Synthesis Paper

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Progress Through Science

Transforming Agriculture Through Innovation: A Case Study Across Production Systems

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Transforming Agriculture Through Innovation: A Case Study Across Production Systems

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Acronyms and Abbreviations

ACABC	Agri-Clinics and Agri-Business Centres
AIF	Agriculture Infrastructure Fund
AHIDF	Animal Husbandry Infrastructure Development Fund
APEDA	Agricultural and Processed Food Products Export Development Authority
ATIC	Agricultural Technology Information Centre
ATMA	Agricultural Technology Management Agency
BIRAC	Biotechnology Industry Research Assistance Council
CA	Conservation Agriculture
Criyagen	Criyagen Agri and Biotech Pvt. Ltd. (Bengaluru)
DBT	Direct Benefit Transfer
DNP	Dynamic Nutrient Provider
eNAM	Electronic National Agriculture Market
FAI	Fertilizer Association of India
FAO	Food and Agriculture Organization of the United Nations
FICCI	Federation of Indian Chambers of Commerce and Industry
FLD	Front Line Demonstration
FPO	Farmer-Producer Organization
FRI	Forest Research Institute
GDP	Gross Domestic Product
GCARD3	Third Global Conference on Agricultural Research and Development

GFAR	Global Forum on Agricultural Research
GI	Geographical Indication
HRD	Human Resource Development
HYV	High-Yielding Variety
IBB	Institute of Bioinformatics & Biotechnology
ICAR	Indian Council of Agricultural Research
ICAR–ABI	ICAR – Agri Business Incubator
ICAR-CIBA	ICAR – Central Institute of Brackishwater Aquaculture
ICAR-CIFA	ICAR – Central Institute of Freshwater Aquaculture
ICAR-CIFE	ICAR – Central Institute of Fisheries Education
ICAR-CIFRI	ICAR – Central Inland Fisheries Research Institute
ICAR-CIFT	ICAR – Central Institute of Fisheries Technology
ICAR-DGR	ICAR – Directorate of Groundnut Research
ICAR-NBAIM	ICAR – National Bureau of Agriculturally Important Microorganisms
ICT	Information and Communication Technology
IFS	Integrated Farming System
IGP	Indo-Gangetic Plains
IGNOU	Indira Gandhi National Open University
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IPRS	In-Pond Raceway System
IPR	Intellectual Property Rights
ITI	Industrial Training Institute
KVK	Krishi Vigyan Kendra
MIDH	Mission for Integrated Development of Horticulture
MKSP	Mahila Kisan Sashaktikaran Pariyojana
MoU	Memorandum of Understanding

MOVCDNER	Mission Organic Value Chain Development for North Eastern Region
MPEDA	Marine Products Export Development Authority
MSME	Micro, Small and Medium Enterprises
NAIF	National Agri-Innovation Fund (ICAR)
NACA	Network of Aquaculture Centres in Asia-Pacific
NABARD	National Bank for Agriculture and Rural Development
NEF	Navara Eco Farm
NFDB	National Fisheries Development Board
NFSM	National Food Security Mission
NIV	National Institute of Virology
NLM	National Livestock Mission
NMSA	National Mission for Sustainable Agriculture
NPK	Nitrogen, Phosphorus and Potassium
NRFS	Navara Rice Farmers' Society
NRLM	National Rural Livelihood Mission
ODOP	One District One Product
PKVY	Paramparagat Krishi Vikas Yojana
PMFME	Pradhan Mantri Formalization of Micro Food Processing Enterprises
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PPV & FRA	Protection of Plant Varieties and Farmers' Rights Authority
PRASHAD	Pilgrimage Rejuvenation and Spiritual Heritage Augmentation Drive
R&D	Research and Development
RAS	Recirculatory Aquaculture System
RGM	Rashtriya Gokul Mission

RKVY	Rashtriya Krishi Vikas Yojana
RKVY-RAFTAAR	Rashtriya Krishi Vikas Yojana – Remunerative Approaches for Agriculture and Allied Sectors Rejuvenation
RT	Responsible Tourism
SAU	State Agricultural University
SAMETI	State Agricultural Management and Extension Training Institute
SD	Swadesh Darshan
SDG	Sustainable Development Goal
SFAC	Small Farmers' Agri-Business Consortium
SHC	Soil Health Card
SHG	Self-Help Group
SMAM	Sub-Mission on Agricultural Mechanization
SOC	Soil Organic Carbon
SRT	Saguna Regenerative Technique
TAAS	Trust for Advancement of Agricultural Sciences
TRIFED	Tribal Cooperative Marketing Development Federation of India
UAS	University of Agricultural Sciences
USA	United States of America
US	United States

Transforming Agriculture Through Innovation: A Case Study Across Production Systems

Prologue

Indian agriculture has come a long way since independence, with a change of priorities over the decades. It has reached the stage of impressive achievements, accompanied by unprecedented challenges. India has made tremendous advancements in food grain production, moving from a food-deficient to a food-surplus country, as a result of scientific research, innovations, technological advancements, and innovative extension services to the farmers. Food grain production has increased more than six-times since independence, from 51 million tonnes (mt) in 1950-51 to 332.22 mt in 2023-24. All India production of pulses increased from 16.32 million tonnes during 2015-16 to approx. 25.20 mt during 2024-25. Oilseed production increased to 39.66 mt (2023-24), and horticulture production increased to 363.08 mt (Directorate of Economics and Statistics, 2023). Also, the livestock and dairy sector has emerged as a significant engine of growth in agriculture, playing a vital role in the overall agricultural landscape. India's milk production was 239.30 mt, egg production 142.77 billion, and fish production increased to an impressive 18.40 mt during 2023-24. Agriculture must be accepted as an important sector of the national economy, which has a direct role to contribute towards

Sustainable Development Goals (SDGs), promote inclusive development and welfare of millions of smallholder farmers, and accelerate the growth of national economy (Paroda, 2022).

The agriculture sector including the allied activities has long been the backbone of the Indian economy, playing a vital role in national income and employment. This sector contributes approx. 16 per cent of the country's gross domestic product (GDP) for FY24 (PE) at current prices and supports about 46.1 per cent of the population. Not only does its performance directly impact food security, but it also influences other sectors, sustaining livelihoods and supporting economic growth (Economic Survey, 2024-25). There is also an urgent need for scientific agro-eco-regional planning and a balanced 'agri-food system-based' multi-sectoral approach for faster agricultural growth and to contribute at least one trillion (20%) of the targeted five trillion economy, and to meet SDGs by 2030 (Paroda, 2022). The smallholders and marginal farmers (with < 2 ha), accounting for nearly 86.2 per cent of 146 million farm families, tilling to around 47.4 per cent of total cultivable land and accounting for > 50 per cent of the total agricultural production, are vital for India's agrarian economy (10th Agriculture Census 2015-16), and also for alleviating current major challenges of hunger and poverty being faced by the country (Paroda, 2022).

Agriculture is not just about growing crops— it is about resilience, adaptation, and making informed decisions under uncertainty. Since independence, NPK use increased from merely 0.07 mt (~0.5 kg NPK/ha of gross sown area) in 1950-51 to 29.8 mt (147 kg NPK/ha of gross sown area) by 2021-22– a rise of 426-fold (FAI, 2021-22). On all counts, it appears that increasing fertilizer use (along with HYVs, irrigation, etc.) played a major role in food grains production and took India from a deficit situation of the 1960s and 1970s to that of self-sufficiency by the 1990s. Since the early 2000s, India has been exporting food grains to several needy nations around the world (Katyal, 2023).

On the other side, a majority of farmers are leaving agriculture for different reasons and relocating to cities in pursuit of better living conditions. Hence, a paradigm shift is needed from 'Youth as a Farmer' to 'Youth as Value-Chain Developer and Entrepreneur' (TAAS, 2018). Today, smallholders are facing many challenges like limited access to financial resources, high input costs, poor infrastructure, vulnerability to climate change and weather volatility and low market price for agricultural produce. Although, this is frequently ascribed to distress, yet despite the difficulties and limitations, many farmers have achieved great success in agriculture and allied sectors and are thriving well. These farmers improved their own lives and also of others through their ingenuity and hard work. Documenting and disseminating success stories of these farmers can inspire millions of farmers across India, as well as motivate them and enhance their self-confidence, leading to agripreneurship. This paper presents the synthesis of success stories of innovative farmers across the different production systems and distills key lessons for learning and replication by the various stakeholders to empower the farming communities.

Success Stories: A Powerful Tool for Replication

The Trust for Advancement of Agricultural Sciences (TAAS) documented and published the success stories of innovative farmers and entrepreneurs with the aim of inspiring other farmers to strengthen their belief in their potential and cultivation. Today, many of these innovative farmers have transcended traditional cultivation, emerging as successful entrepreneurs and influential leaders in their field and communities. The entrepreneurial drive of these successful entrepreneurs has not only improved their livelihoods but also contributed significantly to the economic vitality of the country, creating jobs and fostering development.

The details of the following seven success stories of the innovative farmers across the production systems in India

highlighting their creativity, resilience, and contributions to sustainable agriculture are enumerated here.

- Saguna Regenerative Technique and Agro-tourism: Success Story of Mr. Chandrashekhar Hari Bhadsavle, Neral (Karjat), Maharashtra.
- Biofertilizers and Biopesticides for Enhancing Agricultural Production: Story of Dr. Basavaraj Girennavar, Bengaluru, Karnataka.
- *Navara* Rice - A Success Story of P. Narayanan Unny, Palghat, Kerala.
- Resilience in Dairy Farming - A Success Story of Nikki Pilania Chaudhary, Pilibhit, Uttar Pradesh.
- A Woman Entrepreneur's Journey from Adversity to Prosperity of Saneha Sharma, Mandi, Himachal Pradesh.
- Fish Farming in North India – A Success Story of Padma Shri Sultan Singh, Nilokheri (Haryana).
- BioPrime: An Enterprise Providing Innovative Solutions for Sustainable Agriculture - Story of Dr Renuka Diwan, Pune (Maharashtra).

1. Sustainable Agriculture and Agro-tourism Development Through Saguna Regenerative Technique

The success story of Mr. Chandrashekhar Hari Bhadsavle on Saguna Regenerative Technique (SRT) and Agro-tourism unfolds the details of how the innovative techniques and commitment to sustainable practices became a compelling force in enticing the youth back to the agricultural landscape. *Krishi Ratna* and *Krishi Bhushan* Awardee, Shri Chandrashekhar Hari Bhadsavle is a distinguished figure in the realm of agriculture, acclaimed for his innovative and sustainable farming practices. He embarked on a journey that transformed his own farmland

and also left an indelible mark on the agricultural landscape of Maharashtra.

Forty-five years ago, a promising young man with Master's degree in Food Science and Technology from California made a life-changing decision; he left a promising career in the United States to return to India. At the foothills of Matheran in Maharashtra, nestled amidst the vibrant landscapes of India, he discovered a patch of barren, degraded land that would become the foundation of a remarkable journey - Saguna Baug. At this place, a story of extraordinary dedication and commitment unfolded. As he stepped onto the barren and degraded land, Chandrashekhar sowed the seeds of Saguna Baug. The initial focus on rice cultivation stemmed from the abundant rainfall in the area. During 1977-1995, he relied on conventional, labour intensive farming but his vision went far beyond farming. He transformed 55 acres of farmland into one of India's pioneering agro-tourism destinations, creating a space where agriculture and tourism coexisted harmoniously. Saguna Baug became a living example of sustainable farming, drawing visitors to experience the synergy between rural traditions and modern innovation. Today, Saguna Baug is more than a farm—it is a symbol of dedication, sustainability, and the extraordinary impact of one person's vision. It stands as a beacon for those seeking to witness the beauty of nature, agriculture, and rural life working together in perfect harmony.

The major attraction of Saguna Baug- Agro-tourism includes fruit orchards, *bamboo* plantation, field crops, farm ponds, natural vegetation, conservation agriculture, vermicompost unit, dairy unit, biogas plant, apiary, market, boat house, food plaza, etc. Adventure camp activity (buffalo riding, swimming, fishing, horse riding, bullock cart riding, archery, etc.) is also an added attraction for the visitors, besides agriculture. He introduced Saguna Regenerative Technique (SRT) to a handful of farmers in village Neral (Karjat), Maharashtra, in 2013. Once a degraded land, the 'Saguna Baug' is now a success story of tapping the natural

resources to grow food crops, *bamboo*, also to rear livestock and fish, and promote biodiversity in and around its farm.

SRT is a conservation agriculture (CA), no-till method, essentially a regenerative method of farming that does not involve the disruption of soil structure through tillage. Key features of SRT are: no-till farming, permanent raised beds, crop residue and crop rotation. Zero till saves 30- 40 per cent cost of production in paddy. Not requiring transplanting saves 50 per cent labor and 50 per cent water. For a one ha paddy plot within a smallholding (<2 ha), adoption of SRT requires an indicative capital investment of ₹17,000–23,000 towards permanent raised beds and basic implements. However, this is offset by recurring savings of 30–40 per cent in the cost of cultivation and about 50 per cent savings in irrigation costs per season. Studies by Joseph *et al.* (2023) in the cotton (*Gossypium hirsutum* L.) - wheat (*Triticum aestivum* L.) system in the Indo-Gangetic Plains (IGP) indicated that the permanent raised beds with residue retention recorded 29–39 per cent higher soil organic carbon (SOC) stocks compared to conventional tillage. The conservation agriculture plots showed a mean SOC sequestration rate of ~0.76 Mg C/ha/year**,** which is nearly 70 per cent higher than under conventional tillage (~0.44 Mg C/ha/year). In deeper layers, conservation agriculture increased soil organic carbon sequestration by 0.24 Mg C/ha/year, demonstrating long-term carbon stabilization potential. In addition to carbon gains, conservation agriculture (CA) systems also improved soil biological fertility. Microbial biomass carbon increased by 44–52 per cent, and labile carbon by 30–33 per cent. These improvements enhance nutrient cycling efficiency and support a reduced reliance on chemical fertilizers when used alongside biofertilizers. Collectively, these quantified responses highlight the environmental benefits of SRT-type no-till systems and provide clear, farmer-oriented evidence of improvements in soil health, carbon storage, and overall sustainability. Today, SRT is practiced by a number of farmers in different parts of Maharashtra.

The sale proceeds of Saguna Baug Agro-tourism have increased from ₹ 3,87,61,916 (2021-22) to ₹6,16,67,928.14 (2022-23). Mr. Chandrashekhar received recognition/ awards from many national and international organizations. In the year 2021, the Food and Agriculture Organization of the United Nations (FAO) recognized the benefits of SRT and posted it on its official website.

Key Highlights

- A living example of sustainable farming
- Conservation agriculture improved
  - Mean SOC sequestration rate increased compared to conventional tillage
  - Soil biological fertility improved
- SRT-type no-till systems improved soil health, carbon storage, and overall sustainability
- Skill enhancement through training in conservation agriculture
- Attracted agro-tourism
  - Adventure camp activity/boating/horse riding

2. A Young Entrepreneur's Journey in Biofertilizers and Biopesticides

Born in the agrarian village of Janamatti, Karnataka, Dr. Basavaraj Girennavar witnessed firsthand the hardships faced by farmers—perennial droughts, poor cropping patterns, and the overuse of chemical fertilizers that degraded the soil and environment. Motivated to make a difference, he pursued higher studies and received B.Sc. and M.Sc. degrees in Agriculture, and

later earned a Ph.D. from Texas A&M University, USA. In 2007, he founded Criyagen LLC in the United States, but challenges in sustainability prompted him to return to India in 2008, determined to serve local farmers despite societal and familial opposition. He confronted deeply ingrained traditional farming practices and skepticism around organic products, as well as operational hurdles like staff management and market resistance.

Starting at the University of Agricultural Sciences (UAS), Dharwad, as an incubation center, Dr. Girennavar launched Dynamic Nutrient Provider (DNP) in 2009. The product gained remarkable traction, reaching 22,000 tons by 2019. Over time, Criyagen developed more than 50 innovative products, including Bio-NPK, Zen-Bio Fertilizer, and Bio-Maxx, introducing tablet and capsule formulations to make fertilizers more user-friendly for farmers. To scale production and ensure quality, he established a state-of-the-art manufacturing facility in Doddaballapur, near Bengaluru, along with satellite units in Vijayapura, Anantapur, and Sonipat for localized distribution. Recognizing the power of technology, he launched the Criyagen AgriApp, which has been downloaded over 500,000 times, providing farmers with real-time guidance and resources.

Innovation has been central to his journey. He set-up a dedicated R&D lab equipped WITH automated soil testing for 13 parameters and secured patents for DNP, Zen-Bio Fertilizer, and Bio-Maxx, reinforcing his commitment to sustainable agriculture. Today, Dr. Basavaraj Girennavar stands as a visionary entrepreneur who has transformed the biofertilizer and biopesticide sector in India, empowering farmers while protecting the environment.

Criyagen has demonstrated remarkable growth in both revenue and agricultural impact, with its earnings rising from ₹5.66 lakh in 2009 to ₹34.19 crore in 2018. This growth reflects the widespread adoption of biofertilizer technologies and the increasing confidence of farmers in eco-friendly, and low-cost solutions. The use of biofertilizers and related technologies has

led to significant improvements in crop yields. In sugarcane, yields increased from 90 to 161 tons per acre with DNP, while paddy yields rose from 2,925 to 4,225 kg per acre. Potato farmers in Kolar achieved 12,500 kg per acre even under drought conditions by using DNP and foliar sprays. Areca plantations were also revived, with yields improving from 8 to 13 quintals per acre.

For small and marginal farmers, biofertilizers represent a low-capital, high-impact intervention. ICAR trials showed that Bio-NPK and other microbial consortia can reduce 25–50 per cent of the recommended NPK dose without compromising yields, generating net savings of ₹1,500–3,000 per hectare per season for cereals. Specific formulations, such as Bio NPK liquid, can save 25–30 kg of nitrogen, 10–15 kg of phosphorus, and 2–5 kg of potassium per hectare. Phosphorus-solubilizing formulations like Bio Phos and Bio Phos+ reduce phosphorus requirements by 30 kg P_2O_5 per hectare and can replace up to 50 per cent of phosphorus fertilizer in wheat and maize when integrated with reduced basal doses. PUSA biofertilizers contribute an additional 20–30 kg of nitrogen, 20–25 kg of P_2O_5, and 10–15 kg of potassium per hectare through enhanced nutrient mobilization. Nitrogen-fixing biofertilizers such as Bio-Bacter and RhizoNBAIM can save 20–25 kg and 25–30 kg of nitrogen per hectare, respectively. In groundnut, ICAR-DGR's NutBoost and NutMagic consortia achieve 30–40 per cent savings in phosphatic fertilizers, 25 per cent savings in potassic fertilizers, and 25–30 per cent savings in nitrogen, along with documented yield gains.

These quantified reductions from farmer field demonstrations clearly showed that biofertilizers can lower NPK use substantially while maintaining or even improving crop productivity. The resulting cost savings, combined with improvements in soil biological health, make biofertilizers a practical and beneficial option for small and marginal farmers.

Criyagen produces 25,000 tons of biofertilizers annually and plans to scale soil testing services to 300,000 samples per year

under the Global Soil Health Service. The company employs 125 direct staff and 100 contract labourers, thereby contributing to rural employment. By providing farmers with a wide range of affordable, high-quality, eco-friendly products, Criyagen has helped them grow more with confidence. In recognition of his efforts, Dr. Basavaraj Girennavar received the Udyoga Rattan Award for outstanding achievements in agriculture.

Key Highlights

- Criyagen produces effective biofertilizers and biopesticides
  - Provides farmers affordable, high-quality, eco-friendly products
- Provides soil testing services
- Generates rural employment
- Criyagen demonstrated increase in earnings: ₹5.66 lakh (2009) to ₹34.19 crore (2018)

3. Navara Rice: The Golden Grain of Ayurveda

Mr. P. Narayanan Unny, a marketing executive-turned-farmer, left his good job to save and conserve valuable landrace of rice called *Navara*. *Navara* rice has been attributed with numerous nutritional and medicinal properties and widely used in various *Ayurvedic* treatments. Unlike other rice varieties, which are white, *Navara* is deep red and cultivated in the Palghat region for more than 2,000 years. The product was registered as GI, and this initiative was purely a farmer-led initiative and scaling-up *Navara* rice cultivation in Palakkad district. After years of strenuous efforts, he could evaluate, purify the seeds, and gradually moved

into large-scale cultivation of pure *Navara* rice in his 115-year-old 18-acre farm, popularly known as '*Navara* Eco Farm'. This farm is now getting wider recognition both nationally and globally. Mr. P Narayanan Unny took the lead and established the Navara Rice Farmers' Society (NRFS).

Navara Eco Farm (NEF) has evolved into a distinctive tourism destination catering to visitors with diverse interests. It has become a good tourist destination for students from schools, colleges, and universities, IPR and GI experts, agricultural scientists, farmers, conservationists, travelers, media persons, environmentalists, and celebrities. Recognized for its commitment to sustainable practices, NEF is featured on Kerala Tourism's official website: www.keralatourism.org. NEF is also a recognized unit under the Responsible Tourism (RT) Mission, an initiative by the Department of Tourism, Government of Kerala.

Navara Kizhi, also known as *Navara Potli*, is a highly regarded *Ayurvedic* treatment celebrated for its ability to induce therapeutic sweating. It helps relieve muscle and joint stiffness, alleviates pain, nourishes and strengthens muscles and joints, and promotes overall well-being. He has pioneered large-scale cultivation of *Navara* rice and officially registered as an authorized user, to support sustainable cultivation and promote its use in traditional ayurvedic therapies.

Considering his outstanding contributions to conserving this landrace, the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), Government of India, conferred the Plant Genome Savior Community Award on Mr. P. Narayanan Unny.

4. Resilience in Dairy Farming

Ms. Nikki Pilania, an economist-turned-agri-entrepreneur, has been actively engaged in transforming agriculture and dairy farming in rural India since 2011. A graduate in Economics from

Key Highlights

- *Navara* Eco Farm- evaluated and purified the seeds, and initiated large-scale cultivation of pure *Navara* rice
- This unique landrace has been conserved
- Eco-Farm evolved as a distinctive tourism destination
- *Navara Potli*, is a highly regarded *Ayurvedic* treatment, relieves muscle and joint stiffness, alleviates pain, nourishes and strengthens muscles and joints, and promotes overall well-being.

the University of Delhi, she went to UK to complete her Master's in Business Economics and Finance from the University of Surrey. After marrying Gaurav, a postgraduate in Economics from the Delhi School of Economics, Nikki chose to move to his family farm in village Tanda Vijaisi, Pilibhit district of Uttar Pradesh. Inspired by Gaurav's commitment to a rigorous rural life and meaningful contribution to agriculture, she began her journey in the largely unfamiliar fields of farming and dairying. Since then, she has been dedicated to addressing the structural and economic challenges faced by dairy producers in India, while advocating for environmentally sustainable and farmer-centric solutions.

In 2011 and 2012, Nikki, along with Gaurav, planted about 5,000 poplar trees at their farm. They followed the best package of practices and got very high poplar timber yields in six years. These package of practices for higher timber yields were shared by them with several hundred farmers in the region. Nikki made a presentation on her work on poplar agroforestry and shared the

economic returns of poplar-based agroforestry vis-à-vis paddy-wheat crop rotation in the 24th Session of the International Poplar Commission held in 2012 at the Forest Research Institute (FRI), Dehradun. Nikki took several initiatives in agriculture to explore and come up with the best agricultural practices that are economically beneficial and environmentally sustainable. She successfully promoted conservation agricultural practices such as zero tillage in wheat and direct-seeded rice in paddy amongst farmers in the region.

Nikki made significant contributions for round the year supply of green fodder, enhancing livestock nutrition, maximizing the efficiency of concentrate mix, cow comfort for profitable dairy operation, breeding efficiency, manure management, value addition and marketing, livestock-crop-tree integration, circular systems approach, and promoting conservation agricultural practices. She clearly demonstrated that a dairy farmer with a well-managed 10 cow dairy farm and supportive ecosystem taking care of essential needs such good cattle breed, provision of good nutrition and veterinary support, will get a return over investment amounting ₹ 32,750 per month.

In 2016, Nikki was selected as one of the top six youth agripreneurs worldwide by the Global Forum on Agricultural Research (GFAR) and was invited to the third Global Conference on Agricultural Research and Development (GCARD3) held in Johannesburg, South Africa, in April 2016. The Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, has invited Nikki thrice as a young dairy farmer/agripreneur, to share her insights into the dairy farming sector in India. She served as a Board Member at the Youth Alliance for Zero Hunger, and has also been a member of the Committee on World Food Security since 2019.

In 2021, Nikki co-founded 'Mango Dairies' with Gaurav, which aims to deeply engage with milk producers on producing high-quality milk efficiently. Nikki aims to make dairying profitable

Key Highlights

- Addressed the structural and economic challenges faced by dairy producers in India, while advocating for environmentally sustainable and farmer-centric solutions.
- Adopted poplar-based agroforestry successfully.
- Demonstrated that a dairy farmer with a well-managed 10-cow dairy farm and supportive ecosystem, will get a handsome return.
- Established a dairy-focused FPO, '*Terai* Farmer Producer Company Limited', to uplift and strengthen dairy farming.

for the dairy producers and, with the support of Gaurav and a few farmers, has also established a dairy-focused FPO called '*Terai* Farmer Producer Company Limited' in June 2021 to do strong collaborative work together with the farmers to uplift and strengthen dairy farming as well as dairy farmers. Nikki aims to transform dairy farming in India and build a thriving community of dairy farmers and at the same time delivering the highest quality milk and milk products to consumers.

5. Journey from Adversity to Prosperity

Ms. Saneha, a determined woman farmer from a remote village in Mandi, Himachal Pradesh, even after an early marriage at the age of 20 years pursued her education and graduated from IGNOU in 2007. Realizing her passion for learning, her husband and in-laws supported her for further education. Her sheer grit, determination, and desire to improve lives changed

her destiny completely. Ms. Saneha's journey began in 2012, when she was elected Vice President of *Chachyot Krishak Society*, a registered Farmer Producer Organization (FPO). The society focuses on livelihood improvement for farm women through income-generating activities like processing agricultural produce, handicrafts, and mushroom cultivation. Currently, as President, Saneha leads 30 women's Self-Help Groups (SHGs) with 8-10 members in each group. She completed computer and fashion design courses at ITI, Mandi, sharpening her skills and opening a boutique in 2015.

Ms. Saneha shifted from traditional farming to the Integrated Farming System (IFS). Before adopting IFS, Ms. Saneha was growing traditional crops like maize and wheat in a 0.48 ha area along with rearing of milch animals, but the earnings were not sufficient to meet her family's needs. Later on, after acquiring several skills from the *Krishi Vigyan Kendra* (KVK), she adopted IFS at her farm. Crop production, dairy, vegetable nursery production, oyster mushroom cultivation, and value addition are the major components of her farming practices in the IFS. Ms. Saneha learned how to make jams, juices, jellies, pickles, *chutneys*, and even processed millet products. She has developed expertise in drying and processing mushrooms into a range of value-added products such as soups, pickles, *ketchups*, and nuggets. This initiative not only minimizes food wastage but also enhances the economic value of the produce. Annually, she produces approximately 800 kg of these products, generating additional income for her farm. Furthermore, she actively imparts training to members of self-help groups (SHGs), enabling them to acquire skills in preparing and marketing these value-added mushroom products.

Ms. Saneha is marketing the products made by her SHGs in various local/ state/national level fairs organized by different agencies. National Rural Livelihood Mission is also providing a platform in the form of Sunday Kisan Mandi for the sale of SHG's products. To expand her reach, she has partnered with Brooke

India, an NGO dedicated to animal welfare. She has established connections with retailers and wholesalers, while exploring other avenues like direct customer marketing and utilizing various social media platforms. Ms. Saneha became a leading force in the International Year of Millets-2023 in the Mandi district of Himachal Pradesh.

Ms. Saneha is acting as a master trainer for many developmental agencies. During the past three years (February 2021-March 2024), she conducted 42 trainings as Master Trainer to empower 1,747 women of 230 SHGs in area of mushroom cultivation, processing and value addition of agricultural produce, natural farming, management of dairy, dairy farming and vermi-composting, awareness camp on banking, pine needle fuel

Key Highlights

- Sheer grit, determination, and desire to improve lives changed the destiny of a determined woman farmer from a remote village in Mandi, Himachal Pradesh
- Crop production, dairy, vegetable nursery production, oyster mushroom cultivation, and value addition are the major components of her farming practices in the IFS
- Conducted trainings in area of mushroom cultivation, processing and value addition of agricultural produce, natural farming, dairy farming and vermi-composting, awareness camp on banking, pine needle fuel cakes, soap making, cow dung diyas, women health, multipurpose processing machine, and animal health care.

cakes, soap making, cow dung diyas, women health, multipurpose processing machine, and animal health care. It is immensely satisfying to see that each member of these SHGs is now earning an additional income of ₹ 8,000-10,000 per month. Her story serves as a powerful eye-opener and source of inspiration for millions of young smallholder farmers who aspire to take up farming and lead a dignified, comfortable and sustainable life. Ms. Saneha's journey gained national recognition in 2023. Doordarshan, a national television channel, invited her to their Shimla studio for an interview. She has been conferred with several awards and recognitions by many organizations for her entrepreneurial work.

6. Fish Farming in North India

Shri Sultan Singh, a farmer from Butana, Karnal, Haryana born in a farming family, was initially uninterested in growing traditional crops like rice and wheat. He invested his personal savings of ₹ 28,000 in 1983 to start fish farming on his own farm, at a time when the practice was almost unknown in North India, especially in a predominantly vegetarian state with no local fish seed hatcheries. With fish seed available only from Kolkata, he initially faced extremely high mortality rates of 60–70 per cent due to long-distance transportation. By leasing community ponds at a nominal rate of ₹ 500/year, he generated an income of ₹ 1,62,000 within 18 months through scientific fish farming. His initiative was inspired by a village boy who successfully earned a livelihood from fishing in a community pond. Despite facing initial resistance due to deep rooted social and cultural perceptions that viewed fishing as a lower-caste occupation, he remained determined. His efforts were strengthened after receiving initial technical training from Dr. Jagdish Chander Markandey at KVK, Karnal, which enabled him to adopt improved practices and transform a low-cost resource into a sustainable and profitable enterprise.

He established North India's first fish hatchery in 1986 on 5 acres of barren land. He adopted advanced technologies such as

Recirculatory Aquaculture System (RAS) and In-Pond Raceway System (IPRS). He introduced new fish species: Pangasius, *Shingi*, *Desi Magur*, and *Chitala* and built India's first freshwater fish processing plant in 2011 for value-added products. He also launched "Fish Bite" retail stores for ready-to-eat fish products. He received advanced training from premier institutions including ICAR-Central Institute of Fisheries Education (CIFE), Mumbai; ICAR-Central Institute of Fisheries Technology (CIFT), Cochin; ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore; ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneshwar; ICAR-Central Institute of Brackishwater Aquaculture (CIBA), Chennai; and Network of Aquaculture Centres in Asia-Pacific (NACA), China. He introduced freshwater prawn culture and the endangered *Shinghada* fish in Haryana, contributing to aquaculture diversification and conservation. He developed integrated aquaponics and hydroponics systems for organic vegetable production and established a quality control laboratory in 2016 for fish product testing. By integrating dairy, poultry, and stud farming, he utilized farm waste for fish feed, promoting sustainable circular farming. Through the adoption of RAS technology, fish production increased from 65.4 metric tons in 2016 to 122.2 metric tons in 2019, while revenue grew from ₹1.86 crore (2014–15) to ₹3.97 crore (2018–19). He has trained 20,000 farmers and 761 students (2018-19) in fish farming techniques and transformed village ponds, boosting *Gram Panchayat* lease income from ₹ 500 to ₹ 15 lakhs annually. He developed 35 value-added fish products, increasing production from 3.6 tons (2016) to 22.1 tons (2019). He achieved the first successful captive breeding of *Chitala* fish in India through innovative hideout-based techniques. He initiated reservoir farming in Rajasthan, generating multi-crore revenue and significantly enhancing inland fisheries productivity. His efforts enabled 70 farmers from reserved categories to adopt fish farming contributing to livelihood improvement and social inclusion. He also provided free research facilities and fish seeds to Ph.D. scholars, strengthening fisheries research and capacity building.

He overcame the challenges like seed mortality, lack of expertise, and vegetarian culture. He has encouraged farmer groups to process and export the fish products to increase income. He provides free training and continuous mentorship to aspiring fish farmers, urging them to remain determined despite daily challenges in fish farming. He champions knowledge sharing as a means of building confidence, professional recognition and long - term success. Through his advocacy, he promoted fish farming as a sustainable and viable livelihood particularly for students without a science background. In 2012, he was awarded the Best Incubator Award by the Hon'ble Former President of India, Dr. APJ Abdul Kalam. He is a recipient of many state and national

Key Highlights

- A farmer from Butana, Karnal, Haryana invested his personal savings of ₹ 28,000 in 1983 to start fish farming on his own farm.
- KVK, Karnal, enabled him to adopt improved fisheries practices
- Established North India's first fish hatchery in 1986
- Launched "Fish Bite" retail stores for ready-to-eat fish products
- Adopted recirculatory aquaculture system and in-pond raceway system
- Developed integrated aquaponics and hydroponics systems for organic vegetable production
- Trained entrepreneurs in fish farming techniques and transformed village ponds
- Conferred with *Padma Shri* Award

awards, including the prestigious *Padma Shri* Award of the Government of India in 2020.

7. An Enterprise Providing Innovative Solutions for Sustainable Agriculture

The BioPrime, a Pune-based company, is developing innovative solutions to address crop production challenges and improve quality outcomes. Dr. Renuka Diwan is a dynamic leader whose career bridges ground-breaking scientific research, entrepreneurial success, and strong advocacy for women in agri-tech. A visionary plant biotechnologist and accomplished entrepreneur, Dr. Diwan has over 25 years of experience in R&D spanning plant genetic engineering, bioactive compounds, and microbial solutions. She combines academic rigor with strategic vision to drive the mission of BioPrime Agrisolutions: "From Nature, For Nature." As Co-Founder and Chief Executive Officer of BioPrime Agrisolutions Pvt. Ltd. since 2016, Dr. Diwan has built a fast-growing agri-biotech start-up focused on climate-resilient biologicals. She has spearheaded strategic initiatives, forged co-development and licensing partnerships, and expanded markets across India, the United States, Southeast Asia, and Africa. Under her leadership, BioPrime has raised $6 million in funding to accelerate research on biofungicides and bioinsecticides. She oversaw the successful launch of proprietary innovation platforms such as SNIPR and the Bionexus Microbial Library, which houses more than 15,000 isolates. Before co-founding BioPrime, Dr. Diwan conducted impactful scientific work, exploring the anti-cancer effects of coumarins and flavonoids targeting topoisomerase I & II, which led to a patent on coumarin extraction. She holds a Ph.D. in Plant Biotechnology from the University of Pune, India, and completed postdoctoral research in plant genetic engineering at both the University of Pune and Cambia in Australia. She has also contributed extensively to academia, serving as visiting faculty at the Institute of Bioinformatics and Biotechnology (IBB) and the National Institute of Virology (NIV) in Pune, as well as a member of the Advisory Board for Environment & Sustainability Studies at

the University of Pune. Her academic contributions include more than 10 peer-reviewed research papers published in high-impact journals, and she is the inventor of several patents. Dr. Diwan's work has been widely recognized with prestigious awards, including the FICCI-BIRAC Women in Entrepreneurial Research Award, recognition among the BioAg Top 10 Innovative Startups in Rio de Janeiro, the Samunnati Women Startup Leaders Award, and the Global BioAg Innovation Award in India.

Key Highlights

- BioPrime Agrisolutions: "From Nature, For Nature." is a fast-growing agri-biotech start-up focussing on development of climate-resilient biologicals.
- Developed innovative solutions to address crop production challenges and improve quality outcomes.
- Expanded markets across India, the United States, Southeast Asia, and Africa.
- BioPrime has raised $6 million in funding to accelerate research on biofungicides and bioinsecticides.

Learning Through Lessons

There had been exciting examples of learning through the lessons from these success stories of innovative farmers across diverse production systems which are enumerated below:

- Agro-tourism, emerging as a promising agricultural enterprise, has become a sustainable source of income for

rural communities. The integration of initiatives like the Saguna Regenerative Technique with agro-tourism has had a profound impact, creating successful models that inspire other young farmers. As a result, educated and skilled youth are increasingly returning to villages. Many young people started taking inspiration and started 'agro-tourism and eco-tourism' projects in rural India, launching innovative agro-tourism and eco-tourism projects. These initiatives generate livelihoods and also foster a meaningful connection between rural areas and urban populations. To fully harness its potential, the promotion of agro-tourism should align with rural tourism, health tourism, and adventure tourism, ensuring a holistic approach to sustainable rural development.

- Biofertilizers and biopesticides are crucial for sustainable agriculture because they enhance soil health, reduce the need for chemical fertilizers, and control pests and diseases naturally. Strengthening quality control, standardization, and micro-region-specific guidelines for biofertilizers is essential to ensure their efficacy and farmer trust. Expanding the reach of *Krishi Vigyan Kendras* (KVKs) and field extension services can enhance the dissemination of biofertilizer technologies and improve knowledge flow to farmers. Early experiences in agripreneurship underscore the value of resilience, showing how initial challenges can be transformed into opportunities for growth. Furthermore, educating farmers about organic and sustainable products is crucial to reducing reliance on chemical fertilizers and promoting long-term soil health and productivity. Technology integration through an AgriApp improves farmer decision-making and increases profitability. Hence, strong mentorship is required from scientists of research institutes for the success of any enterprise/business for the farmers.
- *Navara* rice, having numerous nutritional and medicinal properties, is endemic to Kerala. Unlike other rice varieties, which are white in color, *Navara* is deep red and cultivated

in the Palghat region for more than 2,000 years. In the past 4-5 decades, it had reached a stage of near extinction. Considering its importance due to high medicinal value, particularly in various *Ayurvedic* treatments for the wellbeing of people, the government should support the '*Navara* Revival Program'. Support for cultivation in the scaling-up section in the form of ecosystem services, and then support infrastructure facilities for primary processing for procurement, transportation, storage, drying, value-addition, testing, packing, branding, and marketing. Also, GI-based crop clusters, such as *Navara* rice and other traditional landraces should be promoted with dedicated support for seed purification, organic cultivation, primary processing, packaging, branding, and domestic/export marketing, to develop high-value niche products and strengthen the branding of specialty crops. There is need for scaling-up of cultivation through ecosystem services and investment in end-to-end infrastructure for primary processing—covering procurement, transport, storage, drying, value addition, testing, packaging, branding, and marketing. Policy support is also needed to meet the newer challenges, like the destruction of the *Navara* crop from the attack of wild animals. Introducing special risk-mitigation instruments (e.g., targeted compensation and subsidized physical barriers) through community fencing and timely compensation for high-value crops in wildlife-conflict zones according to climate-risk, and implementation of policy recommendations need immediate attention.

- From an impoverished homemaker to a successful farmer and entrepreneur, the story of Ms. Saneha Sharma is an inspiring tale of how women in rural India can take charge of their destiny. As an entrepreneur, preparing a sound financial strategy with a focus on cash flow management is essential. The KVK, Mandi, has created a supportive environment that fosters the growth and development of entrepreneurs like Ms. Saneha, for the benefit of the community and society as

a whole. Providing start-up grants, incubation, and market linkage support for women farmer groups and women FPOs engaged in processing, branding, and direct marketing for value-chain development and rural infrastructure is extremely essential. Women play a pivotal role in all economic and crop production activities in agriculture in general, and in the hills in particular. In Himachal Pradesh, women farmers are the backbone of subsistence agriculture. Yet owing to gender insensitivity, they do not receive the desired recognition and support. Existence of women farmers' needs and rights has been largely ignored, and in many cases, their condition is hardly any better than that of unpaid farm labour. Therefore, the need to mainstream the women farmers in developmental activities and exploit their potential with adequate recompense is of utmost importance. There is a need to reduce the drudgery of women farmers and make their efforts worthwhile and economical. It is extremely important to design targeted training, incubation, and mentorship programs modeled on the success stories and linking them with agripreneurship and skill development.

- The Indian dairy industry is crucial as it is the world's largest milk producer, contributes significantly to the economy (about 5% of the national economy and 25% of agricultural GDP), and provides livelihoods to over 80 million farmers, primarily a large number of women. It also essentially provides nutritional security through milk and dairy products and empowers rural communities with initiatives like cooperatives, fostering inclusive growth. Incentivising climate-smart dairy systems (fodder diversification, crop–livestock integration, manure management, renewable energy use, etc.) leads to greening the livestock sector and reducing its environmental footprint. The dairy profession needs strong focus, committed efforts, and a lot of patience. Good networks/ collaborative efforts with the farming community and various other stakeholders must be continuously

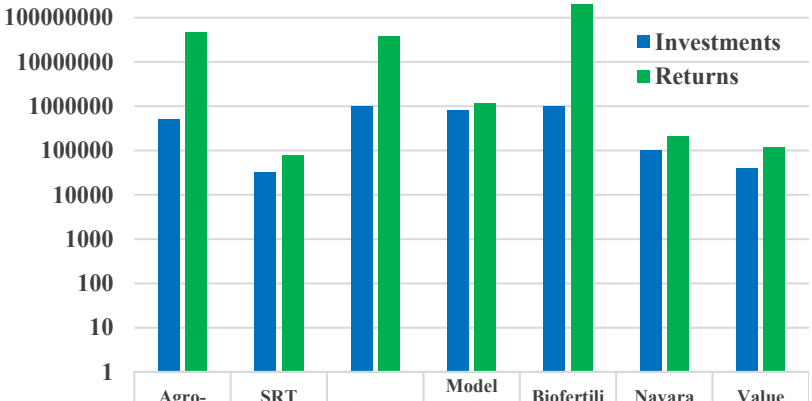
built for the growth and development of the sector. As an entrepreneur, one needs to have a sound financial strategy in place with a clear focus on cash flow. The journey of an entrepreneur is tough, especially in the agriculture sector, but a strong purpose and vision to— transform the lives of people and meaningfully contribute to attain social, economic, and environmental sustainability, makes the journey worthwhile, hence, all efforts must be made on the ground for growth and development of dairy sector. Entrepreneurs should be prepared for resistance, and hence must create awareness amongst customers, prove product value, and build credibility. It is very important to seek the help and support of mentors who have walked the path before you, and surround yourself with a network that challenges you, supports you, and helps navigate difficult decisions. One should always think in terms of scale, from the smallest detail to the largest impact. The solution should not just work in a controlled environment; it should be organic and replicable across diverse users and conditions. A business that truly understands and prioritizes its customers will always have an edge over competitors.

- Indian fisheries and aquaculture are economically important and a fast-growing production sector contributing significantly to the national economy in terms of food, nutrition, socio-economic development, and providing livelihood support and gainful employment to more than 14 million people. Youth and entrepreneurs should be encouraged to promote the adoption of fish farming as a profession because this sector has immense scope for growth through the use of new technologies, innovative approaches, as well as upscaling and out-scaling of production of fish and fish products.
- BioPrime's products represent a holistic approach to transforming Indian agriculture, reducing dependency on imports, enhancing farmer resilience, improving resource efficiency, and supporting national sustainability goals.

This aligns with global and national climate goals, further strengthening India's position as a leader in sustainable agricultural practices. Today, BioPrime has won the trust of over 100,000 farmers, with many embracing a permanent shift towards sustainable biological inputs. Across diverse crops and geographies, BioPrime's innovations helped farmers to: (i) increase yields by 20-40 per cent; (ii) reduce input costs (fertilizers, pesticides, post-harvest losses) even up to 80 per cent; (iii) command higher prices (up to 3× higher in premium markets); and (iv) expand market reach and reduce middlemen dependency.

Returns Over Investments in Different Agrienterprises

A glance at returns over investments in different successful agrienterprises (Fig. 1) observed that the maximum returns over investments were recorded in biofertilizer enterprise i.e. ₹34.19 crore during 2018-19 followed by agro-tourism (₹4.76 crore) during 2022-23 and fishery (₹3.77 crore) during 2019-20.



	Agro-tourism	SRT (per ha)	Fishery	Model Dairy (10 cow)	Biofertilizer	Navara Rice	Value addition
Investment	500000	32680	1000000	795000	1000000	100275	40000
Returns	47622939	77,000	37769874	1188000	341956991	210200	120000

Fig. 1: *Returns over Investments in Different Agrientreprises (₹)*

It is evident that the maximum enhancement of returns of Criagen, Doddaballarpur, Bengaluru was due to establishment of state-of-the art facility for large scale production of various products like biofertilizers (500,000 litres and 1,000,000 kg), enhanced organic fertilizer (50,000 tons), humate fertilizer (5,000 tons), amino acid based fertilizer (500 tons) and foliar spray products (200,000 litres) at Criyagen, Doddaballarpur, Bengaluru.

In case of agro-tourism, the high returns (₹ 4.76 crore) reported as sale proceeds of *Saguna Baug* Agro-Tourism Private Limited during 2022-23 was due to *Saguna* shop sales, sales on amazon and agriculture sales of *Saguna Baug* products. It was also noted that maximum returns were due to incorporation and efficient management of various activities of student's study visit/tours, exposure visit of farmers and other visitors, home stay and adventure facilities created for the visitors at *Saguna Baug* Agro-tourism.

In case of fishery enterprise, the maximum returns (₹ 3.77 crore) during 2019-20 was reported as revenue due to maximum efforts taken for fish production (fish and fish seed hatchery), fish breeding, creation of in-pond raceway fish production with RAS infrastructure and equipments, establishment of quality control laboratory, fish processing plant for value addition of fish products (fish bite, fish cutlets, etc.) and marketing.

In a model dairy (10 cows) with investment of ₹ 7,95,000, the annual return was ₹ 11,88,000. The net profit from 10-cows model dairy farm was total revenue (₹ 11,88,000) – total cost (₹ 7,95,000) = ₹ 3,93,000 per annum or ₹ 32,750 per month. Hence, there is a huge scope for improving the income of small and marginal farmers from cow based dairy farming and integrating dairy with agriculture and other components for promoting integrated farming system model in India.

It is obvious from the data on returns over investments from the value addition enterprise that there was annual return of ₹ 1,20,000 with investment of ₹ 40,000 and the net profit from

value addition was ₹ 80,000 (200%). Hence, it is concluded that value addition and processing is an emerging area for promoting small and marginal farmers especially self- help groups (SHGs) for enhancing farm income and profitability.

In case of *Navara* rice, the return of ₹ 2,10,200 was obtained by investing ₹ 1,00,275 per hectare. Hence, the net profit per hectare from *Navara* rice cultivation was ₹ 1,09,925. There are many challenges (low yield, pest problem, damage by birds and animal) in cultivation of *Navara* rice, however, due to its high medicinal value, farmers are cultivating this crucial landrace of rice for use in *Ayurvedic* treatment, attracting tourism and earning high profit.

Saguna Regenerative Technique (SRT) is a conservation agriculture and regenerative method of farming developed and popularized by Mr. Chandrashekhar Bhadsavle. In SRT cultivation, with per acre investment of ₹ 32,680, the returns per acre in paddy was ₹ 77,000 at farmer's field and the net profit was ₹ 44,320 per acre. However, in traditional paddy cultivation, the investment per acre was ₹ 39,967 and the returns per acre was ₹ 45,500, with a small profit of ₹ 5,533 per acre at farmers field.

Key Sources of Returns

The key sources of returns over investments in different agri-enterprises are diverse and given in Table 1.

Key Factors of Success in Agripreneurship

- ***Adoption of sustainable agricultural practices*:** Farmers who adopt sustainable farming practices such as organic farming, agroforestry, soil and water conservation, dairy, fishery, and value addition to enhance long-term health, resilience and profitability, are more successful.
- ***Technological integration*:** Utilizing modern technologies in agriculture and allied sectors leads to greater efficiency

Table 1: Key sources of returns over investments in different agri-enterprises

Success story / model	Key sources of returns
SRT / No-till regenerative farming	Cost reduction, yield gain, water saving
Agrotourism	Visitors fee, recreation fee, sale of farm produce
Biofertilizer production and use (DNP, NutBoost, etc.)	Reduced chemical inputs, higher yields
Navara rice conservation and value chain	Niche premium price, medicinal value, GI-based marketing
Women-led IFS and value addition	Diversified enterprises, year-round income
Youth-led dairy enterprise	Clean milk production, value addition, and herd efficiency
Integrated fish farming	Multi-tier value chain, processing and retail integration
BioPrime agri-biological enterprise	High-margin biotech products, export readiness

and productivity. The integration of modern technologies in agriculture and allied sectors is crucial for boosting productivity, improving efficiency, and ensuring sustainable agricultural development.

- ***Knowledge exchange and information*:** Engaging with fellow farmers, interacting with input dealers, and accessing mass media significantly help farmers to stay informed about new emerging techniques, improved farming methods and best agricultural practices, thereby enhancing decision-making, productivity, and sustainability.
- ***Resource management*:** Innovative farmers strategically plan around their specific soil and water resources, ensuring that investments are aligned with long-term productivity and

sustainability. Effective resource management is crucial for the success of agrienterprises, as natural resources often constitute the most valuable assets for smallholder farmers.

- ***Scientific rigor***: Every product is backed by years of research and validated through extensive trials. BioPrime developed a deep gene-level understanding of each product-identifying the biomolecules involved and pathways they activate. In parallel, BioPrime demonstrated consistent performance through multi-location multi-crop trials. This rigorous understanding of each prodcut's performance on target crops is critical to ensuring long-term success.
- ***Farmer-centric approach***: Solutions are designed to be easy to use, affordable, and impactful for farmers. Benchmarks on usage trends, pricing norms and prevalent agronomic practices are gathered before any product development commences. These success metrics guide ensuring every innovation is truly farmer focused and results driven.
- ***Clarity on go-to-market approach***: Most of the players in the industry opt for a business-to-consumer models and establish their own distribution networks. However, it is important for every enterprise to choose its own specific model, allowing it to invest more in research and product development rather than in working capital and credit cycles. The focus should always remain on early revenue generation and maintaining positive unit economics.
- ***Sustainability***: Promoting resource use efficiency and reducing environmental impact is the key to building a greener, more sustainable future - From Nature, For Nature, Always!

Scaling of Innovation: Integrating Findings into Development Initiatives

Rural India possesses immense potential for inclusive growth, as reflected in diverse success stories across agriculture,

allied sectors, rural enterprises, and community-led initiatives. To systematically replicate and scale-up these proven models for the wider farming community, a comprehensive and strategically aligned approach is essential. The systematic replication and scaling of rural success stories require coordinated efforts across institutions, infrastructure, finance, technology, and human capital development. A holistic, participatory, and market-oriented strategy will enable rural India to transform from subsistence-based systems to resilient, diversified, and value-driven rural economies. Through sustained policy support and community engagement, the benefits of proven success models can be extended to the broader farming community, ensuring inclusive and sustainable growth.

Encouraging Agrotourism and Ecotourism

Recently, agrotourism and ecotourism have emerged as an innovative extension model of agri-preneurship offering significant potential to enhance farm profitability. By integrating agriculture with experiential travel, farmers can create additional revenue streams while promoting sustainable resource use and preserving local culture.

The Ministry of Tourism supports tourism infrastructure development across the country through its central sector programs such as Swadesh Darshan (SD), Pilgrimage Rejuvenation and Spiritual, Heritage Augmentation Drive (PRASHAD), and Assistance to Central Agencies for Tourism Infrastructure Development. These initiatives provide financial support to State Governments and Union Territories (UT) Administrations to strengthen tourism infrastructure and promote thematic circuits. Notably, the Rural Circuit has been identified as a key thematic area under the Swadesh Darshan Scheme highlighting the importance of rural tourism in national development.

With the launch of Swadesh Darshan 2.0 (SD 2.0), the government has shifted the focus towards a more sustainable,

responsible and destination-centric approach, and also formulated national strategies for development of rural tourism and promotion of rural homestays in India. This phase emphasizes holistic development, community participation, and enhanced tourist experiences.

India's rural landscape, rich in natural resources, traditional knowledge, and cultural heritage, presents immense opportunities for young and enthusiastic entrepreneurs. Successful case studies in agrotourism and ecotourism demonstrate how effective resource management, innovation, and community involvement can transform rural economies. Such models not only improve farm profitability but also generate employment for rural youth, artisans, craftsmen, and both skilled and unskilled workers.

By creating local employment opportunities and strengthening rural livelihoods, agrotourism initiatives play a vital role in reducing rural-to-urban migration. Therefore, documenting, promoting, and replicating successful agrotourism and ecotourism models can significantly contribute to sustainable rural development and inclusive economic growth in India.

Scaling SRT and Conservation Agriculture

The Saguna regenerative technique (SRT) and conservation agriculture (CA) have demonstrated significant benefits in enhancing productivity and sustainability. Their successful outcomes have encouraged widespread adoption among farmers in the region. Given this momentum, there is an urgent need to integrate SRT and CA into ongoing government programs and schemes, to promote large-scale adoption, ensure sustainability, and maximize socio-economic and environmental benefits. The following strategies need to be adopted for scaling SRT and conservation agriculture:

- Integrating Saguna Regenerative Technique (SRT) into national programs such as National Mission for Sustainable Agriculture (NMSA), *Paramparagat Krishi Vikas Yojana*

(PKVY), *Rashtriya Krishi Vikas Yojana* (RKVY), and *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY), especially in aspirational districts with rice–based systems.

- Supporting farmers to adopt no-till permanent raised beds through convergence with the Sub-Mission on Agricultural Mechanization (SMAM) for custom-hiring centers and zero-till implements.
- Embedding SRT-based demonstrations into KVK field level demonstrations (FLDs), State Department demonstrations, Agricultural Technology Management Agency (ATMA) farmer-participatory learning, and ICAR's CA research clusters.
- Strengthening farmers training and exposure under ATMA, *Rashtriya Krishi Vikas Yojana* - Remunerative Approaches for Agriculture and Allied Sectors Rejuvenation (RKVY-RAFTAAR) which is a flagship scheme of the Ministry of Agriculture and Farmers' Welfare, Government of India, designed to make farming a profitable economic activity, and State Agricultural Management and Extension Training Institutes (SAMETIs) to demonstrate cost savings (30–40%), water-use reduction (50%), and SOC gains.

Promoting Use of Biofertilizers and Biopesticides

The innovative farmers–friendly initiatives of developing biofertilizers and biopesticides have successfully demonstrated enhanced agricultural production and ensured sustainability. This shows the massive need and scope of biofertilizers in Indian agriculture. This success story is an inspiration to all the youth of the country that research-backed entrepreneurship will yield highly promising results. The Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) and *Paramparagat Krishi Vikash Yojana* (PKVY) programs encourage the use of biofertilizers. Through direct benefit transfer (DBT) for on-farm and off-farm organic inputs, including biofertilizer, farmers receive financial assistance of ₹15,000/ha for a period

of three years under the PKVY scheme. Farmers receive financial support under MOVCDNER for off-farm and on-farm organic inputs, including biofertilizer, at a rate of ₹ 32,500 per hectare for a period of three years. ICAR recommends the integrated use of fertilizers and manures. Biofertilizers, both in liquid and powdered form, have been developed and promoted under the All-India Network Project on Soil Biodiversity. Biofertilizers for phosphorus solubilization, nitrogen fixation, potassium, and zinc solubilization suitable for different crops across the country are developed, and many of them are commercialized.

For replicating biofertilizer entrepreneurship and on-farm adoption, the following strategies need to be adopted:

- Aligning biofertilizer promotion with PKVY, MOVCDNER, NFSM, and Soil Health Card (SHC) recommendations to promote a 25–50 per cent reduction in chemical fertilizers.
- Establishing regional biofertilizer incubation units under RKVY-RAFTAAR, ICAR–ABI, and MSME schemes.
- Strengthening quality control and certification through State Biofertilizer Quality Laboratories and ICAR–NBAIM guidelines.
- Integrating digital advisory platforms (like AgriApp) with State Agriculture Departments for farmer-centric nutrient advisories.
- Promoting community action for biofertilizer application under agricultural extension schemes.

Conserving and Cultivating Landraces

Conserving and cultivating *Navara* rice organically and using it for its medicinal value for people's welfare is an exciting and inspiring success story. These types of successful models need to be promoted and scaled-up for the economic empowerment of the farming community. To encourage the farmers and farming communities for conserving the landraces of different crops,

the Plant Genome Savior Award is provided, which recognizes farming communities for their significant contribution towards conservation of plant genetic resources. Instituted by the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), it is given annually in different categories: (i) Plant Genome Savior Community Award for a community (₹10 lakh), (ii) Plant Genome Savior Farmer Reward for an individual farmer (₹1.5 lakh), and (iii) Plant Genome Savior Farmer Recognition (₹ 1.0 lakh).

The following strategies are applicable for scaling *Navara* rice conservation, and value chain can be applied for conserving the landraces of other crops:

- Supporting *Navara* clusters under GI-based crop development, One District One Product (ODOP), and State Organic Farming Missions duly supported by intensive ICT back-up.
- Facilitating infrastructure development for seed purification, drying, storage, value addition, and marketing through *Pradhan Mantri Formalization of Micro Food Processing Enterprises* (PMFME), Mission for Integrated Development of Horticulture (MIDH) and *Rashtriya Krishi Vikas Yojana* (RKVY).
- Integrating *Navara* eco-tourism with Kerala Responsible Tourism Mission and *Swadesh Darshan* 2.0 for rural tourism development.
- Implementing community fencing and wildlife-conflict compensation schemes under the Forest Department, Crop Insurance, and State Disaster Mitigation Funds.

Resilience in Dairy Farming

The success story on Resilience in Dairy Farming, is an example of strong purpose and vision to transform the lives of people and meaningfully contribute to attain social, economic, and environmental sustainability. Specialized skill and knowledge in the most emerging field of dairy farming are helping the dairy farmers

revolutionize milk production. Through the subject skills combined with emerging issues relating to dairy farming, representation in international platforms such as the Global Forum on Agricultural Research (GFAR), the Food and Agriculture Organization of the United Nations (FAO), Youth Alliance for Zero Hunger (YAZH), will be an inspiration to educated youth for transforming agriculture in India. This success story is a torchbearer to many non-agrarian students for utilizing their strengths and skills in the agricultural field and empowering Indian agriculture.

Replication strategies for livestock and dairy entrepreneurship on the lines suggested below will be extremely useful:

- Aligning dairy entrepreneurship with *Rashtriya Gokul Mission* (RGM), National Livestock Mission (NLM), and Animal Husbandry Infrastructure Development Fund (AHIDF).
- Promoting fodder innovations-seed availability and poplar–dairy agroforestry systems through the National Agroforestry Policy, National Mission for Sustainable Agriculture (NMSA), and State Fodder Missions.
- Integrating clean-milk and residue-free production models into dairy cooperatives, FPOs, and private dairies.
- Strengthening farmer collectives like the Terai Dairy FPO through Small Farmers' Agri-Business Consortium (SFAC), National Bank for Agriculture and Rural Development (NABARD), and Dairy FPO Scheme.
- Developing youth-focused dairy incubation and mentoring under KVK ARYA Program, and RKVY-RAFTAAR.
- Addressing primary healthcare and nutrition supplements for dairy animals.

Integrating Farming and Value Chain

The success story on "Adversity to Prosperity" is an excellent example of women's empowerment on an entrepreneurial

journey which has clearly established, how leadership can shape communities with direction and a goal. The training provided to hundreds of women and guidance to their SHGs in the right direction in value addition and networking have helped the women earn additional income of ₹8,000-10,000 per month. The schemes, such as *Mahila Kisan Sashaktikaran Pariyojana* (MKSP), *Rashtriya Mahila Kisan Yojana,* will help young entrepreneurs to enroll and empower other women farmers. This is a good example of how a leader with vision and purpose will lead the followers to great success.

The following strategies are suggested for scaling up the women-led integrated farming and value addition:

- Integrating Farming System (IFS) demonstrations into ATMA, KVKs, NFSM, and RKVY for wider replication.
- Providing equipment support for processing units through PMFME, NRLM, MSME schemes, and State Food Processing Missions.
- Linking women SHGs engaged in value addition to NRLM, Day-NRLM Producer Enterprises, and State Rural Livelihood Missions.
- Providing branding, marketing, and e-commerce support for value-added products through PMFME, ODOP, and TRIFED/ State Handloom and Handicraft Boards.
- Developing capacity building of farm women and SHGs in IFS, processing and value addition.

Aquaculture Development for Farm Profitability

Fish farming is an important and challenging sector to enhance the farm profitability of the farming community. The success story on Fish Farming in North India is a good example of determination, and courage to enter into fish farming against the socio-cultural beliefs of the community. It is a business model which involved research activities, funded many research projects

of students, and motivated people to adopt fish farming on a large scale. This needs to be replicated within the state of Haryana and also the neighboring states. For youth to take up entrepreneurship in fish-based startups, they can get support from the schemes of respective state governments and the *Pradhan Mantri Matsya Sampada Yojana* (PMMSY), a transformative scheme for the fisheries sector for the welfare of fishermen under the aegis of the Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. It aims to address critical gaps in fish production and productivity, quality, technology, post-harvest infrastructure and management, and strengthen the value chain.

Strategies recommended for scaling the fisheries and aquaculture activities are as follows:

- Integrating hatchery–grow-out–processing clusters under *Pradhan Mantri Matsya Sampada Yojana* (PMMSY), supporting infrastructure such as nurseries, RAS, IPRS units, cold chains, and retail outlets.
- Promoting fisheries entrepreneurship under PMMSY's Entrepreneurship Model, offering 40–60 per cent capital subsidies.
- Institutionalizing farmers training using impactful fisheries models through ICAR-CIFE, ICAR-CIFRI, ICAR-CIFA, State Fisheries Departments and National Fishery Development Board (NFDB).
- Supporting the development of fish FPOs through NABARD, SFAC, and PMMSY's cooperative strengthening component.

Innovative Solutions for Sustainable Agriculture

The BioPrime story showcases a potent combination of scientific rigor, strategic resourcefulness, and unwavering dedication to a sustainable future. As BioPrime continues to make steady progress towards agricultural innovation, expanding globally and strengthening strategic collaborations, it is on the right path

to serve for more sustainable and resilient agriculture and become one of the most successful biological companies in the world. As an enterprise, taking the huge scientific research knowledge and transforming it into field-level technologies is a game changer for Bio Prime, which has made its place in global markets and was also awarded the FICCI-BIRAC Women in Entrepreneurial Research Award, recognition among the BioAg Top 10 Innovative Startups in Rio de Janeiro, the Samunnati Women Startup Leaders Award, and the Global BioAg Innovation Award in India.

The following strategies are suggested for scaling of Agri-Tech and Biological Enterprises:

- Integrating biostimulant and biological pesticide use into IPM, INM, NFSM, and State Plant Health Missions.
- Supporting R&D industry farmer collaboration under ICAR–ABI, DBT–BIRAC, Startup India, and Agriculture Infrastructure Fund (AIF).
- Facilitating international certification, regulatory clearances, and export facilitation using APEDA, MPEDA, and ICAR–ABI networks.

The Way Forward

Across India, the success stories of innovative agri-entrepreneurs—from agrotourism, biofertilizers, organic farming, and dairy entrepreneurship to women-led value addition, fish farming, and biotechnology— emphasize the significance of rural India as a sustainable agriculture transformation hub. Agrotourism is an innovative extension model that combines livelihood diversification with rural rejuvenation. Employment opportunities are created, and rural-urban migration is curtailed. The entrepreneurship in biofertilizers illustrated the impact of science-based enterprises on enhancing farm productivity, reducing dependence on chemicals, and improving soil health. The conservation-based farming model underscores the value

of indigenous genetic resources in agriculture and the welfare of people. Women-led enterprises in dairy farming and self-help group (SHG) development, highlighted the transformative impact of empowering women with leadership, technical, and financial skills. Their efforts created enhanced livelihood opportunities and also reshaped community dynamics by developing confidence and self-reliance among rural women. Likewise, the success story on fish farming stands as an evidence to courage, innovation, and the power of challenging socio-cultural norms to create new economic opportunities. The emergence of technology-driven agribusinesses demonstrated the potential of biotechnology in building climate-resilient and globally competitive agricultural systems. Collectively, these stories signify that rural India is no longer confined to subsistence agriculture but is steadily moving toward knowledge-intensive, innovation-led, partnership and value-driven agri-enterprises.

Strengthening Research–Extension Linkages

The success stories clearly demonstrated that strong research–extension linkages are driving innovation at the farm level. Farmer-led experimentation, continuous technical support by KVKs, SAUs, and ICAR institutes, and iterative refinement of practices such as SRT, biofertilizers, indigenous rice conservation, integrated farming, and aquaculture models collectively strengthen technology adoption. Enhancing these linkages at the cutting edge level through collaborative on-farm trials, joint scientist–farmer learning platforms, and real-time advisory mechanisms is essential for scaling these innovations across diverse agro-climatic zones.

Integrating Lessons into Public and Private Extension Systems

There is a need to integrate the proven lessons from these models into public and private extension channels. Public extension

systems, including State Agriculture Departments, KVKs, ATMAs, can incorporate these success stories into experiential learning modules, farmer field schools, and demonstrations. Private extension platforms, agri-tech companies, input firms, and FPO-led advisories can operationalize these learnings through digital tools, customized package of practices, and pay-for-service models. Strengthening convergence between public and private extension will ensure that validated technologies reach farmers rapidly and at scale. Further, outcome of such success stories may be integrated in training modules in HRD institutions at various levels.

Motivating and Promoting Farm Youth and Women Agripreneurs

The experiences documented clearly highlight the significant potential for youth and women to become drivers of agricultural transformation. Creating opportunities for them requires promoting agripreneurship through targeted incubation, skill development, mentoring, and access to seed funding under programs such as RKVY-RAFTAAR, ACABC, PMFME, AIF, and PMMSY. Encouraging youth-led FPOs, cooperative enterprises, biological input startups, dairy and fishery enterprises, and integrated farming projects can translate success-story insights into sustainable business models. Showcasing role models from within the community and building peer networks are essential to inspire replication. Successful youth enterprises across the sectors may provide upscaled social recognition to the farming.

Providing Institutional Backup for Replication at Scale

Replicating these successful models at scale requires strong institutional support that combines supportive public policy, affordable and timely credit, efficient markets, and continuous access to innovations. Linking farmers and rural entrepreneurs to credit windows under AIF, NABARD, NRLM, NLM, PMMSY, and dairy and fisheries infrastructure funds is critical. Strengthening

market linkages through ODOP, PMFME, eNAM, cooperatives, and FPOs will ensure assured demand and fair prices. Institutionalizing climate-smart technologies, biological inputs, mechanization services, and value-chain infrastructure through coordinated efforts of ICAR, State Departments, financial institutions, and private players will create an empowering ecosystem for widespread and sustained replication of these success stories. A collaborative, multi-stakeholder approach involving research institutions, the public and private sectors, and cooperatives will be vital to ensure the holistic development of the rural enterprise ecosystem. Capacity building, incubation, and mentoring initiatives under programs like RKVY-RAFTAAR, NAIF (ICAR), and ACABC are necessary to strengthen entrepreneurship development, with a particular emphasis on women and youth. To promote technology transfer, adaptive research, and field validation before large-scale deployment, ICAR institutes, startups, and industry should collaborate to support research-backed entrepreneurship. Necessary dialogue with farmers, farmer's organizations (FOs) and related stakeholders is essential to drive ownership when a technology is introduced for farmer participatory or adaptive research. Before the transfer of a technology, it would also be essential to lay out well-conceived field research or pilots to validate adaptive research findings. By aligning national missions, strengthening institutional frameworks, and nurturing farmers, the nation can pave the way for a self-reliant, resilient, and globally competitive agricultural sector that truly embodies the vision of *Atmanirbhar Bharat*.

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Brief Resume

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