.

FAO (2023) defines 'GRB as a separate budget line for women where, nor dividing government expenditure 50:50 between women and men. Instead, it looks at the budget from a gender perspective to analyze how it will meet and respond to the different needs of women and men, girls and boys. It can also involve an assessment of the intersection of gender aspects with other dimensions (for example age, class or religion), making sure no one is left behind, especially the most vulnerable people.

The Promise of Gender-Responsive Budgeting in Agriculture

Agriculture, as a primary driver of many economies, stands to benefit significantly from the incorporation of gender-responsive approaches. GRB can break down barriers that limit women's access to resources, such as land, credit, and technology, thereby boosting

productivity. When agricultural budgets consider the unique needs of both men and women, it can lead to more effective and sustainable development.

However, the effectiveness of GRB in agriculture policies depends on its integration at every stage of the budgetary process. Mere lip service to gender considerations without tangible budgetary adjustments may fall short of bringing about real change. Furthermore, a comprehensive assessment of the challenges faced by women in agriculture is crucial for crafting targeted interventions.

Gender-Responsive Budgeting Helps Governments To

- Promote and enact global agreements for gender equality and rural development.
- Fulfil international pledges on gender equality and rural development.
- Enhance gender awareness among policymakers to ensure budget and policy considerations address the diverse needs of men and women.
- Establish robust accountability measures for public resource allocation, with a focus on supporting women.
- Optimize public resource utilization, highlighting gender equality's potential for significant gains in agriculture, rural development, and food security.
- Enhance budget transparency for universal understanding and encourage widespread public participation.
- Expose government priorities and policy impact gaps for greater transparency.

GRB Statement Adopted in India

In 2000, India introduced gender-responsive budgeting in the public sector, complemented by the National Policy for the Empowerment of Women. Subsequently, in 2004–2005, the Ministry of Women and Child Development (MWCD) embraced the mission of "Budgeting for Gender Equity." This initiative led to the formulation of a Strategic Framework, emphasizing key aspects of gender equality are:

- Establishing specialized Gender Budget Cells within various ministries and departments.
- Conducting orientation sessions for both government and non-government stakeholders to familiarize them with the principles and tools of Gender Responsive Budgeting (GRB).

- Compiling databases that are sex-disaggregated and gender-sensitive to facilitate comprehensive gender analysis.
- Formulating a gender budget charter outlining principles and guidelines for gender-inclusive budgeting practices.
- Issuing annual reports through the Gender Budget Statement, detailing the progress and impact of gender-responsive budgeting efforts.
- Creating central coordinating centers for GRB at both national and subnational levels to serve as focal points for effective implementation and coordination.

Consequently, the gender budgeting statement saw a significant expansion, encompassing over 33 demands for grants. There was also a notable increase in the presence of gender-responsive budgeting cells across various ministry departments. The gender statement further categorized gender-sensitive allocations into distinct programs aimed at benefiting women, emphasizing a clear distinction between public expenditure and allocations specifically designed to support women-centric initiatives.

The Four Stages of the budget cycle

1. Gender Analysis and Planning

- This stage involves conducting a thorough gender analysis to identify how budgetary decisions impact different genders.
- It includes setting gender-sensitive objectives and priorities to address gender inequalities.

2. Budget Formulation with Gender Mainstreaming

- Integrating gender considerations into the formulation of budget proposals and allocations.
- Ensuring that budget priorities reflect the needs and priorities identified during the gender analysis stage.

3. Gender-Responsive Budget Implementation

- Putting the budget into action, with a focus on implementing programs and policies that promote gender equality.
- Allocating resources to gender-responsive initiatives and tracking expenditures to ensure they align with gender-specific goals.

4. Monitoring and Evaluation with a Gender Lens

- Regularly assessing the impact of budgetary decisions on gender equality.
- Conducting gender-sensitive audits and evaluations to measure the effectiveness of gender-responsive budgeting measures.

Critique and Challenges

While the concept of GRB holds immense promise, there are notable challenges in its implementation. Critics argue that translating gender-responsive intentions into concrete budgetary allocations is easier said than done. Skepticism also surrounds the actual impact of GRB, with some asserting that it may be more symbolic than substantive, failing to bring about tangible changes on the ground.

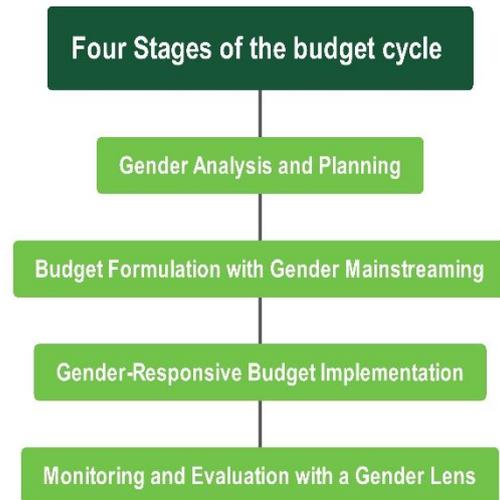
Moreover, GRB's success depends heavily on accurate and comprehensive gender-disaggregated data. Many countries still lack the necessary data infrastructure, hindering the effective implementation of GRB in policymaking. To overcome this, investments in data collection and analysis must be prioritized.

Conclusion

In conclusion, the adoption of Gender-Responsive Budgeting in agriculture and climate policies represents a step in the right direction towards a more equitable and sustainable future. However, it is crucial to acknowledge and address the challenges in its implementation. A commitment to genuine gender equality requires not just rhetoric but tangible actions backed by resources. As we navigate the complex terrain of policymaking, integrating GRB into the heart of our strategies can pave the way for a more inclusive and resilient world.

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UNDERSTANDING THE BIOLOGICAL FRONTIER: THE LEAF EXPERIMENT ON ARTEMIS III

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The Artemis III mission represents a civilizational threshold, transitioning humanity from lunar visitors to potential architects of a permanent extraterrestrial presence. Central to this goal is the Lunar Effects on Agricultural Flora (LEAF) experiment, a pioneering systems biology payload designed to investigate how the unique stresses of the Moon's surface (specifically partial gravity and high radiation) affect the growth and nutrition of potential space crops.

The Pedological Frontier: From Regolith to Rhizosphere

Traditional agriculture is a 10,000-year-old dialogue between Earth's biology and its geosphere. On the Moon, this dialogue must be rebuilt from scratch. The lunar surface presents a "regolith" that is chemically and physically hostile to life: it lacks organic matter, contains toxic perchlorates, and consists of jagged, electrostatic glass shards.

The Galactic Gardens concept seeks to transform this barren parent material into a functional soil. The LEAF mission is the first step in this process, utilizing a self-contained "Beta" payload to shield model crops from the vacuum of space while exposing them to the Moon's unique gravitational and radiological environment.

Scientific Objectives and the Redox Hypothesis

The primary mission of LEAF is to perform the first comprehensive, organism-wide assessment of plant physiology in the lunar environment. This involves answering critical questions about how biophysical stressors beyond Low Earth Orbit (LEO) impact photosynthetic productivity, nutrient density, and molecular signaling.

The experiment is built around the Redox State Hypothesis. In the harsh lunar environment, space stressors such as Galactic Cosmic Rays (GCR) and partial gravity create an Oxidant-Antioxidant Imbalance within plant cells.

- **Radiolysis:** High-energy radiation can split water molecules within cells, producing Reactive Oxygen Species (ROS).
- **Systemic Response:** This imbalance triggers shifts in hormone levels and gene expression.
- **Resulting Strains:** If defense mechanisms (like antioxidant upregulation) are insufficient, plants may suffer from slowed growth, macronutrient breakdown, and even cell death.

The mission also targets on several other critical scientific objectives:

- **Biophysical Stress Characterization:** Monitoring how partial gravity (1/6g) and elevated deep-space radiation affect germination, photosynthetic efficiency, and nutritional quality.
- **Genome-Wide Biomolecular Mapping:** Returning seedling samples to Earth to apply advanced systems biology tools, identifying deviations in gene expression and metabolic pathways triggered by lunar stressors.

Advanced Instrumentation: The LEAF Payload

The LEAF payload is a self-contained "mini-greenhouse" designed to shield its occupants from the vacuum of space while precisely monitoring their condition. It utilizes three core systems:

- **Lunar Environment Monitoring (LEM):** A suite of sensors that continuously measures lunar gravity, radiation levels, and acceleration.
- **Plant Habitat Support (PHS):** This system provides a "cabin-like" atmosphere, controlling temperature, humidity, and CO² levels while facilitating gas exchange for photosynthesis.

- **Plant Health Imaging (PHI):** A high-resolution camera system that tracks seed germination, clonal reproduction, and morphology, allowing scientists on Earth to watch the plants develop in real-time.

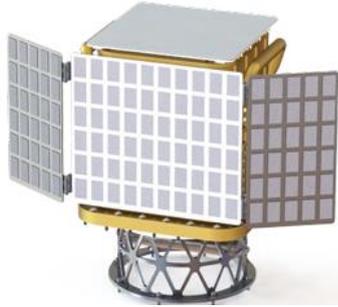


Fig. 1: LEAF beta payload concept



Fig. 2: (a) B.rapa (b) Wolfia (c) Growth chamber

The Pioneer Species

Three distinct plant types have been selected for their nutritional density and well-understood genetic profiles:

- **Brassica rapa (Wisconsin Fast Plants):** Chosen for their rapid 14-day lifecycle, these plants allow scientists to observe a complete developmental transition within a single lunar mission. LEAF will compare red and green varieties to see if high-antioxidant (anthocyanin) levels provide better radiation resilience.
- **Wolffia (Duckweed):** A "superfood" candidate that contains up to 50% high-quality protein and is exceptionally resistant to radiation.
- **Arabidopsis thaliana:** A fundamental model organism in plant biology, used as a genetic baseline to map specific DNA deviations caused by the lunar environment.

Artemis III vs. Chang'e 4: A New Benchmark

LEAF builds on the lessons of the 2019 Chinese Chang'e 4 mission, which successfully germinated a cotton seed on the far side of the Moon. However, the Chang'e 4 experiment suffered a thermal control failure after only nine days, ending the study prematurely.

In contrast, LEAF is designed for a more robust and longer-term assessment. Crucially, Artemis III astronauts will collect seedling samples and return them to Earth. This allows

researchers to perform advanced "omics" to identify the exact genomic "scars" left by space travel.

By identifying the specific genes that allow plants to survive and even thrive on the Moon, LEAF is not just growing food; it is engineering the biological foundation for human life on Mars and beyond.

Conclusion

As we look toward the 2030s, the "Galactic Garden" will evolve from a miniature payload into a Bioregenerative Life Support System (BLSS). These systems will not only provide nutrition but will actively purify the air, remove CO², and recycle water, creating a closed-loop economy that makes permanent lunar habitation and eventually the journey to Mars-a biological reality.

The LEAF mission proves that the Earth is no longer a limit, but a starting point. By understanding how the "soul of the soil" survives in the silence of the Moon, we are ensuring that wherever humanity travels, we carry the green spark of life with us.

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THE WINNING TRIO: MISSION, VISION, AND GOALS FOR ORGANIZATION'S

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In the contemporary global business environment, organizations grapple with unprecedented challenges and opportunities, necessitating a clear sense of purpose encapsulated in their mission, vision, and goals. These elements act as guiding principles, steering decision-making and strategic planning while fostering a shared sense of purpose among employees. The mission statement serves as the foundation, articulating why the organization exists and its fundamental aspirations, creating a touchstone for stakeholders. Complementary to this, the vision statement propels the organization into the future, inspiring stakeholders with an aspirational image and fostering a collective commitment among employees. Operationalizing these principles requires the establishment of clear and measurable goals, serving as building blocks for success and guiding strategic initiatives. The synergy between mission, vision, and goals forms the strategic backbone of organizational success, propelling innovation, adaptation, and sustained growth, positioning the company to thrive in an ever-evolving business landscape.

In the dynamic landscape of today's global business environment, organizations face unprecedented challenges and opportunities. To navigate this intricate terrain successfully, businesses must possess a clear sense of purpose and direction, encapsulated in their mission, vision, and goals. These fundamental elements serve as the compass guiding the organization towards success, providing a framework for decision-making, strategic planning, and fostering a sense of shared purpose among employees.

The mission statement serves as the bedrock upon which an organization builds its identity and defines its raison d'être. It articulates the fundamental purpose of the organization, answering the crucial question of why the organization exists and what it aspires to achieve. A well-crafted mission statement not only communicates the company's core values and principles but also establishes a roadmap for the actions and behaviours that align with its purpose. This declaration becomes the touchstone for employees, stakeholders, and customers alike, creating a sense of unity and direction. Complementing the mission, the vision statement propels the organization into the future by articulating a compelling and aspirational picture of what the organization aims to become. It acts as a beacon, inspiring and motivating stakeholders to strive for greatness. A visionary statement goes beyond short-term objectives, encapsulating the organization's long-term aspirations, values, and desired impact on the world. It serves as a source of inspiration for employees, fostering a collective commitment to a shared vision and creating a sense of belonging to something greater than individual tasks and roles. To operationalize the mission and vision, organizations must establish clear and measurable goals. Goals provide the specific targets and milestones that, when achieved, contribute to the fulfilment of the broader mission and realization of the vision. These goals are the building blocks of success, guiding strategic initiatives, resource allocation, and performance evaluations. Well-defined goals create a roadmap for progress, enabling organizations to track their journey and make informed decisions to stay on course.

In essence, the synergy between mission, vision, and goals forms the strategic backbone of organizational success. They not only define the organization's purpose but also provide the impetus for innovation, adaptation, and sustained growth. This intricate interplay fosters a resilient and forward-thinking organizational culture, positioning the company to thrive in an ever-evolving business landscape. As we delve deeper into the significance of each element, we will explore how organizations can craft impactful mission and vision statements, set meaningful goals, and leverage these foundational pillars to achieve enduring success.

Why Having Clarity in Mission, Vision and Goal is Important?

Mission and vision statements play a crucial role in organizational success by providing direction as a compass, guiding individuals and entities toward their intended destination. A vision statement sets the desired future state, serving as a long-term aspiration, while goals break down this vision into specific, measurable, achievable, relevant, and time-bound objectives.

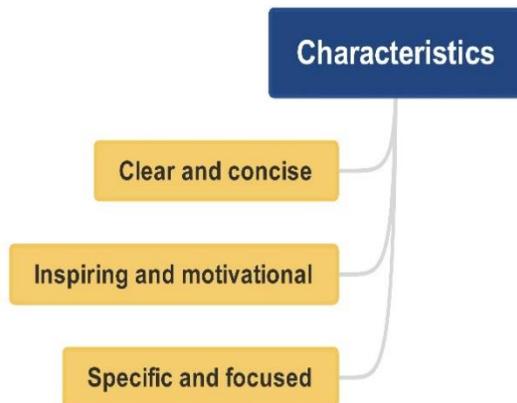


Beyond navigation, a clear mission and vision inspire and motivate individuals or teams, fostering a shared sense of purpose. They also facilitate alignment and collaboration by establishing common objectives, reducing conflicts, and promoting teamwork. Furthermore, a well-defined mission and vision attract support and resources from stakeholders such as customers, employees, investors, and partners, creating a foundation for sustained success and growth. These elements collectively contribute to organizational cohesion, effectiveness, and the ability to thrive in a dynamic environment.

Mission

- Mission is the core purpose of an organization or a company. It is a summary of the aims and core values.
- A mission statement is a concise and clear declaration of an organization's purpose.
- It defines the organization's reason for existing and its primary objectives.
- The mission statement provides direction and helps guide decision-making processes.
- A mission should fit your identity. If it doesn't it is very hard to executive your mission.

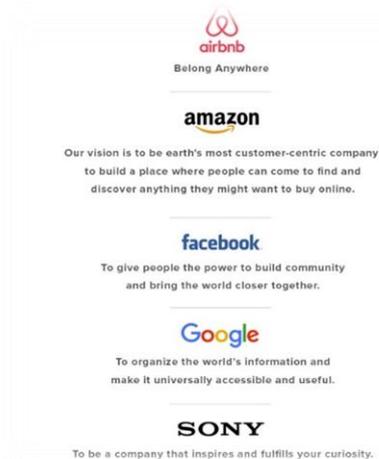
Characteristics of Effective Mission Statements



- **Clear and concise:** Communicate the organization's purpose in a few sentences.
- **Inspiring and motivational:** Engage stakeholders and inspire commitment.
- **Specific and focused:** Clearly define the organization's scope and target audience.

Examples of Mission Statements

- **Google:** "To organize the world's information and make it universally accessible and useful."
- **Nike:** "To bring inspiration and innovation to every athlete in the world."
- **UNICEF:** "To ensure every child's right to survive and thrive."



Source: <https://www.linkedin.com/pulse/power-brand-mission-beyond-profit-purpose-ahmad-mushtaq/>

Vision

- A vision statement describes the desired future state of an organization.
- It provides a clear picture of what the organization strives to achieve.
- A compelling vision statement inspires and aligns stakeholders towards a common goal.

Characteristics of Effective Vision Statements

- **Inspirational and aspirational:** Motivate and challenge stakeholders.
- **Future-oriented:** Describe what the organization aims to become in the long term.
- **Realistic and achievable:** Balanced with the organization's capabilities.

Examples of Vision Statements

- **Microsoft:** "Empower every person and every organization on the planet to achieve more."
- **SpaceX:** "To enable human exploration and colonization of Mars."

- **Amazon:** "To be Earth's most customer-centric company, where customers can find and discover anything they might want to buy online."



Source: <https://www.ebaqdesign.com/blog/vision-statements/>

Goals

- Goals serve as a roadmap to help organizations achieve their mission and vision.
- Goals should be specific, measurable, achievable, relevant, and time-bound (SMART) objectives.
- Goals provide clarity and focus for strategic planning and decision-making.

Types of Goals

- **Strategic Goals:** Long-term objectives that guide overall organizational direction.
- **Tactical Goals:** Medium-term objectives that support strategic goals and facilitate implementation.
- **Operational Goals:** Short-term objectives that focus on day-to-day activities and processes.

Characteristics of Effective Goals



Examples of Goals for organization

- Increase market share by 10% within the next fiscal year.
- Reduce customer complaints by 20% through improved customer service training.
- Launch a new product line within six months to target a new market segment.

Importance of Mission, Vision, and Goals

- **Guides decision-making:** Provides a framework for setting priorities and making strategic choices.
- **Inspires stakeholders:** Engages and motivates employees, customers, and investors.
- **Measures success:** Allows organizations to track progress and evaluate performance.

Conclusion

- Mission, vision, and goals are vital components of organizational success.
- They provide direction, inspire stakeholders, and guide decision-making.
- Aligning and implementing them effectively ensures clarity and focus.

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BREAKING BARRIERS: EMPOWERING WOMEN IN THE LANGUAGE OF TECH AND ARTIFICIAL INTELLIGENCE

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The development of technology and skill in digital abilities has become essential for both socioeconomic advancement and personal empowerment in an increasingly interconnected world. However, disparities in opportunity and access continue to be caused by a persistent and unsettling issue known as the "digital divide." When it comes to utilizing technology's transformative potential, women in particular face unique challenges.

The gap between those who have access to and are proficient in using digital technologies and those who do not is known as the "digital divide." This gap includes not only the accessibility of infrastructure and hardware but also the knowledge and abilities needed to successfully navigate the digital world. Although this problem affects people worldwide, women are disproportionately affected, which hinders their potential and progress in a variety of areas.

In the digital age, empowering women goes beyond simply giving them access to computers, smartphones, and the internet. It requires creating an atmosphere that encourages their active participation in developing the digital landscape. This empowerment can take many forms, including encouraging women to pursue careers in technology, pushing for more women to be involved in AI development and decision-making, and making sure digital platforms are inclusive and sensitive to the needs of various audiences.

Language plays a crucial role in building digital inclusion. The predominance of particular languages on the internet can create linguistic barriers that prevent women from fully participating in the online space. Language has a significant impact on how we interact with search engines, AI-powered virtual assistants, and technology. Ensuring that digital services and content are available in a variety of languages can significantly increase access and engagement for women with different linguistic origins.

Additionally, AI has emerged as a powerful catalyst for numerous technical advancements, with its incorporation into many aspects of daily life becoming increasingly widespread. However, AI is still vulnerable to cultural prejudices, which could reinforce gender inequality and stereotypes.

Developing ethically designed AI systems that embrace diversity and exhibit understanding of gender-specific requirements and concerns is essential to empowering women through AI. Furthermore, it is crucial to foster a diverse workforce in AI research and development to guarantee the development of AI solutions from a more thorough and all-encompassing perspective.

In addition to being a matter of social justice, reducing the digital divide and empowering women via technology, language, and AI is a wise investment in humankind's future.

The facts that women account for half of the world's population, their contributions to technology and innovation have the potential to significantly and positively alter the world. We can unleash latent potential, creativity, and ingenuity that can drive economic growth, foster global cooperation, and solve pressing issues by closing the digital divide.

In this era of unparalleled technological advancements, there is a unique opportunity to rethink about traditional gender roles and empower women to become active participants and leaders in the digital world. Thus, research aims to explore the multifaceted strategies to bridge the digital divide and shed light on the transformational potential of empowering women through technology, language, and AI. By examining successful initiatives, sharing best practices, and envisioning future possibilities, we can pave the way for a more inclusive, equitable, and prosperous digital future for all.

The Gender Gap in Technology and AI

Globally, less than 30% of technology workers are women, and less than 20% are involved in AI research and development (World Economic Forum, 2023). Deeply ingrained cultural preconceptions, restricted access to STEM education, and discrimination in the workplace are the main causes of this gender gap.

Women often face a "double bind" since they are expected to do exceedingly well while also dealing with prejudices that cast doubt on their technical proficiency (UNESCO, 2021).

Increasing the number of women working in AI could increase global GDP by around \$12 trillion by 2025, according to a McKinsey estimate from 2022. However, structural obstacles still keep women from fully participating in these quickly developing fields.

Challenges Faced by Women in the Digital World

- 1. Limited technology accessibility:** In many areas, women have less access than men to digital devices like computers, laptops, and smartphones. Their ability to participate in online activities and take use of the benefits of the digital world is limited by this lack of ownership.
- 2. Connectivity disparities:** Women often face difficulties in obtaining reliable internet connectivity, even when they have access to devices. In rural or economically challenged locations, where infrastructure development lags behind urban areas, this is especially noticeable.
- 3. Gender-based digital literacy gaps:** There are still gender differences in digital literacy worldwide. Women are more likely to have challenges in learning the necessary skills to use digital technology efficiently. This hinders their ability to use digital tools, traverse online platforms, and engage in the digital economy.
- 4. Gender biases and stereotypes:** Women may be discouraged from pursuing jobs in technology and have limited access to STEM (Science, Technology, Engineering, and Mathematics) education due to cultural norms and gender biases. These prejudices uphold social norms, which restrict women's participation in technology-related fields and widen the digital divide.

The Power of Language and AI

As a fundamental component of human communication, language plays a crucial role in influencing technology and user experiences. Furthermore, the development of language-oriented solutions that might empower women and lessen the digital gap is made possible by unprecedented opportunities presented by AI developments. Let's examine how affirmative transformations can be fueled by language and AI:

- 1. Multilingual Interfaces:** English-speaking consumers are the target audience for many digital platforms and technology. Women from a variety of linguistic backgrounds can

effectively engage with digital tools and services by expanding language support, integrating indigenous languages, and offering user-friendly interfaces.

2. **Educational Resources and Content:** AI-powered language tools can help create instructional materials tailored to women's needs and learning styles. Online courses, interactive platforms, and language learning apps can improve digital literacy and provide women the tools they need to succeed in the digital age.
3. **Voice Recognition and Virtual Assistants:** By allowing hands-free engagement with digital gadgets, voice-activated technology and virtual assistants have the potential to empower women. These tools can help close the digital literacy gap and make opportunities, services, and information more accessible.
4. **AI-powered skill development:** AI systems may identify individual knowledge gaps, provide tailored recommendations, and efficiently support personalized skill growth. Women can improve their digital skills and increase their employability in technology-related fields by utilizing AI in educational and career training programs.
5. **Enabling entrepreneurship through AI:** Language barriers in online markets can be overcome by AI-driven language technology, giving women entrepreneurs access to a larger customer base. Additionally, AI-powered analytics can provide priceless insights into market dynamics and consumer behavior, empowering women to make wise business decisions.

Closing the Divide: Collaborative Efforts

A multidimensional and cooperative strategy including a range of stakeholders, including governments, educational institutions, non-governmental organizations, and the commercial sector, is required to address the digital gap and empower women through technology. To do this, a number of crucial tactics can be used:

1. **Enhancing Connectivity:** To enable fair access for women, governments and groups should actively work to improve internet infrastructure in underserved areas while advocating for cost-effective connectivity options.
2. **Fostering Digital Literacy:** Initiatives that concentrate on offering women comprehensive digital literacy programs that are customized to meet their unique

requirements are essential. These programs should include both technical skill and increased knowledge of digital security.

3. **Encouraging diversity and inclusion:** Women will have more chances if inclusive settings are established and gender prejudices in the technology industry are addressed. This includes promoting increased women involvement in leadership positions, technology-related careers, and STEM education.
4. **Collaborative Innovation:** Developing cooperative relationships between governments, NGOs, and tech companies can propel innovative developments in AI-powered language solutions, guaranteeing that they successfully tackle the unique needs and difficulties faced by women.

Conclusion

A significant obstacle to attaining gender equality and boosting women's empowerment is the digital divide. We have the ability to close this gap by utilizing language and AI, empowering women and creating a more inclusive digital future. We can guarantee fair opportunities for women to take use of technology's revolutionary potential and thrive in the digital age by addressing issues of access, connectivity, digital literacy, and gender biases. It is collective responsibility to create a world in which women can overcome these challenges and help to create a more successful and fair society for the greater good.

While skill development is important, it is insufficient on its own; institutional cultures must be changed, inclusive technologies must be created, and supportive public policies must be put in place for sustained growth. Increased economic and social fairness for women and better, more responsible technical innovation for society as a whole are two advantages of full inclusion.

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UNEARTHING THE SHADOWS: A COMPREHENSIVE SEQUENCE FOR MONITORING AND EVALUATING CHILD LABOUR IN AGRICULTURE

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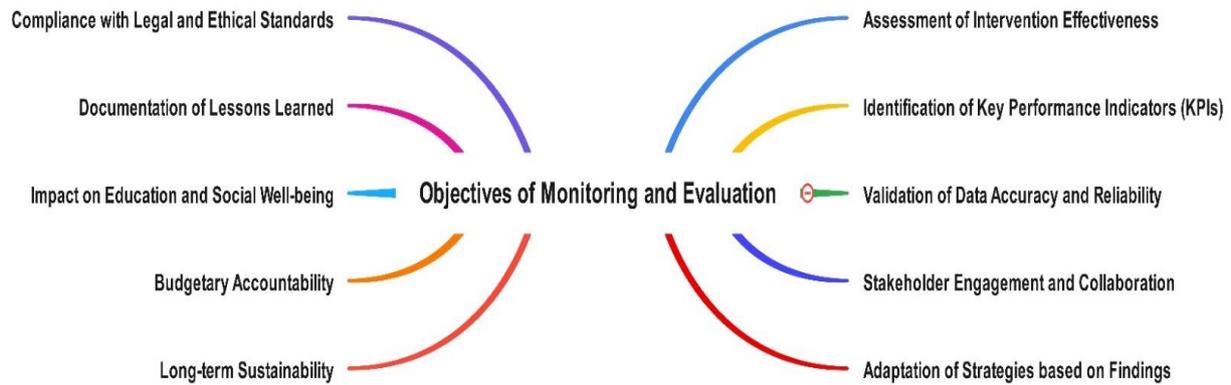
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The article addresses the persistent issue of child labour in agriculture, offering a comprehensive framework for monitoring, evaluating interventions, and providing policy recommendations. The prevalence of child labour, as highlighted by the International Labour Organization, underscores the urgency of effective strategies. The proposed monitoring framework integrates diverse data collection methods, emphasizing community engagement and ethical considerations. Evaluation methods include impact assessments and stakeholder interviews for a nuanced analysis. Policy recommendations advocate legislative enhancements, educational investments, and collaborations with the private sector. Recognizing the complexity, ongoing evaluations and collaborative efforts are crucial for sustained success. The aim is to create a world where every child is free from exploitative labour.

Child labour in agriculture remains a persistent global challenge, a stark violation of children's rights and a complex issue intertwined with socio-economic, cultural, and legislative factors. The International Labour Organization (ILO) estimates that over 108 million children are engaged in agricultural activities, exposing them to hazardous conditions and jeopardizing their well-being. As we grapple with the multifaceted nature of child labour in agriculture, it becomes imperative to develop a structured framework for monitoring and evaluating interventions. This article explores the intricate dimensions of this issue and proposes a comprehensive approach that integrates key components of monitoring and evaluation to foster a more nuanced understanding and effective eradication of child labour in the agricultural.

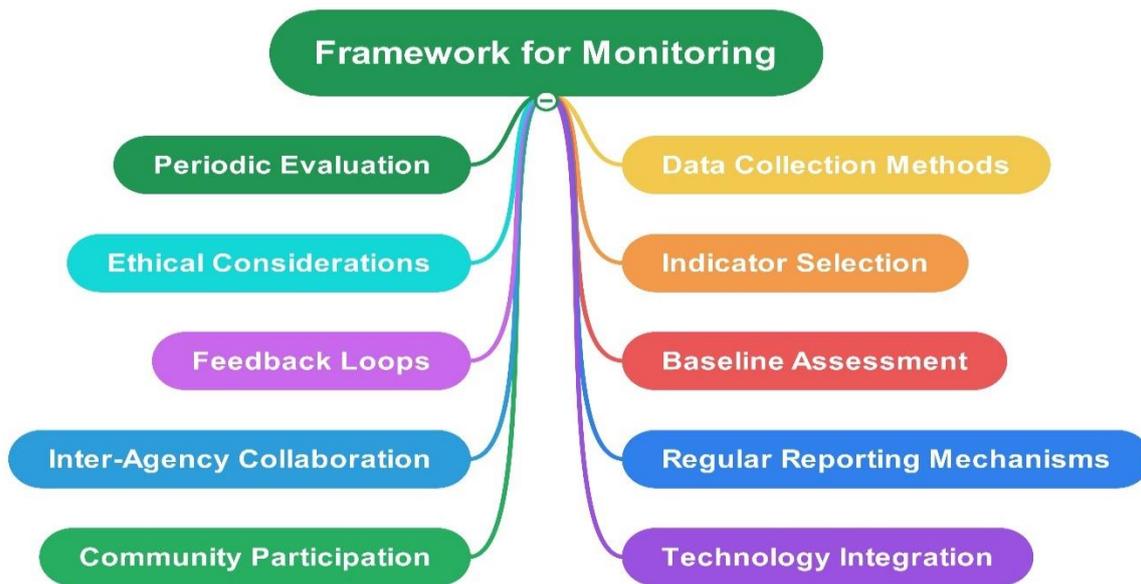
Objectives of Monitoring and Evaluation



Monitoring and evaluation (M&E) in the context of combating child labour in agriculture serves as a critical tool for ensuring the effectiveness and impact of interventions. The primary goal is to assess the outcomes and benefits of ongoing initiatives in addressing the root causes of child labour and providing tangible improvements to the lives of affected children. This involves the establishment of specific, measurable, and time-bound key performance indicators (KPIs) that serve as benchmarks for progress, covering short-term, medium-term, and long-term objectives. Additionally, the validation of data accuracy and reliability is paramount, employing rigorous methods such as triangulation to ensure that collected information forms a trustworthy basis for decision-making.

Another key set of objectives involves the adaptability and accountability of interventions. M&E activities aim to assess stakeholder engagement and collaboration, evaluating the level of cooperation among government agencies, NGOs, communities, and the private sector. By leveraging monitoring and evaluation findings, the objective is to adapt and refine intervention strategies, identifying successful approaches and modifying ineffective methods for continuous improvement. Furthermore, ensuring compliance with legal and ethical standards is crucial, emphasizing human rights and sustainable practices in eradicating child labour. Additionally, documenting lessons learned from both successful and unsuccessful interventions contributes to a collective knowledge base, enabling informed decision-making and preventing the repetition of ineffective strategies. These objectives collectively form a comprehensive framework for evaluating, enhancing, and sustaining efforts to combat child labour in agriculture.

Framework for Monitoring



The monitoring framework for combating child labour in agriculture employs a comprehensive strategy. It utilizes a mix of quantitative and qualitative data collection methods, including surveys, interviews, focus group discussions, and direct observations, to capture the multifaceted aspects of child labour. Clear and measurable indicators, categorized across short, medium, and long-term outcomes, enable a nuanced understanding of progress. A baseline assessment establishes the current prevalence and nature of child labour, serving as a reference point for evaluating intervention effectiveness. Regular reporting mechanisms, coupled with technology integration such as mobile data collection tools and GIS mapping, ensure efficient and accurate tracking of progress. Active community participation is fostered to align interventions with unique local needs, and inter-agency collaboration enhances coordination among stakeholders.

Feedback loops enable continuous communication, allowing for real-time adjustments based on emerging challenges. Ethical considerations prioritize child rights, confidentiality, and informed consent in data collection. Capacity building initiatives for local partners enhance the effectiveness of monitoring activities, providing training on data collection methods, ethical standards, and technology use. Periodic evaluations are integrated to assess and refine the monitoring framework over time, ensuring ongoing relevance and efficiency in the fight against child labour in agriculture. This holistic approach aims to create a dynamic and adaptive

monitoring system that actively involves communities and stakeholders, utilizing technology and ethical considerations to drive effective intervention strategies.

Framework for Evaluation

The child labor eradication evaluation framework is a comprehensive and interconnected approach designed to measure the impact and effectiveness of interventions. Through Impact Evaluation, utilizing both quantitative and qualitative methods, we gain insights into changes in child labor prevalence and its socio-economic determinants. This is complemented by Case Studies, providing contextualized perspectives on intervention outcomes and influencing factors in diverse agricultural settings.

Stakeholder Interviews further enrich the evaluation by capturing diverse perspectives from government officials, NGOs, community leaders, and affected families. A Process Evaluation scrutinizes the implementation process, identifying strengths, weaknesses, and areas for improvement. Simultaneously, a Cost-Benefit Analysis sheds light on the economic efficiency of interventions, considering both monetary and non-monetary aspects associated with eradicating child labour.

The Educational Impact Assessment focuses on changes in school enrolment, attendance, and educational attainment, linking interventions with improved access to education. The Community Empowerment Assessment evaluates the contribution of interventions to community awareness, participation, and the development of sustainable practices against child labour. This connects seamlessly with a Sustainability Analysis that explores the long-term resilience of interventions and potential community ownership beyond the intervention period.

Ensuring a participatory approach, the framework integrates Feedback from Stakeholders and Affected Communities, allowing their perspectives to shape the evaluation. By comparing findings with Baseline Data, the framework provides a dynamic understanding of change over time, pinpointing areas requiring attention or modification. The Policy Alignment Assessment ensures interventions not only comply with existing child labour policies but also contribute to policy development.

In essence, this interconnected framework encompasses impact assessment, case studies, stakeholder engagement, process evaluation, cost-benefit analysis, educational and community impact assessments, sustainability analysis, feedback integration, baseline data

comparison, and policy alignment assessment. This holistic approach aims to continually refine and enhance the effectiveness of interventions in eradicating child labour in agriculture.

Data Collection and Analysis



A comprehensive approach to data collection is devised, beginning with a meticulously crafted survey covering key aspects of child labour in agriculture, ensuring cultural sensitivity and age-appropriateness. Qualitative insights are garnered through interviews and focus group discussions with affected children, families, and community members, providing a nuanced understanding of the underlying factors contributing to child labour.

Real-time information on working conditions and the prevalence of child labour is obtained through direct observations, while technology integration, including mobile data collection tools, enhances efficiency and facilitates prompt responses to emerging issues. Data triangulation is implemented by cross-verifying information from various sources, combining quantitative and qualitative data for a more reliable and comprehensive understanding.

Geospatial mapping, utilizing GIS, visually analyses the prevalence of child labour, identifying hotspots and potential correlations with socio-economic variables. Structured interviews with key stakeholders provide valuable perspectives on root causes, intervention effectiveness, and areas for improvement. Longitudinal data collection tracks changes over

time, assessing the impact of interventions on reducing child labour and improving overall well-being.

Ethical considerations remain paramount throughout the process, with a focus on informed consent, confidentiality, and anonymity, especially for child participants. Quantitative data is analysed using statistical methods and software tools, examining prevalence rates, demographic trends, and correlations. Qualitative data undergoes coding and thematic analysis to identify recurring themes and narratives, providing insights into social, cultural, and economic factors contributing to child labour.

The analysis is enriched through community validation sessions, fostering a participatory approach that ensures community perspectives are considered, contributing to the accuracy and relevance of the final analysis. This comprehensive strategy ensures a robust understanding of child labour in agriculture and facilitates informed decision-making for effective interventions.

Policy Recommendations

In order to comprehensively address and eradicate child labour in agriculture, a robust set of policy recommendations is proposed. Firstly, there is a crucial need to strengthen legislative frameworks both at the national and international levels. This involves enhancing existing legal structures by imposing stricter penalties on violators and ensuring the enforcement mechanisms are effective, with specific attention given to hazardous agricultural work. Secondly, adopting integrated approaches is essential, combining economic development, education, and social welfare initiatives to address the root causes of child labour. Allocating resources for the improvement of education in agricultural communities, including building schools, providing scholarships, and implementing awareness campaigns, is a pivotal step to break the cycle of poverty leading to child labour. Thirdly, targeted social protection programs for vulnerable families engaged in agriculture, encompassing conditional cash transfers, food assistance, and healthcare benefits, can alleviate economic pressures that force children into labour. Strengthening labour inspections and monitoring specifically focused on agricultural practices is crucial, requiring an increase in both frequency and intensity to ensure compliance with child labour laws and the identification and rectification of hazardous working conditions. Additionally, investing in capacity building for law enforcement agencies, the judiciary, and relevant government bodies is essential, involving training on identifying and addressing child labour issues and raising awareness about the importance of eradicating child

labour. Collaborating with the private sector, implementing community-based empowerment programs, promoting data sharing, launching public awareness campaigns, providing incentives for responsible businesses, and supporting research and monitoring initiatives are integral components of a comprehensive strategy to combat child labour in agriculture. These policy recommendations collectively strive to create a conducive environment for sustainable change and the elimination of child labour.

Conclusion

In summary, eradicating child labour in agriculture requires a holistic approach encompassing monitoring, evaluation, and policy interventions. The proposed frameworks emphasize community engagement, ethical considerations, and technological integration for effective data collection. Evaluation methods like impact assessments and stakeholder interviews provide a nuanced understanding of intervention effectiveness. Policy recommendations advocate for legislative enhancements, educational investments, and collaborations with the private sector. Recognizing the complexity of the issue, ongoing evaluations and collaborative efforts are crucial for sustained success. By adopting these comprehensive strategies, we aim to create a world where every child is free from the burdens of exploitative labour in agriculture.

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ACHIEVING HIGHER YIELD IN POTATO FARMING THROUGH TPS AND ARC METHOD

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One significant crop that can significantly improve food security is the potato. Potatoes can also improve nutritional security by addressing the issue of "hidden hunger" (the micronutrient shortage) due to their high nutritional value and capacity to create a significant amount of dry matter (Lal et al., 2023). After wheat, rice, and maize, potatoes (*Solanum tuberosum L.*) are the fourth-largest crop in the world. They are members of the Solanaceae family. One of the most significant food crops in the world, potatoes are prized for their great nutritional value and productivity. Innovative methods like True Potato Seed (TPS) and the ARC (Apical Rooted Cutting) approach are revolutionising production systems by increasing output, lowering seed prices, and limiting disease transmission. Traditionally, potatoes are grown from seed tubers. In the latter part of the 1970s, the International Potato Center (abbreviated CIP, for Centro Internacional de la Papa) introduced true potato seed (TPS) as a substitute for growing potatoes from seed tubers. "True Potato Seed" (TPS), also known as sexual or botanical potato seed, is a radical substitute for seed tubers in the production of commercial potato crops. TPS has a number of benefits, including low planting material costs, less pathogen/pest transmission, ease of use, minimal storage and transportation costs, etc. In fact, TPS is devoid of almost all illnesses, including systemically transmitted viruses, with a few significant exceptions (such as potato spindle tuber viroid). A significant quantity of priceless potato stocks that are utilised as seed can be preserved for human consumption by employing TPS. The apical (top) shoot of disease-free mother plants is taken and rooted in a controlled nursery setting prior to being transplanted into the field using the Apical Rooted Cutting (ARC) technique.

Production of hybrid TPS

Planting of hybridization block: At 50 x 25 cm, entire tubers of desired parents or cut seed pieces (23–30g) are sown. Separate blocks of male and female lines should be planted under artificially extended photoperiods using high-density sodium vapour lamps with a power output of 100/250 W per 100 square meters. Five to six hours after sunset, from germination to berry setting, additional light is provided. Two to three batches of male lines should be planted two weeks earlier to provide a steady supply of pollen.

Hybridization: The female flower bunches are cut so that each cluster contains six to eight large buds. The right-stage blooms of the male parents are gathered in the morning, and the anthers are removed and stored overnight. If they are not needed immediately, they are stored in a refrigerator at 6–10°C. The next morning, extract the pollen by shaking the anthers in a nylon tea sieve. But it works better to utilise fresh pollen every day. Each receptive stigma should be pollinated twice by dipping it in pollen every eight hours.

Harvesting of berries and seed extraction: After 6–7 weeks of pollination, harvest the berries and let them ripen at room temperature until they are tender. Turn the berries into pulp by macerating them by hand or with a reverse screw juice extractor. To separate the seeds from the trash, treat the pulp with 10% HCl and stir for 20 minutes. To get rid of the acid, wash the seeds three or four times with water. To disinfect the seeds' surfaces, soak them in 0.05% sodium hypochlorite for ten minutes. To bring the moisture level down to 5–6%, dry the cleaned seeds in the shade and then expose them to the sun. Place the seeds in twin polythene bags and keep them in a refrigerator at or below 20 °C over calcium chloride as a desiccant.

Advantages of TPS

- TPS requirement for planting one hectare land cost 20 times less than the seed tubers.
- During pollination and fertilisation, a number of bacteria, fungi, viruses, and nematodes that infect seed tubers are filtered out. As a result, TPS eliminates illness and reduces the need for seed health checks.
- The TPS crop's segregating population has a multiline impact that improves protection against disease outbreaks.
- TPS can be stored at room temperature under dry conditions without the loss of viability for many years.
- Unlike seed tubers which are bulky, there is no transportation problem with TPS.

- A significant quantity of valuable potato stocks that are utilised as seed can be used as table potatoes by employing TPS. The nation will use six million tonnes of seed tubers by 2020, up from the current 3.1 million tonnes.
- Tuber seed production for present area under potato requires 40,000 ha land whereas for the production of TPS for the same area only 2000 ha land is required.
- Disease free potato tuber seed can be produced only in northern plains and north-western hills, whereas, TPS can be produced in most parts of the country.
- In tuber seed propagation varieties are likely to undergo pathological and physiological degeneration but in hybrid TPS the hybrid vigour is ensured.

Constraints in Adopting TPS Technology

Crops grown via TPS require more work, ongoing care, and are more vulnerable to weather-related disasters like drought, strong rainfall, and extreme heat than crops grown from seed tubers. Compared to the traditional potato crop grown from seed tubers, the TPS crop takes an additional 20 to 25 days to reach maturity. Adoption of this technology is also hampered by the limited selection of hybrid TPS populations. Since TPS is a segregating offspring, its yield is less consistent than that of the traditional potato crop, which lowers its market value.

Production Procedure Involved in ARC

Cocopeat: perlite in a 2:1 ratio, aeroponics or fogponics, cocopeat mixture, coconut coir, and rockwool cubes are the rooting media required for the production of ARCs. IBA, NAA, and GA3 are the necessary hormones, and a balanced ratio of NPK, zinc, and boron is necessary for improved shoot growth and root development. ARC is a low-cost potato production innovation in which tissue-cultured microplants are sown in the nursery to create a mother bed. The mother plants regularly harvest the apical cutting with two leaves (2–3 cm) every 12–15 days to either replant in the mother bed for re-cutting or to plant in pot trays that include a **vermiculite:** perlite combination (1:1) and coco peat-perlite blend to promote roots. In forty-five days, one microplant yields eight rooted cuttings. For the development of first generation seeds, root cuttings that are 15 to 20 days old are planted in open fields or preparatory net buildings. Under controlled conditions, the mother plant's juvenile state may last longer and result in ARCs (Kumari, 2024 and NAAS, 2021).

Principle of Apical Rooted Cutting Technology

A rooted transplant made from tissue culture plants known as mother plants is called an apical rooted cutting (ARC). The technique's underlying idea is that the mother plant, which has simple, rounded juvenile leaves, can produce apical cuttings that have the potential to grow roots. As long as the mother plant is still in its juvenile stage and has not reached physiological maturity, which is indicated by the growth of compound leaves, vascularization, and tuberization, it can be used to produce ARC (VanderZaag *et al.*, 2021). Under controlled circumstances, the mother plant's juvenility can be preserved for an extended period of time, and it can continue to generate ARCs for many generations. In the field or greenhouse, the ARCs can be transplanted to create tiny tubers that are virus- and disease-free and comparable to nucleus seed (G0). As planting material for potato cultivation or seed production, the ARCs can be given to farmers or sold to seed businesses for the generation of seeds tuber.

Benefits of ARC

Compared to conventional method, ARCs' in potato has several benefits:

- With ARCs, higher multiplication rates—20–50 times per production cycle—are achieved.
- Because there is no dormancy, planting can be done between two and four weeks after rooted.
- As the plantlets are made from meristem-culture so they are free from any disease.
- Lesser requirement of labour with uniform spacing.
- This technique's affordability also makes it possible to incorporate new types from throughout the globe into the manufacturing chain.
- Mechanisation is used in ridge development to ensure healthy tuber growth and adequate soil aeration.
- By combining traditional and cutting-edge technology in ARCs, growers can produce seeds quickly, cutting down on the time needed to produce new plantlets.
- Greater adaptability because it can be more readily transferred from a lab to a greenhouse or field without causing any stress, which helps farmers produce potatoes without any issues.

- Because it produces high-quality seed at a low cost with rapid rates of multiplication and allows farmers to use both seed and ware potatoes, it can be a lucrative enterprise for small farms.
- Helpful for areas where seed production is negligible. (Buckseth *et al.*, 2022, Wauters *et al.*, 2022, Sadawarti *et al.*, 2024, Chakraborty, 2026).

Constraints

- Mortality rate is high in planting material along with disease and pest susceptibility
- Inadequate storage and facility of warehousing
- Labour shortage in peak season
- Lack of quality planting material
- Lack of transport facility
- Lower price of potato produced through ARCs
- Lack of adequate technical information transfer to farmers' (Madhu and Basavaraj, 2025 and Moolimane *et al.*, 2025).

Suggestion to Farmers

Apical Rooted Cutting (ARC) and True Potato Seed (TPS) are two planting techniques that potato producers frequently select. Both approaches offer benefits, but the decision is based on output objectives, farm size, and budget. In TPS, potato plants are grown from botanical seeds. It is an inexpensive choice that is simple to move and store. Small and marginal farmers can benefit from this approach, particularly in areas where certified seed tubers are costly. TPS crops, however, may exhibit variance in tuber size and plant growth, necessitating cautious nursery management. Cuttings from tissue-cultured plants are used in the ARC technique. It yields consistent, disease-free crops with improved tuber size consistency and a larger potential yield. It is more appropriate for commercial farming for seed potato production, while having a greater initial cost than TPS.

For farmers aiming at higher yield and better market returns, the ARC method is generally more profitable. However, for those with limited investment capacity, TPS is a practical and economical alternative. The final choice should be based on available resources and production goals.

Conclusion

Innovative and scientific techniques like TPS and ARC can help grow potatoes with a higher yield. While the Apical Rooted Cutting technique increases productivity and multiplication, True Potato Seed technology lowers seed costs and disease transmission. These techniques can greatly boost farmers' productivity and profitability when paired with integrated pest control, nutrition management, and good agronomic practices. Apical root cuttings are less expensive per plant but offer all the advantages of plants grown in vitro. The apical root cutting-based techniques have also become more cost-effective because of their excellent tuberization potential. Therefore, the apical root cutting-based system becomes cost-effective for multipliers to sell high-quality seed and allows small farmers to participate in the production of potato seed because of the high productivity of rooted apical cuttings, the short time needed to produce disease-free and superior quality seed tubers, the high rate of multiplication, and the lower cost. TPS techniques are high-yielding, economical, and sustainable substitutes for traditional tuber-based propagation in the face of growing seed prices and disease issues. They have the potential to revolutionise potato production methods and improve global food security and farmer wealth if properly implemented.

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