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# Integrated dairy farming system model for fragmented landholders issues and mitigation strategies in North India

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**Abstract**

A vital component of India's rural economy, the livestock industry employs millions of marginal, small and landless farmers and substantially contributes to the country's food supply. The cattle industry has shown resilience throughout time, continuously registering positive growth rates despite hardships like droughts. Small and marginal farmers mostly depend on cattle as a source of income, devoting a sizeable amount of their budget to animal husbandry. The economic surveys conducted in 2016–17 and 2017–18 emphasize how livestock contributes more to agricultural revenue overall, underscoring the sector's expanding importance. Women are vital to the cattle industry and many of them are involved in dairy groups. A comprehensive strategy for enhancing the livelihoods of small and marginalized farmers, Integrated Farming Systems (IFS) encourages resource efficiency, food security and recycling of nutrients. IFS provide options for employment, revenue generation and sustainable production by combining field crops with farm animals. IFS improves environmental sustainability, profitability and productivity by managing resources well. Different models have been created to improve farm revenue and productivity in the context of dairy-based IFS. These models provide small farmers with a holistic solution by combining crop growing, hydroponics, vermicomposting and other related practices with dairy farming. To bolster the dairy-focused industry, steps need to be taken, including making loans to small farmers hassle-free, encouraging the use of sex-sorted semen technology, creating online marketplaces for bovine germplasm, applying genomic technology to breed improvement, and incorporating livestock into agricultural systems. The livestock industry is greatly aided by research and development, which focuses on topics including breed improvement, thermostable vaccinations, ethno-veterinary treatment and animal feeding plans unique to a certain location. India can increase agricultural production, guarantee food security and improve farmers' livelihoods in a sustainable way by focusing on dairy-based IFS development and provide the required assistance.

**Keywords:** Integrated farming, dairy farming, production, livestock, crop

## 1. Introduction

Animal Husbandry and Dairying is an integral part of the Indian rural economy. Not only does it provide large employment opportunities to landless, small and marginal farmers, it also contributes significantly to the food basket by providing nutritious food to millions. While the percentage contribution of the sector to overall Gross Value Added (GVA) is relatively small (around 4%), it contributes significantly in terms of providing livelihood opportunities to rural households, as more than 65 million households in India are engaged in animal farming activities and more than 73% of rural farming households rear livestock (NITI Ayog, 2021) [17]. As observed in the Doubling Farmer's Income Report - Performance of Agriculture and Allied sector, Livestock Sector has never recorded a negative growth rate in the period from 1980 to 2015 which included several years of drought as well. This trend has been true for the subsequent years i.e. 2016 to 2018 (NITI Ayog, 2021) [17]. The livestock industry proved that it can be counted on to reduce risk and farmers' losses, even in the most dire circumstances involving other subsectors. It is also expected to become the primary driver of the agriculture sector's expansion.

The dependence of small and marginal farmers on livestock, as reported in Economic Survey of 2016-17, is very high. Among the households that possess less than 0.4 hectares of land, almost 50 percent of average household spending on valuable resources is incurred on livestock and poultry. Economic Survey 2017-18 has highlighted the increasing livestock's percentage of overall farm revenue. According to the study, livestock's percentage of overall agricultural revenue grew from 4% in 2002–03 to 13% in 2012–13.

Livestock is one of the sectors where women play significant part and are engaged actively for livelihood. Nearly 43.8 lakhs women producers are involved in diary societies and number of all dairy women societies is also growing at an annual growth rate of about 10%. Considering the increasing share of livestock in farm income of small and marginal farmers and increasing participation of women in livestock sector, the need of re-orientation of government policies towards increased focus on allied activities such as dairying and livestock development have been highlighted in Economic survey 2017-18 (Agriculture and Food management, 2018) [9].

With the objective of improving profitability from the agriculture and allied activities and ensure farmers' income

security, diversification towards high value agricultural activities like livestock rearing activities is needed. Income from this sector can be further improved by ensuring healthier and quality output through implementation of better animal husbandry practices, selection of breeds and focusing on safe and secure post-harvest management systems.

## 2. Integrated farming system (IFS)

The IFS is a systematic farming method designed to raise the standard of living for small and marginal farmers. The IFS encourages higher fertilizer and natural resource efficiency while improving food security and nutrient recycling. Field crops and farm animals should be integrated well for sustainable production, revenue creation, and job possibilities for rural farm households with limited resources. A collection of interconnected agro-economic activities that interact in a specific agricultural environment is known as an integrated farming system. The primary goals are to reduce risks and boost revenue. Approximately 90–95 percent of the nutrients needed are met by recycling resources, which lowers cultivation costs and boosts employment and revenues.

### 2.1 What is the goal of IFS

Varughese and Mathew, 2009 [26] observed that sustainable agriculture is deemed to be the goal of conservation of natural resources, environment protection, and increased prosperity on a sustainable basis. Agro-economic activities that are interconnected and take place in a specific agricultural environment are called farming systems. The main thrust is to reduce risks in diversified farming, although the crop and other enterprises co-exist there. Integrated Farming Systems ensure a rational mixture of one or more elements and cropping, resulting in a complementary effect through the productive use (recycling) of wastes and crop residues. The IFS is regarded as a potential source of extra revenue for the farming community. The IFS assumes increased attention to effective use of available agricultural resources to enhance production in addition to avoiding environmental degradation, according to Dhaka *et al*., 2009 [7]. The integrated farming system was an appropriate approach to minimize risk and increase production, profit, and employment with better resource utilization. Integrated farming was conceptualized by Tony Worth, 2012 [24] as a whole systems approach to farm management and a whole farm strategy. By managing livestock, fodder, fresh produce and arable crops well, farmers may supply safe, healthful, and high-quality food to customers in an ecologically responsible and economically viable manner. These efforts aim to generate efficient and lucrative food. He also provides conservation and enhancement of the environment to society.

### 2.2 Why IFS is needed

Integrated farming systems are increasingly recognized as essential for sustainable agriculture due to their multifaceted benefits. By integrating crops, livestock and other agricultural enterprises, IFS optimize resource use, enhance soil fertility through nutrient cycling and mitigate risks associated with climate change and market fluctuations. This approach not only diversifies farmers' income sources but also promotes environmental sustainability by reducing emissions of greenhouse gases and conserving natural resources. Moreover, IFS contribute to social well-being by improving food security, creating employment opportunities, and enhancing rural livelihoods. IFS reduce risks due to biotic and abiotic stresses and high input cost for meeting rising demand in food, feed and fibre. Overall, IFS represent a holistic farming strategy that addresses productivity, profitability, and environmental stewardship in agriculture.

## 3. Dairy based IFS system

According to Devendra's (2011) [6] research, there are three different kinds of dairy production systems: smallholder, smallholder cooperative and intensive. When it came to increasing intensity, the first two systems were the most significant. Buffaloes dominated the South Asian area, although Holstein-Friesian crossbred cattle were the mainstay of dairy production systems. The Indian economy depends heavily on the husbandry of animals, which accounts for 25.6% of all agricultural GDP and 4.11% of GDP. More than two thirds of rural communities rely on livestock for both their food and means of subsistence. In the India total population of Cattle is 192.49 million in latest livestock census (2019) [1], its showing increment of 0.8% over previous Census. A massive rise in cross-bred cattle and a greater female indigenous cow population are driving the growth. Female Cattle (Cows population) is 145.12 million, which is increased by 18.0%. Nonetheless, compared to the last census, the overall number of Indigenous cattle (both descript and non-descript) has decreased by 6%. With 203.5 million tons of milk produced annually, India ranks first globally in the number of cow. Around 49% of milk is produced by buffaloes & 49% by cattle, of which 57% come from crossbreds between indigenous (*Bos indicus)* and exotic (*Bos Taurus*),dairy cattle while India’s latest national estimates (2019-2020) place the average milk yield per animal per day markedly lower for Crossbred Cows (8.09 kg/day) and for Indigenous Cows (3.90 kg/day) than those found in the US (30 kg/day) and the UK (22 kg/day).

Approximately 65% of the people living in Uttar Pradesh, India are employed in agriculture. The most widely grown crops in the Western Plain Zone of Uttar Pradesh are sugarcane, rice, and wheat. Through these crops, the farmers in this region can meet their demands for sustenance but not their need for grains. A healthy diet deficiency results from the farmer's diet's lack of fruits, vegetables, dairy products, and animal proteins. Consequently, the IFS method is thought to be the most crucial in terms of enhancing family nutrition and financial stability. The crop-based research methodology and cropping systems must give way to agricultural-system-based research, especially for small farmers (Jha *et al*., 2011) [9]. The two key components of the IFS are enhanced land-use efficiency and residue recycling. Based on agro-climatic variables like land type, water availability, farmer socioeconomic position, and market demand, the IFS's components and companies differ by area. To build efficient, comprehensive agricultural systems, components must have strong connections and complementarities with one another (Bell *et al*., 2014) [3].

Integrating land-based enterprises such as aquaculture, poultry, duckeries, apiaries and field and horticultural crops into farmers' biophysical and socio-economic environments is crucial in the IFS to make farming more profitable and dependable (Behera *et al*., 2004; Rautaray *et al*., 2005; Kashyap *et al*., 2015) [2, 20, 12].

The proper management of crop wastes and an appropriate allocation of scarce resources lead to sustainable production for resource-poor farmers. When properly selected, organized, and carried out, a combination of one or more crop operations yields higher returns than a single venture, particularly for small and marginal farmers. Agro-forestry, agri-horticulture, pisciculture, sericulture, production of biogas, mushroom cultivation, dairy, and poultry are a few of the industries that contribute significantly to farm revenue. Tripathi and Rathi (2011) [25] identified different existing farming system models from Uttarakhand such as: crops + dairy, crops + dairy + horticulture + goats, crop + goats + horticulture, crop + dairy + vegetable, vegetable + fish and crop + dairy + other animals. These were the elements in IFS there.

### 3.1 Integrated approach for development of village using livestock by products

A comprehensive strategy for village development that makes use of livestock by-products includes a number of projects meant to improve livelihoods and sustainability. These include the creation of modern Gauthan, the production of biofertilizer (Govaerts *et al*., 2009) [8], the establishment of the Modern Milk Cooperative Society, the production and distribution of balanced fertilizer (from digester effluent), the provision of biogas/methane to villagers for daily cooking activities, the production of electricity using solar energy, the establishment of a small cattle feed plant, the conservation of indigenous breeds, the purchase of cow dung and the production of organic farm produce. This integrated approach not only enhances agricultural productivity and economic resilience but also fosters environmental sustainability and community well-being.

Under this a complete bio gas plant is installed with additional provision of balloon for storing the produced gas and screw press based slurry drying machine for drying of slurry and producing dried mass. The dung is collected/purchased from the villagers and nearby area. It is fed in to the plant and the produced gas is distributed among 135 house of the village through pipe line. The slurry is separated in to two parts one is dried manure and another is liquid which is high in nutrients and beneficial microbes.

In type 1 and type 2 households, low milk output in dairy animals as a result of ignorance regarding mastitis infection was a highly serious limitation (Table 1). Raising awareness about hygiene to prevent mastitis and inclusion of mineral mixture in feeding schedule to increase milk fat content are the farming systems interventions envisaged for dairy cattle. Poor egg production in layer chicken due to rearing of non-descript desi chicken breed was a constraint of medium severity in the type-2 household (Table 2) (Ragar *et al*., 2022) [21]. The farming approach that was intended to enhance the health of animals in every family was routine deworming. The dairy farmers of Northern area are experiencing several problems like high cost of veterinary service and medicine, high cost of cattle feed, non-availability of green and dry fodder round the year, high labour cost, lack of need based training, non-availability of high yielding milch animals. These concerns require being addressed by the U.P. government and veterinary department to increase livestock output and farmer revenue.

Horizontal land growth for agriculture is no longer possible due to population explosion, fast land holding fragmentation and loss of productive cultivated area. Integration of enterprises promotes financial, social and environmental sustainability in addition to helping to provide food, nutrition, and livelihood security (Kumar *et al*., 2017) [14]. Crop and livestock integration benefits both parties since animal excrement may be used as a natural fertilizer to increase crop yields and to maintain soil fertility, whereas crop residues can be used as animal feed, and weeds and other waste materials can be converted into vermin-compost.

The most effective farming system for preserving environmental balance and sustainable agricultural growth, according to the data currently available, is the integrated crop-livestock farming system. It also can improve resource efficiency, the sustainable use of ecological services, and the general resilience of dairy production systems. Therefore, the focus must be placed on the expansion and improvement of the dairy-based IFS module for various scenarios to fit into the socio-economic domain of small and medium-sized farmers and, at the same time, be able to sustainably provide revenue throughout the year. ICAR-NDRI began research on "Developing dairy-based integrated farming system model for income enhancement of small farmers" considering these facts.

### 3.2 Dairy Component

A dairy unit shed having adequate facilities with sufficient open and covered area and concrete floor covered with rubber mats were used for housing of animals. Crop residues, straw, fodder cowpea, Hybrid Napier and berseem were used as per availability of fodder. Cattle and buffaloes fed on an average 25 kg green fodder was provided to animals after chopping to reduce the wastage round the year. When dairy animals were lactating, supplements of polyherbal combination and UMMB were given. The range for each animal every day was 100–315 g. To achieve the nutritional requirement as per the ICAR, 2013 standard, concentrate feed was additionally given at a rate of 1 kg of every 2.5 kg of milk. The dung and shed waste were recycled into the system through vermicomposting and composting; and washing of the shed are recycle to fish pond. Milk yield during morning and evening were recorded daily.

### 3.3 Crop component

The suggested package of techniques was followed for growing the several crop components, such as rice during the kharif season, wheat during the winter and maize/sorghum-cowpea-corn during the summer. Crop waste was used for vermicompost, and crop leftovers were recycled and fed to dairy cows. The system grew fodder crops according to the seasons. Berseem (BL-42) and Mustard (Chinese cabbage) and oat (Kent) were cultivated in the rabi season; cow pea and maize were produced in the

kharif and summer seasons; *Moringa oleifera* and Hybrid Napier-perennial fodder were grown in rows to ensure a year-round supply of green and nutrient-dense fodder. Cowpea and berseem were planted as intercrops in between the rows. Based on the farmers' realization of the technologies' potential, the area of each enterprise is computed. The year-round availability of green fodder was a significant issue, thus focus was placed on producing high-quality green fodder and creating feeding plans for dairy animals.

**Table 1:** Cost and returns of different components of dairy based IFS

| Details (in Rs) | C + B: 6 (12 m) | Goats-10 (18 m) | Poultry (12m) | Ducks (3 m) | Fish (25x15x3 m) | Vermi (4 pits) - compost | Papaya (2) |
|---|---|---|---|---|---|---|---|
| Fixed cost | 3,62,000 | 72000 | | | 24000 | 5000 | |
| Interest + Dep. on FC @ 18% | 97740 | 12,960 | | | 4320 | 1350 | |
| Variable cost | 535740 | 511880 | 12650 | 4400 | 9600 | 4000 | |
| Gross cost (FC+VC) | 633480 | 164840 | 12650 | 4400 | 13920 | 5350 | 300 |
| Gross return | 871705 | 278580 | 27565 | 5320 | 30960 | 15,000 | 1000 |
| Net return | 238225 | 113740 | 14915 | 920 | 17040 | 9650 | 700 |
| B:C ratio | 1.38 | 1.69 | 2.18 | 1.21 | 2.22 | 2.80 | 3.33 |

(Regar *et al*., 2022) [21]

A total of 7580 liters of milk were produced by buffaloes, 6308 liters by cattle and 6012 liters by goats. 350 kg of fish and 257 eggs were sold through the system. One complete cycle of vermin compost produced 1000 kg vermin-compost. Effect of polyherbal mixture supplementation on milk production in cattle was evaluated. Supplementing with a polyherbal combination showed an average 21.53% increase in milk output, with a cost-benefit ratio of 1:10.21 (Bipate and Misra, 2020) [4].

The overall returns from Dairy, Crops and subsidiary enterprises were calculated and observed to be 59.89%, 32.75% and 7.36% respectively. Similar results recorded in a comparative study conducted in Karnataka by Channabasavanna, *et al*., (2009) [5] that Comparing the IFS technique to the standard rice-rice system, productivity and profitability were found to be 26.3 and 32.3 percent higher, respectively. However, another investigation by Kaur *et al*. (2021) [13] in IIFSR, Modipuram on various types of interventions, including waste recycling, improved livestock rearing techniques, diversified crops, improved crop cultivation practices, and the inclusion of poultry, reported increases in income ranging from 84.8 to 103.2 percent. The adoption of integrated farming approach could generate per hectare additional income, depending on inclusion of kind and number of additional farm enterprises and their effective combination as reported by Ponnusamy and Gupta (2009) [18].

**Table 2:** Cost and returns (Rs.) of different enterprise as a whole system of dairy based IFS

| Details | Gross cost | Gross return | Net return | B:C ratio |
|---|---|---|---|---|
| Dairy | 6,33,480 | 8,71,705 | 2,38,225 | 1.38 |
| Goat | 1,64,840 | 2,78,580 | 1,13,740 | 1.69 |
| Poultry | 12,650 | 27,565 | 14,915 | 2.18 |
| Ducks | 4,400 | 5,320 | 920 | 1.21 |
| Fish | 13,920 | 30,960 | 17,040 | 2.22 |
| Papaya | 300 | 1,000 | 700 | 3.33 |
| Vermi-compost | 5,350 | 15,000 | 9,650 | 2.80 |
| Wheat | 23,400 | 57,200 | 33,800 | 2.44 |
| Rice | 19,500 | 30,400 | 10,900 | 1.55 |
| Berseem + Mustard | 25,200 | 72,000 | 46,800 | 2.86 |
| HN | 59,000 | 1,26,300 | 67,300 | 2.24 |
| Maize + cowpea (2:1) | 15850 | 49500 | 33650 | 2.12 |
| IFS as a whole | 9,77,890 | 1,56,5530 | 5,87,640 | 1.60 |
| Return/year | | | 3,91,760 | |

(Regar *et al*., 2022) [21]

**Farm Model I**: **Paddy + Small dairy + Vermi-compost + Hydroponics +Vegetable with drip irrigation + Fish farming**

In this model, a farmer with total landholding of 2.5 acres takes up paddy cultivation in 1.0 acre in Kharif season, dairy farming in 0.2 acres, farm pond in 0.25 acres and vegetable cultivation throughout the year in the remaining. He also under takes hydroponics to provide green fodder for rearing livestock and vermi-composting to provide low cost manure, improve soil health condition and to reduce cost of cultivation. The total capital cost is estimated to be about Rs. 4.68 lakh and recurring cost Rs. 2.92 lakh. The total net income from all activities would be in the range of Rs. 3.57 lakh to Rs. 3.89 lakh per annum. The project would give an IRR of 350%. The bank loan (75% of project cost) can be repaid in 3 years with one year moratorium period.

Farm Model II: Paddy + Small dairy + Vermi-compost+ Hydroponics +Papaya +Vegetable (both with drip irrigation) + fish farming

Farm Model III: Paddy + Small dairy + Vermi-compost+ Hydroponics +Papaya + vegetable (both with drip irrigation) + Fish farming+ Poultry farming.

### 3.4 Measures to strengthen dairy centric sector

**i. Measures for hassle-free loan to small and marginal farmers**

These farmers need easy access to funding in order to make investments in dairy infrastructure, buy premium cattle and implement contemporary farming techniques, all of which will boost their output and stability of income. These programs are essential for promoting equitable growth and strengthening local farmers, guaranteeing their involvement in the nation's goal for dairy development.

**ii. Sex sorted semen technology to increase bovine female population**

Sex sorted semen technology represents a significant advancement in the dairy sector, aimed at enhancing the population of bovine females in India. This technology allows for the selection of desired sex (female) during artificial insemination (AI), thereby optimizing breeding strategies and improving genetic diversity within indigenous cattle breeds like Sahiwal, Gir, and Tharparkar. This technology is a blessing to the farmers to adopt and use sex sorted semen, which would provide an additional economic return and help to overcome the limitations such as reducing the burden of male animal maintenance under the situation of agriculture mechanization, fodder and feed deficits. Sex sorted semen demonstrated very promising results under the majority of Indian small holder farm conditions, with a realized conception rate of 39.9% and a female to male ratio of 91:9 (Joshi *et al*., 2021) [11].

**iii. "E- PASHUDHAN HAAT" (e-market for bovine germplasm)**

E-PASHUDHAN HAAT uses technology to promote fair pricing and transparency in the market, as well as better accessibility to high-quality germplasm. These efforts help to progress and maintain the dairy sector as a whole. Farmers will be able to retain track of their cow's historical data, including health, fertility, and productivity, via an online marketplace for buying and selling cattle (Kumar and Agarwal, 2020) [15].

**iv. Utilisation of Genomic Technology for Genetic Upgradation of Indigenous Dairy Cattle**

Because genomics has made it possible to accurately and efficiently select animals with better genetic potential, improve welfare, health, and productivity, and increase the overall sustainability of dairy cow populations, it has completely changed the breeding and management of dairy cattle (Stanojevic *et al*., 2023) [23]. Genomics technology has completely changed the way native Indian dairy cow breeds like Sahiwal, Gir, Tharparkar, and others are genetically improved. Researchers and breeders can find desirable genetic features linked to disease resistance, tolerance to local conditions, milk output, and feed efficiency by using sophisticated genomic methods.

**v. Effective Integration of Livestock with Agricultural Systems**

In order to address the impact of climate change, increasing livestock productivity and integrating it effectively into agricultural system is considered as an effective strategy. This would improve the soil health and water retention by returning the valuable biomass to the soil and would help in drought proofing. Such recycling of carbon into the soil would not only enhance the soil quality but also help in carbon sequestration. Use of livestock as draft power can reduce the need for fossil fuels. Methane generated from animal waste could provide cooking fuel for rural households through developing biogas energy solutions resulting into increased carbon sequestration.

**vi. Animal Breed Improvement**

To enhance milk production, feed conversion efficiency, growth, reproduction and disease resistance animal breed improvement programs is used. Artificial Insemination is one the most used technology implemented for genetic progress in the bovine population. There are around 113264 AI centers 205 along with 60 semen production centres and 179 frozen semen banks in the country which cater to 1,332.71 lakh breedable female bovines. By adopting AI technology in breeding of animals not only the milk productivity has been enhanced, genital and non-genital diseases in the farm stock have also been reduced considerably. However, in order to implement AI for all breedable bovines, the existing infrastructure has to be increased by at least 25%.

**vii. Dairy Herd Management through Radio Frequency Identification (RFID) Technology**

RFID can enhance automated data gathering that offers fast access to dairy herd data used to enhance feeding and management procedures (Prasad *et al*., 2013) [19]. Additionally, RFID automation will help reduce labor input (Singh *et al*., 2014) [22]. The procedure is helpful for proving ownership, controlling biosecurity, maintaining records, managing farms effectively, registering, insuring and reporting animal theft.

**viii. Processing and Value Addition**

The dairy industry's economic expansion and diversification are greatly aided by the production of khoya, paneer, and other confections. In addition to satisfying a wide range of customer tastes, these value-added products boost dairy farmers' and processors' marketability and earnings.

**xi. Insurance and Credit**

Livestock plays an important productive asset in rural economy, especially for small and marginal farmers in India. Increasing livestock population and intensive rearing practices expose livestock to risk of diseases and shortage of fodder. Diseases can lead to productivity losses and even death. Livestock insurance can play an important role in risk mitigation for livestock owners by providing security from financial losses due to death and disability of productive livestock.

**x. Marketing**

A2 milk is perceived to be having better health benefitsthan the A1 milk primarily derived from high yielding breed such as Holstein Friesian and some crossbreds. The Indian indigenous breeds and buffaloes mostly produce A2 milk and it fetches a higher price when marketed as A2 milk. Concerted efforts should be made to promote A2 milk as

superior health product. A2 milk products can become a unique selling proposition for selling in export markets

**xi. Healthcare and Extension Activities**

All the animals should be uniquely identified to ensure traceability. The surveillance system such as INAPH should be utilized to track the health of animals. System to be developed for annual diagnosis of all animals as regards the diseases such as TB, FMD, Brucellosis etc. apart from general animal health.

## 4. Research and Development

Research and Development need to be focused on promotion of sexed semen of indigenous breeds for regular breeding. The investment for the same may not necessarily come from public sector budget. Existing international and Indian companies in the sexed semen business may be guaranteed a minimal off take by the State Governments/ Cooperatives/ Private sector to ensure viability. This will address the problem of male calves, at the same time ensuring genetic purity of indigenous breeds, while improving productivity. The important areas where focus needs to be provided for R&D are Ethno-veterinary medicines, broiler/ buffalo/ goat/ sheep similar to poultry (which is only reared for meat), dry dairy to address stray cattle (cow dung, urine for medicinal purpose and organic manure), thermo stable FMD vaccines with longer immunity, recovery of IVF embryos, research on heat tolerance capabilities and disease-resistance capabilities of Indian

breeds and region specific animal nutrition strategy for cows and buffalos

## 5. Conclusions and way forward

Results suggest that dairy-based integrated farming structure can improve resource use efficiency and overall production system resilience. It has also increased output and earnings while ensuring food and nutritional security through a consistent supply of milk and eggs throughout the year. Therefore, the focus must be placed on developing dairy-based IFS modules for various scenarios to fit into the socio-economic domain of small and medium-sized farmers and simultaneously be able to sustainably provide money throughout the year. Availability of key inputs and support services needs to be strengthened and improved to enable the small and marginal farmers for dairy based IFS development. A favorable legislative framework for microloan accessibility and assured market will have to be provided for up scaling the developed models.

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