

Entrepreneur diversification in arid agriculture

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Arid regions, marked by low rainfall and harsh climatic conditions, present unique challenges for farming. In India, states like Rajasthan, Gujarat, and parts of Maharashtra are key examples of these regions. To thrive here, farmers need to diversify their agricultural practices to overcome water scarcity, low soil fertility, and climate challenges. This article explores different strategies that farmers can adopt to boost their incomes and resilience through various entrepreneurial ventures. From value-added processing to renewable energy and climate-smart practices, it aims to provide practical insights into transforming arid agriculture.

Keywords: Arid agriculture, Diversification, Entrepreneurship

AGRICULTURE in arid regions of India, Rajasthan, Gujarat, and parts of Maharashtra, faces significant challenges due to low rainfall, high temperature, and limited water resources. Traditional farming methods often struggle to survive with these conditions, leading to reduced yields and economic instability among farmers. In such situation, diversification of agricultural practices becomes a key strategy for ensuring sustainable livelihoods and resilient farming systems but at lower levels of income. Agricultural diversification involves exploring beyond traditional farming by integrating livestock, adopting new technologies, producing value-added products, and creating alternative income through innovative ventures. The goal is to both mitigate farming risks and optimize resources like land, water, and sunlight for economic viability and environmental sustainability. With the right support systems, such as access to finance, training, and market linkages, diversification of not only crops but of enterprises is transforming arid regions into hubs of innovation, driving economic growth and ensuring a better future for farming communities. This article aims to provide practical solutions for farmers, agri-entrepreneurs, and policymakers to boost agricultural productivity in arid areas. The innovative avenues for entrepreneur diversification in arid agriculture are discussed below.

Agri-processing and value addition

Managing post-harvest losses is crucial in arid areas due to limited production, and establishing small agro-processing facilities can be transformative. For instance, setting up oil mills or spice grinding units enables farmers to add value to their produce, leading to higher prices and extended product shelf-life. These

initiatives boost farmers' incomes and create local employment opportunities. The *Pradhan Mantri Kisan Sampada Yojana* (PMKSY) offers financial support for setting up agro-processing clusters, cold chains, and food processing units, helping farmers enhance their profits through value-addition. Additionally, Farmer Producer Organizations (FPOs) can collectively manage processing and marketing, reducing individual costs, improving market access and ensuring better returns for members. This has led to increase in area under cumin cultivation. A value chain for millet products has been developed, with Women Self-Help Groups producing items like biscuits, cakes, and snacks. Their products are now sold online and gaining recognition. One of the self-help group supported by CAZRI has got the opportunity to display its products to the Wives of Head of the Nations of G20 countries in Delhi Summit 2023.

Agri-voltaic systems

Agri-voltaic systems combine solar power generation with crop cultivation, offering a sustainable solution for water-scarce regions like Rajasthan. Besides generating electricity, solar panels provide surface area for rain water harvesting and providing additional income for the farmers. The *Kisan Urja Suraksha evam Utthan Mahabhiyan* (PM-KUSUM) scheme provides subsidies for installing solar panels, making such investments more accessible. Moreover, Rajasthan Renewable Energy Corporation Limited (RRECL) offers incentives and guidance, enhancing the feasibility of these projects. FPOs can also play a role in facilitating the adoption of these systems by pooling resources and negotiating better terms with solar technology providers.



Display of value-added products by farm women during G20 Summit at Delhi

Livestock and forage-based enterprises

Raising small ruminants like goats and sheep is ideal for arid regions due to their adaptability to limited vegetation. Local breeds like *Sirohi* and *Marwari* offer high returns through meat, milk, and wool production, providing a steady income stream. The National Livestock Mission (NLM) offers subsidies for animal shelters and healthcare, reducing costs for farmers. Additionally, cultivating drought-resistant forage like sorghum and hybrid Napier grass ensures consistent fodder availability, supporting dairy production even in dry periods. The *Rashtriya Krishi Vikas Yojana* (RKVY) provides funds to enhance fodder production, boosting livestock productivity and reducing feed costs. Value addition in cow-based products like A2 milk, *desi* ghee, and organic fertilizers opens niche markets for farmers. Support from NABARD and the Dairy Entrepreneurship Development Scheme (DEDS) for small processing units further boosts profitability.

High-value horticulture and protected cultivation

Protected cultivation in greenhouses or polyhouses enables year-round, off-season production of crops like bell peppers and strawberries, leading to higher yields, premium market access, and improved profitability by shielding crops from harsh weather. The Mission for Integrated Development of Horticulture (MIDH) provides financial assistance for setting up such structures, reducing the initial investment burden. Moreover, cultivating date palms in areas like Jaisalmer provides a stable income through high-value fruits. The National Horticulture Board (NHB) offers schemes for area expansion and post-harvest management, helping

farmers enhance yields and access broader markets. The Aromatic Plants Program under the National Medicinal Plants Board (NMPB) supports cultivation, ensuring technical guidance and market linkages for cultivation of medicinal and aromatic plants like ashwagandha, aloe vera, chamomile, Shankhpushpi and Kalmegh.

Seed production and nursery management

Producing quality seeds of drought-resistant crops like pearl millet, mung bean, cluster bean and seed-spices ensures better crop yields and food security. The Seed Village Program supports local seed production, promoting self-reliance and reducing dependency on external sources. Production of certified seeds fetches premium prices, helping farmers increase their income. Besides, establishing nurseries for forestry trees, fruit plants and medicinal plants can be highly lucrative, supporting afforestation efforts and providing income during off-seasons. NABARD and the National Afforestation and Eco-Development Board (NAEB) offer grants for nursery development, supporting income diversification and environmental conservation.

Agroforestry and carbon sequestration

Integrating trees with crops and livestock improves soil health, reduces erosion, and provides additional income through timber and fruits. For example, planting *Khejri* (*Prosopis cineraria*) trees alongside pearl millet enhances soil fertility and provides fodder. Newer plants like *Melia dubia* are also performing good under arid conditions. The National Agroforestry Policy promotes such practices, offering incentives and technical guidance to farmers. Farmers can also

earn through carbon credits by adopting environment friendly practices like agroforestry. Programs like the Green India Mission support these activities, providing technical and financial assistance for climate-resilient agriculture.

Organic and niche markets

Organic farming is profitable for crops like organic spices (cumin, fennel and ajwain), which have strong export potential. The *Paramparagat Krishi Vikas Yojana* (PKVY) supports organic certification, reducing costs for farmers and helping them reach high-value markets. Moreover, growing specialty crops like quinoa, chia, and moringa helps farmers diversify their income streams and meet the needs of health-conscious consumers. FPOs play a key role in collective branding and marketing, improving access to urban and export markets. Khadi and Village Industries Commission (KVIC) supports rural entrepreneurs with marketing and technical assistance, helping them expanding their products (like eco-friendly products such as neem-based herbal soaps) to the consumers.

Technology-driven services and agri-tech innovations

Digital platforms like *Kisan Network* and *DeHaat* help farmers sell directly to buyers, improving profit margins by eliminating intermediaries. E-NAM (National Agriculture Market) enhances transparency and provides better market access, helping farmers secure fair prices. The RKVY-Sub-Mission on Agricultural Mechanization (SMAM) supports the adoption of these technologies, offering financial assistance for advanced tools. Entrepreneurs can seek support from Atal Innovation Mission (AIM) and NABARD's Rural Innovation Fund, making agri-tech solutions more accessible.

Agriculture machinery services

Custom hiring centers offer an affordable way for smallholder farmers to access costly machinery like combine harvesters, threshers, rotavators and laser land leveler. The Custom Hiring Center (CHC) Scheme under RKVY-SMAM provides subsidies for machinery rentals and eventually can lead to enhancing crop productivity. Contract-based services for pest management like plant protection in commercial crops such as cumin, cotton and pomegranate allow farmers to benefit from low-cost and low pesticide residue in the produce while reducing labour burdens. NABARD offers loans for establishing such services, supporting efficiency and specialization in agriculture.

Agri-business and entrepreneurship support

ICAR Institutes like CAZRI, Jodhpur through Agri-Business Incubation initiative provide mentorship and technical assistance to agri-entrepreneurs by turning innovative ideas into viable businesses. Moreover, Agri-business Incubators under *Rashtriya Krishi Vikas Yojana* (RKVY-RAFTAAR) offer funding and guidance, reducing start-up risks. Besides knowledge, access to



Agri-voltaic system at CAZRI, Jodhpur

funding is vital for scaling ventures, and schemes like *Pradhan Mantri Kisan Sampada Yojana* (PMKSY) support infrastructure development for agro-processing units. *Mudra* Loans provide financial support to small-scale entrepreneurs and are promoting rural development.

Agri-tourism and cultural heritage

Arid regions like Rajasthan offer rich cultural heritage that can attract tourists, providing a new source of income for farmers. Farm stays, camel rides, and traditional meals give visitors an authentic rural experience. The *Swadesh Darshan* Scheme supports infrastructure development for agri-tourism, helping farmers create visitor-friendly setups. During events like the Pushkar fair, *Maru Mahotsav* etc. engaging tourists with hands-on farming activities boosts local tourism. Rajasthan Tourism Development Corporation (RTDC) provides promotional support, increasing the visibility and attractiveness of such initiatives.

Impact of entrepreneur diversification in arid regions

Each diversification initiative is to be evaluated based on its potential to contribute to local community well-being. Therefore, a comparative analysis helps to exemplify the multifaceted advantages of adopting diverse agricultural strategies, enabling stakeholders to make informed decisions about their resources and efforts. A detailed comparison of the economic, environmental, and social impacts of various entrepreneur diversification agricultural initiatives, particularly in the context of arid regions is given in Table 1.

Key challenges in entrepreneur diversification

Entrepreneurial diversification in arid agriculture faces several challenges, including limited access to water resources, high initial investment costs, and market access difficulties.

Harsh climate reduces crop productivity, creating risks for entrepreneurs in agriculture. Many farmers also lack technical skills and access to modern technology, limiting innovation. Infrastructure gaps, like inadequate storage and processing facilities, further restrict value addition opportunities. The fragmented smallholdings also make it difficult for entrepreneurs to upscale

Table 1. Impact areas for agricultural initiatives in arid regions

Initiative	Economic impact	Environmental impact	Social impact	Time frame for returns
<i>Agri-Processing and Value Addition</i>	• Boosts local income through value-added products • Generates local employment • Reduces dependency on raw produce prices	• Reduces food wastage through better storage and processing • Supports sustainable packaging practices	• Creates jobs in rural areas • Empowers women through small-scale processing units	Medium-Term (1-3 years)
<i>Agri-Voltaic Systems</i>	• Additional income from selling solar power • Lowers energy costs for farming operations	• Promotes renewable energy use • Reduces carbon footprint by decreasing reliance on fossil fuels	• Improves rural energy access • Reduces the energy burden on local communities	Long-Term (3-5 years)
<i>Livestock and Forage Enterprises</i>	• Provides stable income during crop failures • Expands market for meat, milk, and wool	• Utilizes dryland pastures effectively • Contributes to organic manure availability	• Enhances food security through dairy and meat products • Supports rural livelihoods	Short-Term to Medium-Term (6 months-2 years)
<i>High-Value Horticulture</i>	• Higher profitability from premium crops • Access to new market segments	• More efficient use of water through drip irrigation • Reduces land degradation through controlled environment farming	• Increases skill levels among farmers • Improves dietary diversity in rural communities	Medium-Term (1-3 years)
<i>Seed Production and Nurseries</i>	• Profitable from sale of certified seeds • Lowers costs for local farmers requiring seeds	• Promotes biodiversity through the cultivation of native and drought-resistant varieties	• Improves access to high-quality seeds for small farmers • Supports community-based seed banks	Medium-Term (1-2 years)
<i>Agri-Tourism</i>	• Provides alternative income streams • Boosts local economies through tourism spending	• Encourages conservation of local landscapes and traditional farming practices	• Strengthens cultural ties through showcasing heritage • Fosters community pride	Short-Term to Medium-Term (1-2 years)
<i>Agroforestry and Carbon Sequestration</i>	• Potential income from carbon credits • Revenue from timber and non-timber products	• Increases soil fertility and water retention • Reduces atmospheric carbon through tree planting	• Provides long-term stability to local communities • Creates opportunities for eco-friendly branding	Long-Term (3-10 years)
<i>Organic and Niche Markets</i>	• Higher prices for organic products • Access to export markets	• Reduces chemical runoff into soil and water bodies • Supports sustainable farming practices	• Promotes healthier food consumption • Increases community health awareness	Medium-Term (1-3 years)
<i>Technology-Driven Services</i>	• Improves profitability through better crop management • Reduces costs of inputs through precision farming	• Optimizes water and fertilizer use, reducing environmental impact • Minimizes pesticide usage through targeted interventions	• Enhances digital literacy among rural populations • Connects farmers directly with markets	Short-Term to Medium-Term (1-2 years)
<i>Agriculture Machinery Services</i>	• Lowers labour costs through mechanization • Increases efficiency of farm operations	• Reduces soil compaction with modern machinery • Improves field productivity through precision tillage	• Makes modern agriculture accessible to smallholders • Fosters collaboration among small farmers	Short-Term (6 months-1 year)
<i>Agri-Business and Entrepreneurship</i>	• Drives economic growth through new ventures • Opens up new market opportunities	• Encourages sustainable innovation in agriculture • Promotes development of eco-friendly agri-products	• Develops entrepreneurial skills in rural areas • Creates leadership opportunities among youth	Long-Term (3-5 years)

effectively. The important challenges and their potential solutions for entrepreneur diversification are enlisted in Table 2.

SUMMARY

Arid agriculture faces challenges like post-harvest

losses, limited water resources, and low productivity, but targeted initiatives can help overcome these issues. Establishing small agro-processing units, supported by schemes like PMKSY, helps farmers add value to produce, boosting income. Agri-voltaic systems and solar power under PM-KUSUM reduce energy

Table 2. Key challenges and plausible solutions for entrepreneur diversification in arid regions

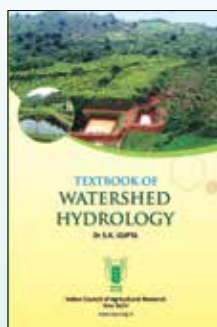
Initiative	Key challenges	Plausible solutions
Agri-Processing and Value Addition	High initial costs for setting up processing units, lack of storage infrastructure	Access to low-interest loans through schemes like PMKSY, development of shared FPO processing units
Agri-Voltaic Systems	High capital investment, maintenance challenges, technical complexity	Subsidies under PM-KUSUM, training programs for maintenance, technical support from RRECL
Livestock and Forage Enterprises	Limited fodder availability during drought, high animal healthcare costs	Support for fodder banks through RKVY, subsidized veterinary services under NLM
High-Value Horticulture	High initial investment in greenhouses, sensitivity to market price fluctuations	Financial aid under MIDH, market linkage support from FPOs for better price realization
Seed Production and Nurseries	Lack of quality inputs, difficulty in certification processes	Training on quality seed production through Seed Village Program, support from NABARD for certification
Agri-Tourism	Poor rural infrastructure, lack of marketing skills among farmers	Infrastructure development under <i>Swadesh Darshan Scheme</i> , training through RTDC for hospitality management
Agroforestry and Carbon Sequestration	Long gestation periods for returns, lack of awareness about carbon credits	Awareness programs on carbon credits, financial support through Green India Mission
Organic and Niche Markets	High certification costs, competition from conventional products	Subsidies for organic certification under PKVY, FPO support for collective marketing efforts
Technology-Driven Services	Low digital literacy, high costs of technology adoption	Digital literacy programs through KVKs, subsidies under SMAM for precision farming tools
Agriculture Machinery Services	High cost of machinery, under-utilization due to small landholdings	Establishment of Custom Hiring Centers, promotion of machinery rental models through FPOs
Agri-Business and Entrepreneurship	Difficulty in accessing investment, lack of mentorship and guidance	Mentorship support through RKVY-RAFTAAR, facilitation of <i>Mudra</i> Loans for small-scale entrepreneurs

costs while increasing crop resilience. Livestock and forage-based enterprises, supported by the National Livestock Mission, provide income stability. Protected cultivation and medicinal crop cultivation offer high-value market access, with schemes like MIDH and NMPB aiding farmers. Digital platforms like e-NAM and precision technologies enhance market access and resource-use. Custom hiring centers and contract services supported by SMAM make modern practices

accessible to smallholders. Support from FPOs and agri-business incubators fosters innovation and entrepreneurship. Looking ahead, sustainable practices, integrated technology, and improved market linkages can transform challenges into opportunities, ensuring resilient, profitable agriculture in arid regions.

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