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Enhancing livelihood security of Bundelkhand

farmers through integrated farming system

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Bundelkhand, a semi-arid region spanning parts of Uttar Pradesh and Madhya Pradesh in India, is characterized by its challenging agro-climatic conditions. Recurrent droughts, erratic rainfall, and poor soil fertility have long plagued the agricultural productivity of the region. As a result, farmers often face economic instability and food insecurity. To combat these challenges, the implementation of Integrated Farming Systems (IFS) has emerged as a promising strategy. IFS offers a promising approach to enhance the livelihood security of farmers in the Bundelkhand region, which faces challenges like water scarcity, soil degradation, and climate change. By combining diverse agricultural practices, IFS can optimize resource utilization, improve soil health, and increase overall farm productivity.

Keywords: Bundelkhand, Integrated farming system, Livelihood, Resource recycling

BUNDELKHAND is an important region of Central India that is spread in the geographical area of 7.08 million ha includes 14 districts, seven each of Uttar Pradesh and Madhya Pradesh and supports 1.84 crore (as per 2011 census) of socio-economically and culturally diverse population. Bundelkhand has a hot and semi-humid climate with high variability depending on the region and with gently sloping upland, distinguished by barren hilly terrain having sparse vegetation, although it was historically forested. The soils in the Bundelkhand region have developed from Vindhyan rocks abounding in gneiss and granites of the Deccan trap with highly ferruginous beds and often soft lime stone. Mono-cropping along with livestock rearing is the major farming practice in the region. Majority of the farmers depend on subsistence type of farming to meet assured, regular and balanced supply of foods along with some cash income for fulfilling family needs. Groundnut, black gram, sesame, wheat, chickpea and mustard are the major crops grown in the region. Winter is the main cropping season and farmers leave their cattle free after harvesting of winter crops and allow them for open grazing-cum-rearing which restrict crop cultivation during summer and rainy season. The production system in Bundelkhand region, is ecologically sensitive due to various climatic and soil constraints. The agriculture in Bundelkhand region is characterized by low and stagnant crop productivity, declining profitability, energy shortage, higher natural resource degradation (soil and water), absolute poverty and malnutrition. Moreover, agriculture here is a risky occupation as erratic rainfall often leads to crop failures. The lack of alternative employment opportunities results in higher emigration from rural areas towards big cities in search of livelihood. Sustainable livelihood security seems to be a challenging task under the existing farming situation. Studies conducted in Bundelkhand region revealed that integrated farming system interventions including improved varieties with agro-techniques, round the year green fodder supply, fruits and vegetables, improved farm machinery and drudgery reducing tools, etc., enhanced productivity, profitability and livelihood of farmers.

Integrated farming systems: A pathway to resilience

IFS offers a holistic approach to address the multidimensional challenges of Bundelkhand's farmers. By integrating multiple components, it maximizes productivity per unit area and reduces dependency on external inputs. The components of IFS are described below:

Crop diversification

Crop diversification should get importance since it not only imparts diversity in the farm produce, but

Vegetables

BN hybrid + cowpea (fodder)

also reduces risk of crop failure due to various weather calamities such as drought and water logging which are major risk factors in Bundelkhand. It will also guarantee minimum production at least for livelihood sustenance under highly unfavourable circumstances. Crop diversification in Bundelkhand over the period has gained momentum due to overall input assurance, irrigation facility, economic growth, diversification in food basket, better market institutions, credit availability, infrastructure, urbanization, contract farming and improving rural education level. It was found that area allocation by the farmers under chickpea, pigeonpea, lentil, sorghum, small millet, pearl millet and linseed crops was reduced over the period of time. The area has shifted towards more profitable crops with less infestation of pests & diseases which includes blackgram, pea, green gram, wheat, barley, sesame, mustard and groundnut. In this region, crop diversification has major positive effect for small millets, sesame and blackgram crop owing to less risk and higher water economy. In Bundelkhand, agroforestry model that integrates trees and shrubs with crops should be promoted. Multipurpose tree species like teak, neem and Melia can provide livelihood support to the resource poor farmers. However, the tree species like Moringa provides nutritional security.

Livestock integration

Livestock is an integral part of IFS and one of the highest revenue generation components. Integrating livestock components with crops and the production of eggs, meat, and milk leads to nutritional security and stable income generation for farmers. Animals feeds on fodder and crop residue produced in IFS and animal manure enriches the soil with organic matter and essential nutrients, reducing the need for synthetic fertilizers. Small ruminants, especially goats are an important component of the rainfed farming systems in semiarid tropics. Inclusion of goats in the rainfed farming system may further enhance the profitability and reduce the associated risk.

Water resource management

The rain water harvesting proved to be the key for reducing chances of crop failures due to droughts, ensuring double cropping (cropping intensity up to 200%) and sustainable intensification in rainfed areas. Integration of in-situ and ex-situ water harvesting practices holds promise to bridge the yield gap while ensuring sustainable intensification and livelihood resilience in the smallholder farming systems. Farm ponds and check dam structures can capture and store rainwater during monsoons, providing a reliable source of water for irrigation during dry spells. The stored water is used through drip irrigation system for their efficient utilization.

Farm pond for supplemental irrigation

Soil health management

The landscape is undulating with characteristics hillocks soil of the region. Soils of the region exhibit greater heterogeneity with regard to texture, depth, fertility (low OC= <0.4%) leading to operational and management problems. In some of the part of this region, there is notable problem of soil erosion and deep ravenous areas due to its topographic gradients & geological setup. Organic practices should be promoted to improve soil fertility, reduce chemical inputs, and enhance soil biodiversity. Crop rotation should be used to break disease cycles, improve soil structure, and maintain nutrient balance. Similarly, green manuring crops should be incorporated to add organic matter and improve soil fertility.

Performance of IFS

The productivity and livelihood associated with monoculture/monocropping based production systems

of Bundelkhand region of Uttar Pradesh is uncertain, owing to prevailing adverse climatic conditions. As a solution to this problem, ICAR-IGFRI, Jhansi with a decade long research effort, has developed various climate-resilient and sustainable integrated farming systems for different agro-ecologies such as irrigated-IFS, rainfed-IFS, urban dairy-IFS etc (Table 1).

- ***Model 1*:** The intensive IFS model of one-ha size besides producing multiple products (grains, fruit, vegetable, fodder, milk, fish, etc.) also resulted in ₹108,638 net return with a benefit cost ratio of 1.58 and generated 293 man-days/year employment as against ₹ 83,655 net return and 119 man-days in groundnut–wheat cropping system. The IFS approach ensured round the year supply of income and a farmer can get approximately ₹ 17,225 to 38,805 every month while he gets income only twice a year by adopting double cropping. Further, nearly 10.22 tonnes of farmyard manure and 2.5 tonnes of farm compost were recycled under IFS that improved soil health as compared to the double cropping.
- ***Model 2*:** The high value crop-based IFS comprising of fruits, vegetables, forage crops and livestock generated net returns of ₹ 146,529 per hectare with benefit to cost ratio of 1.78. The model is labour intensive and generated employment of 336 mandays.
- ***Model 3*:** The small holder dairy-based IFS generated 82.7% more net return (₹ 162,593) with 1.52 benefit cost ratio. The model also generated 251% more employment (418 man-days/ha/year) than groundnut-wheat system. The dairy-based IFS recorded more soil biodiversity (earthworm, fungal, and bacterial count) and by-product recycling (20.4 tonnes farm yard manure and 1.98 tonnes farm-compost).
- ***Model 4*:** The rainfed goat-based IFS model produced 4,979 kg/ha barley equivalent yield consisting of multiple products like barley, chickpea, groundnut, Indian jujube fruits, sesame, fodder (sorghum, *Pennisetum* TSH, Stylosanthes, Leucaena dried leaf meal and spine-less fodder cactus cladodes) and Grewia fruits. The carrying capacity of the above model was 9 and 35 goats under intensive and semi-intensive rearing systems which generated ₹57,989 and ₹ 138,824 per ha, respectively.
- ***Model 5*:** The rainfed forage based IFS model produced total 5,926 kg/ha chickpea equivalent yield and multiple provisioning services including grains, fruits, straw, green fodder, milk, meat, fuel-wood, etc. The model generated net income of ₹ 86,281 with 1.6 benefit to cost ratio.

Table 1. Economic performance of different IFS models developed by IGFRI (Mean of 4 years)

Model	Component	Total cost (₹/ha)	Net returns (₹/ha)	BCR	Employment generation (mandays/ha/yr)
Intensive IFS with balanced enterprises	0.3 ha groundnut – wheat 0.2 ha agri-horticulture (guava + seasonal vegetables) 0.25 ha sorghum – mustard 0.2 ha BN hybrid + cowpea – berseem Water harvesting cum fish pond (20 m × 25 m × 2.5 m) 1 Murra buffalo and 1 cross bred cow	188,151	108,638	1.58	293
High value crop based IFS	0.3 ha agri-horticulture (guava + seasonal vegetables) 0.2 ha groundnut – wheat 0.2 ha seasonal vegetables 0.3 ha BN hybrid + cowpea – berseem 1 Murra buffalo and 1 cross bred cow	188,505	146,529	1.78	336
Dairy based IFS	0.2 ha agri-horticulture (guava + groundnut– wheat) 0.4 ha sorghum – wheat 0.4 ha BN hybrid + cowpea – berseem and 2 Murra buffalo and 2 cross bred cows	315,478	162,593	1.52	418
Rainfed goat based IFS	0.3 ha groundnut - barley 0.25 ha sorghum - chickpea 0.2 ha silvipasture (Subabul + TSH grass + stylo) 0.2 ha agrihorticulture (Ber + sesame - chickpea) Farm pond (20 m × 25 m × 2.5 m) 9 goats with intensive goat rearing system	86,718	57,989	1.6	149
	0.3 ha groundnut – barley 0.25 ha sorghum – chickpea 0.2 ha silvipasture (Subabul + TSH grass + stylo) 0.2 ha agrihorticulture (Ber + sesame - chickpea) Farm pond (20 m × 25 m × 2.5 m) 35 goats with semi-intensive goat rearing system	200,877	138,824	1.7	273
Rainfed forage based IFS	0.3 ha greengram – chickpea 0.15 ha sorghum – oat 0.3 ha silvipasture (Subabul + TSH grass+stylo) 0.2 ha agrihorticulture (Ber+TSH+sesame-chickpea) Farm pond (20 m × 25 m × 2.5 m) 5 goats and 1 cross bred cow	155,363	86,281	1.6	204

Implementation strategies for IFS in Bundelkhand

Adopting IFS in Bundelkhand requires coordinated efforts across stakeholders, including government agencies, research institutions, and local communities. Key strategies include:

***Capacity building and training*:** Farmers need training in resource management, modern agricultural practices, and the economic benefits of diversification. Extension services can play a pivotal role in knowledge dissemination.

***Water management innovations*:** Developing water harvesting structures, such as check dams and percolation tanks, will ensure reliable water supply. Drip irrigation and sprinkler systems can improve water-use efficiency.

***Financial and policy support*:** Subsidies and low-interest loans for adopting IFS components, such as purchase of livestock or drip irrigation systems, can ease the transition for small and marginal farmers. Policies encouraging agroforestry, organic farming, and renewable energy adoption will promote long-term sustainability.

***Market linkages*:** Establishing farmer-producer organizations (FPOs) can improve market access and bargaining power. Value addition through food processing and branding of regional products can boost profitability.

***Research and development*:** Developing location-specific IFS models that consider Bundelkhand's unique agro-climatic conditions will enhance adoption. Collaborative research can also identify drought-resistant crop varieties and efficient animal breeds.

A success story of integrated farming system (IFS) adoption

One of the successful models of ICAR-IGFRI, Jhansi, was adopted by a progressive farmer, Mr. Malkhan Pal, from Padri village, Jhansi, Uttar Pradesh. He owns eight hectares of land, which he strategically allocated as follows: 40% for food crops (rice, wheat, mungbean), 28.3% for fodder crops (berseem, oat, lolium, sorghum, maize, pearl millet, cowpea, guar, perennial BN hybrid grass, etc.), 20% for vegetables (bitter gourd, brinjal, cowpea, tomato, chili, okra, potato, radish, cabbage, bottle gourd), 1.7% for flowers (rose and marigold), and 3.3% for fruit crops (moringa, ber, citrus, papaya, karonda, and guava).

Under the livestock component, Mr. Pal owns 24 buffaloes, 3 cattle, 40 sheep, and 20 goats, totaling to 30 Animal Care Units (ACUs). He also incorporated allied enterprises such as mushroom cultivation, vermicomposting, silage production, and azolla farming into his model.

The annual production from this integrated farming system (IFS) model was highly promising, yielding diverse products viz. 146 q of food grains, 402 q of vegetables, 5 q of flowers, 1597 q of green fodder, 7 q of fruits, 62,050 litres of milk, 25 kg of mushrooms, 10 q of silage and 33 q of vermicompost.

In addition, by-products included 225 q of crop residues, 4.5 q of fuelwood, 0.8 q of sheep wool, 1800 q of FYM, and 1250 kg of goat and sheep meat.

The net economic return from this model was ₹ 7.9 lakhs, with an investment of ₹ 10.2 lakhs per ha, achieving a Benefit-Cost ratio of 1.77. The model also ensured round-the-year employment of 1,006 man-days per ha annually.

As a result of adopting this model, Mr. Malkhan Pal increased his income by 24% while achieving a 15% reduction in production costs. A pre-post comparison over five years showed significant benefits, including 18% improvement in crop productivity, 14% increase in milk productivity, 13% enhancement in fodder availability, 16% improvement in soil fertility, 9% increase in cropping intensity, 14% reduction in the use of chemical fertilizers and 97% recycling of crop-animal by-products.

The key factors contributing to Mr. Pal's successful adoption of the IFS model were his knowledge, interest, and participation in various capacity-building programs. These included a 3-day training program on integrated farming systems at IGFRI, field days, demonstrations, *gosthies* (farmer meetings), and learning through extension literature.

Inspired by Mr. Malkhan Pal's success, 10 other farmers from neighboring villages have shown interest in adopting the IFS models developed by ICAR-IGFRI. These farmers are now enhancing their incomes, improving their livelihoods, and achieving better socio-economic status.

SUMMARY

Integrated Farming Systems offer a comprehensive solution to the challenges faced by Bundelkhand's farmers. By enhancing resource efficiency, diversifying income sources, and promoting environmental sustainability, IFS can significantly improve livelihood security in the region. The success of this approach hinges on proactive policy support, capacity building, and community participation. With concerted efforts, Bundelkhand can transition from vulnerability to resilience, ensuring a better future for its farming communities.

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