ENTREPRENEURSHIP THROUGH INTEGRATED FARMING PRACTICES

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West Bengal University of Animal & Fishery Sciences (WBUAFS)

&

National Institute of Agricultural Extension Management (MANAGE), Hyderabad

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MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

India is an agrarian country. Agriculture and animal Husbandry remains key sector of the Indian economy accounting for around 25 percent share in the gross domestic product. Increased number of people and unemployed graduates living in rural areas are migrating to urban areas in search of jobs. But the country is unable to create ample job opportunities along with economic development. Very poor infrastructure and facilities in rural areas aggravated the population pressure on the urban infrastructure. In this situation this e-book tries to examine the aspects of taking Integrated farming based entrepreneurship with Animal Husbandry, Fishery and allied farming as a career and the solution of the problem. In this new millennium the need is combined, and a composite model is based on the basic principal rural employment provider shaping the profile of local entrepreneurs.

It is a pleasure to note that, West Bengal University of Animal & Fishery Sciences (WBUAFS), and MANAGE, Hyderabad, Telangana are jointly publishing e-book on "Entrepreneurship Development through Integrated Farming Practices" as an immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also I wish West Bengal University of Animal & Fishery Sciences (WBUAFS) many more glorious years in service of Indian Animal Husbandry and allied sector ultimately benefitting the rural stakeholders. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE, Dr. Sushrirekha Das, MAANAGE Fellow, MANAGE Hyderabad, Prof. A. Goswami and Dr. Sukanta Biswas, WBUAFS, Kolkata, for this valuable publication.

Dr. P. Chandra Shekhara
Director General, MANAGE

FOREWARD

Animal Husbandry is the means of sustainable livelihood of rural stakeholders, which significantly contribute in the economy of rural India. It was considered a cost effective livelihood venture, which is dominated mainly by small and marginal landholders. However, in recent times, the situation has changed significantly due to economic liberalization and globalization. Sustainable Animal Husbandry and fishery based Integrated farming practices in the present knowledge-based economy requires knowledge not only of the latest technological tools for raising farm animals, Poultry, Fishery farming practices, but also of how to operate a successful enterprise. Entrepreneurship transforms an idea or vision into a new business or an improvement of an existing business. One of the strategies for economic progress is the creation of employment through holistic integrated farming oriented entrepreneurial ventures. Thus, entrepreneurship through Integrated Farming system (IFS) is recognized as the engine of economic growth across the globe. Hence, developing entrepreneurship through IFS farming capabilities among the younger generation is of paramount importance.

In view of this, the promotion of entrepreneurship in the Animal Husbandry sector assumes significance for boosting Livestock-Fishery businesses as well as increasing the value-addition of livestock-fishery products. This will reduce unemployment, increase efficiency in resource utilization and finally, enhance the income of the rural farming community an unemployed youth of the Country.

In this context, I am gratified that the West Bengal University of Animal & Fishery Sciences (WBUAFS) Kolkata, and National Institute of Agricultural Extension Management (MANAGE), Hyderabad jointly publishing e-book on “Entrepreneurship Development through Integrated Farming Practices”. The e-book is designed to enable participants from different states to understand entrepreneurial opportunities in veterinary, dairy, fisheries, agriculture, horticulture, and allied farming sectors.

I compliment the authors and editorial team of WBUAFS, Kolkata and MANAGE, Hyderabad for publication of an e-book as visionary document for better sustainable application and adoption of the technological practices in holistic development of the state as well as Country

Prof. Arunasis Goswami
Professor & Former
Director, WBUAFS,
Kolkata

PREFACE

India's agriculture industry is rife with undiscovered economic prospects. India faces challenges in its agribusiness because of an unorganised, inefficient farming system and underutilised resources. The government has implemented a number of programmes to improve the agricultural community and boost revenue. Small, dispersed holdings and a lack of capital investments make India's particular environment unsuitable for the single commodity farming methods used in richer nations. In order to increase the production and revenue of small and marginal farmers who have limited resources, the integrated farming system looks to be a workable alternative for Indian agriculture. Since integrated farming does not follow any certain pattern and may be developed based on the facilities and land type available, it can be used to any circumstance. Adoption of an integrated agricultural system can lead to greater job options for rural residents as well as better entrepreneurial prospects for graduates. As it involves little costs and generates significant profits, it will be a better business alternative for female entrepreneurs.

This e- book will form a ready reference and provide an extensive knowledge base on Integrated Farming Practices for the young entrepreneurs.

We are really grateful to WBUAFS, Kolkata, and MANAGE, Hyderabad, for jointly publishing the e-book on "Entrepreneurship Development through Integrated Farming Practices". We also thank the authors who provided timely and insightful contributions to this publication. We are confident that the extensive content of this e-book will be extremely beneficial to extension workers as well as field employees from the line departments.

A.Goswami,
Shahaji Sambhaji Phand,
Sukanta Biswas
Sushrirekha Das

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ENTREPRENEURSHIP THROUGH LIVESTOCK BASED INTEGRATED FARMING SYSTEM (IFS) IN SUSTAINABLE LIVELIHOOD

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INTRODUCTION:

Entrepreneur term is derived from French word **'Entrepredre'** which means to undertake i.e. the person who undertakes the risk of new enterprise. Entrepreneur is one who organises, operates and assumes the risk in a new business venture in an expectation of making a profit. The Entrepreneur introduces something new in the economy, which may be a new product or process or find a new market for a product or process already known. The person is hardworking, optimistic, risk taker and set high target of goals and tries to achieve those amidst odd situations.

General characteristics of an Entrepreneur are- commitment and determination, leadership, opportunity obsession, tolerance of risk, ambiguity and uncertainty, creativity, self-reliance and ability to adapt & motivation to excel etc. So, Entrepreneurship is a dynamic process with Innovation and risk bearing as its two basic elements involving multiplicity of activities towards establishment of an enterprise. Entrepreneurship or Enterprise is called Udyog & Entrepreneur is Udyogi or Udyogpati. The term Entrepreneur first used by Rechard Cantillon in 1755.

Entrepreneurship: Need in Economic Development

Entrepreneurship in one of the most important input in the economic development of a Country. This plays a pivotal role not only in the development of industrial sector, but also to the development of farm & service sector in the Country.

Entrepreneur Role in economic development of the country:

- Promote capital formation
- Create large scale employment opportunities

- promotes balanced regional development
- Reduces concentration of economic power
- Wealth creation and distribution
- Increasing gross national product and per capita income
- Improvement in the standards of living
- Promotes countries export trade
- Induces backward and forward linkages
- Facilitates overall development

Qualitative Attributes of an Entrepreneur:

The Entrepreneur is known for their special attributes, which makes them entrepreneurs. There is no sex determination (Male/Female), to become an Entrepreneur as all are equally competent to become entrepreneur in any sector.

Qualitative Attributes of an Entrepreneur:

Functions of an Entrepreneur:

The important functions of an Entrepreneur are presented as follows:

Idea generation: Most important functions of Entrepreneurs. Idea generation is possible through vision, experience, observation, training & exposure of the entrepreneur.

Raising of funds: All the activities of a business depends upon the finance & its proper management. It is the responsibility of the entrepreneur to raise funds internally & externally.

Procurement of Raw materials& Machinery: This is also important functions to identify chief and regular source of supply of raw materials to reduce production cost. Procure equipment's & machinery to setup the venture.

Market Research: Entrepreneur has to undertake market research persistently in order to know details of the intending products i.e. demand for product, nature & size of the consumer & price of the product etc.

Recruitment of Manpower: Entrepreneur has to recruit staff as per need & size of the organisation. Training may also be imparted for CBP.

Implementation of the project: Identified project is to be implemented at time bound manner. All the activities from the conception steps to commissioning stage are to be accomplished in accordance with the implementation schedule to avoid cost & time overrun.

Types of Entrepreneurs:

Broadly classified as per the types of business, use of technology, growth, stage of development, area, organization & gender etc.

Various Types of Entrepreneurs:

Business Entrepreneur:

The individual who conceive an idea for a new product or service and then creates a business by utilising both production and marketing resources.

Agricultural Entrepreneur:

They undertake agricultural activities such as- raising & marketing of crops by mechanization, value addition and application of technology etc.

Veterinary, Dairy & Fishery Entrepreneur:

They undertake activities such as- raising & marketing of livestock, Poultry & their products as well as fish and fish product by mechanization, value addition and application of technology etc.

Technical Entrepreneur:

They develop new and improved quality of good because office craftsmanship, concentrates more on production than marketing.

Women Entrepreneurs:

In 1988, for the first time, definition of women entrepreneur was evolved. The most popular activity of women was food processing, garments making etc.

Rural Entrepreneurs:

According to area entrepreneurs may be classified as rural or urban or global entrepreneurs. Rural entrepreneurs include rural artisan, village industries, handicrafts and handlooms etc.

Induced Entrepreneur:

They are induced or motivated to take up an entrepreneurial task due to the policy measures of the government that provide assistance incentives concessions and other facilities to start a venture.

Fabian Entrepreneur:

This is characterized by great caution and scepticism in practicing any change. Such entrepreneurs do not want any changes and not desire to adopt new methods. They are shy & lazy, their dealings are determined by customs, religion, tradition & past practices.

Phases of Entrepreneurial Venture:

Several phases in Entrepreneur venture as follows:

Phase-I-Preparation:

Preparation deals with search for solution, seeking information about the problems which arise during the entrepreneur process

Phase-II- Incubation:

It is the stage of subconscious assimilation of information, where it is allowed to ferment. The process of mental fermentation allows the entrepreneur to collect and assimilates relevant information and develops clarity of thinking.

Phase-III Idea Generation:

Various ideas & Solutions are generated at this state the approaches to problem solving relating to the new venture at tested in real life situation using the individual research previous experiences inside and risk.

Phase-IV Identification of Enterprise:

This may come from unsatisfied needs of an entrepreneur as well as unsatisfied personal need. The most important task in this phase is to identify a solution, which is likely to be successful and profitable in the long run.

Phase-V Initiation of Enterprise:

Entrepreneur needs to create an organisation to transform the concept into marketable products by utilising and combining physical and other resources. The entrepreneur interact with the environment to transform ideas into reality.

Phase-VI Nurturing of Enterprise:

Organisation translates the business concept into marketable products or services and offers it to the customer. The entrepreneur gets feedback or market response in terms of sales and profitability etc.

Phase-VII Concluding Phase:

Entrepreneurial process does not end with achieving stability and success. The organisation shall require different managerial style as the environment changes and competition gradually builds up more and more.

Process of Entrepreneurship Development:

EDP is a process involving number of phases and steps which are as follows:

Stimulatory Phase: This Phase includes all activities that generate awareness and willingness among the specific target group. Important activities under this stage are-

Support Phase: This phase includes all such activities that help entrepreneurs to setup and run their enterprises. The activities in this phase are-

Sustaining Phase: The activities in this phase are those that help the entrepreneur in continued efficient and profitable running of the enterprise. These includes-

The process of Entrepreneurship development does not end with sustain phase, it is a continuous cycle.

Integrated farming system (IFS) as sustainable entrepreneur venture:

IF means combining crop production with livestock management that complement each other in a way that is a well-symbiotic relationship that is currently economically viable and profitable, environmentally friendly, and benefiting from the diversity of production. In IFS, agriculture can be integrated with livestock, poultry, and fish are kept in one place to create year-round employment and additional income.

It is a combination of different agricultural activities in a unit area of land aimed at;

1. Maximum return from unit area
2. Maintaining soil status and fertility
3. Ensuring supplementary and complementary enterprise relationships to use the by-products of one component of the farming system as inputs to the other
4. To reduce environmental pollution.

Elements of integrated Farming System:

- Farm Ponds
- Biological Pesticides
- Biogas
- Bio-fertilizers
- Solar Energy
- Vermi-compost making
- Green Manuring

● Rainwater harvesting
● Watershed management

Advantages of an Integrated Farming System:

● Integrated farming can generate a steady income through products such as eggs, meat, milk, vegetables, silkworms, and cocoons. Cultivation of fodder crops such as intercropping and border cropping will result in the availability of nutritious fodder for animals.

● Energy-saving - The IFS system effectively reduces the additional dependence on fossil fuels as a source of energy by providing alternative fuel sources as by-products of various enterprises. Example of biogas.

● Meeting the fodder crisis - Perennial legume fodder trees can be grown within the boundaries of the farm. These bean trees not only fix nitrogen for the field but also provide quality fodder for the animals.

● Solving the Fuel and Timber Crisis - Fuel and industrial wood production is achieved through IFS. It also reduces deforestation and helps protect the natural ecosystem.

● Employment Generation - The combination of agricultural and livestock enterprises will increase the demand for labor and increase employment opportunities.

● Agro-industries-The high production of agro-products in IFS also greatly contributes to the growth of agro-industries and agribusiness in the country.

● Increased input efficiency - Input efficiency in this farming system has increased significantly as dependence on external inputs such as fertilizers, food, agrochemicals, and energy has decreased.

● Yearly income-Due to the variety of businesses in IFS, the farmer earns year-round income. It has a positive effect on farmers' lifestyle components such as food, shelter, health, and education.

● The improved production system is one of the most important benefits of integrated farming. An increase in productivity means that economic yield per unit area per unit increases over time due to the intensity of crops and allied farming enterprises.

● As productivity increases, so does the profit margin. This is because we are using the waste material or by-product of one enterprise as input to another farming enterprise.

● Adopting new technology is one of the major benefits of an integrated farming system. This is because money is needed to adopt the technology. Large farmers have finances so they can easily adopt it. However, small farmers generally face financial constraints. But because of the integrated farming system, they have the opportunity to increase their profits from farming and adapt to new technologies.

Integrated Farming System Models

Integrated farming can have many variants that can be used according to the environmental conditions of the place. This may include combinations such as;

- Fish and livestock integrated system
- Fish-duck integrated farming
- Cattle-fish integrated farming
- Integrated fish farming with agriculture
- Fish farming with vegetable farming
- Integrated fish farming with rabbit farming
- Integrated fish with pig farming

Approach to increase overall productivity & sustainability of ifs:

- Adopting a better cropping system based on rainfall and soil moisture availability,
- Selection of suitable varieties of cereal crops, species of trees that provide pods/leaves for a long period or the whole year.
- In the rainy season extra fodder leaves, crop residues, etc., should be stored as silage/grass for the lean season (summer).

Limitations of Integrated Farming System:

- Lack of awareness about the sustainable farming system.
- Unavailability of various farming system models.
- Lack of easy and reasonable interest rate credit facilities.
- Unavailability of certain marketing facilities, especially for perishable products.
- Lack of storage facilities.
- Lack of timely availability of input.
- Lack of education/knowledge in farming communities especially rural

Preparation of project in integrated farming system (IFS):

To prepare an Entrepreneurial Scheme, this should have component as follows:

- Technical assumptions
- Fixed &working capital
- Expenditure & Income schedule
- Bank repayment schedule
- Economic feasibility Analysis
- Bank Appraisal to finance the Project

Integrated project on goat -duck and fish farming project.

Total project cost : Rs. 7,32,000/-

Margin money (25%) : Rs. 1,83,000/-

Loan component (75%) : Rs. 5,49,000/-

Few assumptions related to project:

- Total 50-bigha lands in which 30 Bigha as pond/water surface is of farmer's own property and rest 20 Bigha for fodder cultivation.
- To maintain adlibidum supply of green fodder 7 acres (21 Bigha) of land is to be cultivated with Hybrid Napier grass. Cost of cultivation and average production are assumed to be Rs. 2000/acre/year and 400-500 quintal/acre/years respectively.
- Average kidding interval is 8 months &Sex ratio in case of newborn kids is 1:1.
- Number of kids per kidding is 1 in case of 1st kidding and 2 in case of subsequent kidding. Breeding will be done after 15 months age in female & 18 months in male.
- Mortality rate of kid is 10% and that of adult is 5%.
- Age of doe at the time of purchase is 3 month & age of buck at the time of purchase is 6 month. Breeding ratio is 1:8.
- Selling age of the meat purpose goat (Male goat) is 1 year and Female goat as parent stock in one year. After 4th kidding, parent stock is to cull & new parent stock (150+20) is to be maintained from the existing stock.
- Space requirement- Buck -20 sq. ft./buck Doe -10 sq. ft./doe. Adult - 6 sq. ft./goat
- Feed requirement-
- Buck-200-gm/-day/ buck for 56 days during breeding season
- Doe -150 gm/ day/ doe for 42 days during breeding season
- Kid - 100 gm/ day /kid from 2 months.
- Cost of insurance in case of live animal is 4% of the insured amount.
- Cost of medicine is Rs. 25/ animal/ year for adult & Rs. 10/ kid/year.
- Depreciation rate of goat house equipment is 10%.
- Selling rate of male goat after 1year and female is Rs. 1000/ male and Rs. 800/ female respectively.
- Selling rate of culled male and female is Rs 1500/ male and Rs. 1200/ female respectively. Salvage value of dead is Rs. 100/- per animal.
- Cost of goat ration is Rs. 7/ kg.
- Rate of Bank Interest upon loan is 12%per annum.

- Instalment will start at the end of the second year and repayment will be made in four instalments (One instalment in a year).
- Income of selling gunny bags will compensate the miscellaneous expenditure of farm.
- To obtain 500 Khaki-Campbell laying ducks, 1100-day-old ducklings will be purchased. As genetically sex ratio is 1:1 so to obtain 500 female duck 1000 day old bird should be purchased & with this 10% of the total bird (100) is taken extra to cover mortality, culling etc. Sexing is not possible in day old ducklings, so after 2 months when sexing is done, the total 500 female ducks will be kept separately as laying stock & rest part of birds as drakes (500) are reared up to 6 months for selling as meat bird @ Rs. 40/- bird.
- In every Bigha of pond 1000-1500 fish lings are cultivated & after one year each fish will be average 800-1000 gms wt. Average 500 kg fish will be obtained in every Bigha pond & in 30 bigha (10 Acre) pond average 150-quintal fish will be obtained per year. Cost of fish is @ Rs.40/-per kg fish. The cost of fish ling @ Rs. 1/- per fish ling & the ratio of Rohui : Katla =1:1
- Rent of net for fish catching @ Rs. 2000/- per year.
- Labour charges for overall maintenance, feed supply and other works are @ Rs. 2000/- per month.
- Depreciation cost of duck house & others @ 10%on the cost.
- Mortality rate of fish @20%. Cost of electricity @ Rs. 600/- per month for farm. Dung as a bio- fertiliser is given @ 1000 kg per bigha and cost of dung @ Rs. 300/- per 1000 kg. So total cost of dung per year is9000/.
- Daily feed consumption up to (0-8 weeks): 4.5 Kgs& then in free-range system 40-50 gm feed/ Duck/day is required @ Rs. 8 /kg. Rest parts will be collected from pond, which is not taken, into account.
- Age of first egg laying starts in 140-150 days, but we assume that full laying starts at 6 months age & continue up to 2 years @ 180-200 eggs /duck/year upto 2 years where 80% duck will be productive & cost of egg @ Rs. 2/- per egg.
- Cost of Duckling is Rs. 15/- bird. Cost of insurance of duck @ Rs. 1/- per bird for whole life.
- In free-range system 2.5 –3 Sqft space is required per duck and the house is made at the bank of pond for easy drainage of litter & manure of duck in pond as it is integrated farming. The cost of construction @ Rs. 8 /- bird /sqft.

- Equipment's like- feeder, waterier, & others @ Rs. 4/- per duck.
- Selling of duck for meat purpose after the laying period @ Rs. 40/- per duck.
- Medicine, vaccine, litter cost for duck @ Rs. 8 /- per bird for every batch.
- Duckling mortality is 10% & Adult mortality is 5-7%

A. Fixed Expenditure:

a) Cost of Construction:

Space requirement	
Buck 20 X 20 sq. ft.=400	
doe160 X 10 sq. ft.=1600	
Adult goat 6 X 600 sq. ft.=3600	
Total space requirement= 5600 sq. ft	
Construction	**Cost**
Total cost of construction	Rs. (5600 X 50) = Rs. 2,80, 000/-
Cost of purchasing 120 doe	Rs. 500/ doe= Rs. 60,000/-
Cost of purchasing 15 bucks	Rs. 800/ buck=Rs. 12,000/-
Total cost to purchase animals=	Rs.72, 000/-
Construction cost for 2000 birds @3 Sqft/ bird @ Rs. 8/- bird/ Sqft.	2000X3X8=48,000/-
Cost of purchasing 15 bucks	Rs. 800/ buck=Rs. 12,000
Total cost to purchase animals	Rs.72, 000/-
Construction cost for 2000 birds@ 3 Sqft/ bird @ Rs. 8/- bird/ Sqft. So total cost:	2000X3X8=48,000/-
Cost of equipment's for Duck	Rs. 8,000/-
Cost of equipment's for goat	Rs. 10,000/-
Total cost to purchase animals=	Rs.72, 000/-
Construction cost for 2000 birds@ 3 Sqft/ bird	Rs. 8/- bird/ Sqft.
So total cost	2000X3X8=48,000/-
Cost of equipment's for goat	Rs. 10,000/-
Cost of equipment's for Duck	Rs. 8,000/-
Total fixed expenditure=	**Rs. (2, 80,000 + 72,000 + 18,000 + 48,000) = Rs 4, 18,000/-**

B. RECURRING EXPENDITURE (Rs.):

Items	1st year	2nd year	3rd year	4th year	5th year
Cost of IMC	45000	45000	45000	45000	45000
Cost of Duckling	16500	-----	16500	----	16500
Fodder cultivation	14000	14000	14000	14000	14000
Concentrate for goat	34493	51,660	1,03,201	79,359	1,11,510
Duck feed	110640	58400	139440	58400	139440
Cost of medicine, vaccine for goat	3375	4575	8760	7570	8250
Cost of medicine, vaccine for Duck	8800	---	8800	---	8800
Insurance for goat	2880	2880	4880	7280	4400
Iinsurance for Duck	1100	----	1100	----	1100
Cost of electricity	7200	7200	7200	7200	7200
Labour cost	24000	24000	24000	24000	24000
Depreciation cost of goat & Duck house	34,600	34,600	34,600	34,600	34,600
Cost of Dung & Net	11000	11000	11000	11000	11000
Total	3,13,588	2,53,315	4,18,481	2,88,409	4,25,800

Total Project Cost = Fixed Expenditure + Recurring Expenditure 1st year

Total Project Cost =3,13,588 + 4,18,000 =7,31,588/-

C. INCOME STATEMENT:

Items	1st year	2nd year	3rd year	4th year	5th year
Sale of goat (He)	---	---	34000	2,31,000	2,35,000
Sale of goat (She)	---	---	----	1,01,600	1,88,000
Culled buck	---	---	---	18000	---
Culled doe	---	---	---	1,32,000	---
Salvage value of dead	----	1200	4000	6500	5000
Sale of fish	600000	600000	600000	600000	600000

Sale of Egg	80000	160000	160000	160000	160000
Sale of Duck meat	20000	---	40000	---	40000
Total	7,00000	7,61000	8,38,000	12,49,100	12,28,000

D. BANK STATEMENT:

Year	Total loan	Interest	Installment without interest	Amount payable to bank	Balance at the end of year	Gross profit	Net profit
1st yr	5,49000	65,880	----	65,880	5,49,000	386412	320532
2nd yr	549000	65,880	1,37,250	2,03,130	4,11,750	507885	304755
3rd yr	4,11,750	49,410	1,37,250	1,86,660	2,74,500	419519	232859
4th yr	2,74,500	32,940	1,37,250	1,70,190	1,37,250	960691	790501
5th yr	1,37,250	16,470	1,37,250	1,53,720	----	802200	648480
						3076707	2297127

- At the end of the 5th year live animals of worth Rs.5,06,565 /- is kept to maintain the flow of the farm. Sell of eggs =1,60000
- After deducting the feed cost of duck rest amount remain is1,60,000 – 38,400 = 1,21,600/-
- Total Monetary stock at the end of 5th year is=5,06,565+ 1,21,600=6,28,165/-
- Therefore, net profit at the end of the 6th year is Rs. (22,97,127+6,28,165) = 29,25,292/-
- Therefore, monthly income from this project is Rs. 48,755/-
- Certified that, the project is economically viable and technically feasible.

ENTREPRENEURSHIP DEVELOPMENT PROGRAMME:

The programs designed to help a person to strengthen his entrepreneurial motives, to acquire skills & capacity is necessary for playing his entrepreneurial role effectively. There are several types of EDP program organised such as: EDP awareness trg, motivation program &product oriented EDP trg program, skill dev. program, MDP in the country.EDP program which aims to promote EDP & self-employment avenues in rural & urban areas of the country as follows:

- **National Institute for ETP& Small Business Dev. (NISBUD):**
  Institute was set up in 1983 by the Min. of SSI, GOI as an apex body for coordinating & overseeing activities of business institutions or agencies engaged in EDP particularly in the area of a small industry & business.

- **Entrepreneurship Dev. Institute of India (EDI):**
  EDI is an autonomous, non-profits institution set up in 1983 & sponsored by apex financial institutions namely-IDBI bank, SBI, IFCI limited, ICICI limited in Gandhinagar, Gujarat. www.ediindia.org.in
- **Indian Institute For Entrepreneurship (IIE):**
  IIE was setup in 1993 at Guwahati by the Min. of SSI, GOIas an autonomous national institute in the country.
- **Ministry of Small Scale Industries (MSSI):**
  The Min. of SSI, GOIis the nodal ministry for the formulation of policy, promotion, development& protection of SSI in the country.
- **Small Industries Development Organization (SIDO):**
  This was set up in 1954 on the recommendations of ford foundation. It provides a wide spectrum of services to the small industries sector through its 26 to offices and 21 autonomous bodies under its management.
- **National Small Industries Corporation Limited (NSICL):**
  NSICL is an ISO: 9001-2000 company was set up in 1955 by the GOI with a view to promoting, aid dost and faster growth of small industries in the country.
- **National Institute for Small Industry Extension & Training (NISIET):**
  The NISIET is an autonomous institute of the Min. of SSI, GOI& set up in 1960 as a premier institute for promotion, development & modernization of the small & medium scale industry sector in India.
- **Small Industries Dev. Bank of India (SIDBI):**
  SIDBI was set up in April 1990 under an act of the Indian parliament as a prime financial institution to promote, finance, development of small scale industries and co-ordinate functions of other similar institutions in the country.
- **Khadi and Village Industries Commission (KVIC):**
  KVIC is a statutory body was set up in April 1957 under the act of parliament and took over the work of former all India Khadi and village industries board of the Country.

SPECIALISED EDP PROGRAMS (EDP) IN INDIA:

There are a number of EDP programs for the development of Entrepreneurship in the country, which has made it a hotspot destination for start-ups in the country. The different agencies of Govt. training & consultancy programs for skill development & empowering rural educated youths in the country.

- **Prime Minister Employ. Generation program (PMEGP):**
- The PMEGP program is a central sector scheme administered by the Min. of MSME, GOI by merging two schemes namely PMRY& REGP that were in Operation till 31st March 2008. PMEGP is a new credit linked subsidy program for generation of employment opportunities through set up of micro-enterprises in rural as well as urban areas.
- **Swarna Jayanti Gram Swarozgar Yojana through SHG (SGSY):**
- **SGSY** program was launched by the Min. of RD, GOI with merging six programs as IRDP, TRYSEM, DWCRA, GKY, SITRA In 1st April 1997. The program is aimed at assisting the poor; realize realizing their latent entrepreneur potential to build sustainable self-employment developing micro Enterprises among the poor in the country.
- **National Institute of Rural Development (NIRD):**
- NIRD is an autonomous organization set up by Min. of RD, GOI in April 1962 as a NICD and renamed as a NIRD on 20th Sept. 1977. It focuses on strengthening PRI system & CBP of PRI functionaries to network of SIRD of states.
- **MANAGE:**
- MANAGE is located at Hyderabad is an Apex national institute set up in 1987 under the Min. of Agriculture, GOI for effective management of Agricultural Extension system through consultancy, Training, Education, Research information & documentation service. Recently manage implemented AC&ABC scheme to train Agri & allied graduates which provide service & advice to farmers on agriculture, animal Husbandry and allied activities & provided training for start-up loans on any specified ventures can be taken up by trained graduate individually or jointly.

RECENT REFORMS IN EDP PROGRAMS IN INDIA:

- **Ministry of Skill Dev. &ETP (MSDE):** The Department of SDE has come into existence on 31st July 2014 and later created as a Min. of SDE on 10th Nov. 2014. It is responsible for the coordination of all state-level EDP across the country for better skill and entrepreneurship development in India.
- **National Skill Dev. Mission &EDP Scheme:** NSD Mission was launched on 15 July 2015 by the GOI on World Youth skill day under the Min. of SKD, GOI. The mission is to create, convergence across sectors & states in terms of skilled training activities to achieve the vision of skilled India.

- **Pradhan Mantri Kaushal Vikas Yojana(PMKVY):** The PMKVY is a flagship outcome-based skill training scheme of the MSD&E,GOI on 16 July 2015. The aim of the scheme is to offer 24 lacs Indian youth a meaningful Industries relevant skills training to rural youth in the country.
- **Make in India & Start-Up India:**
- This initiative was launched on 25th Sept. 2014 by the GOI to encourage domestic &multinational Enterprises to manufacture their products in the country. This initiative will provide a new dimension to EDP & helps in setting up a network of start-ups in the country.
- **Atal Innovation Mission (AIM) & Self-Employ For Talent Utilization (SETU):**
- AIM platform was set up to 2015 budget with Niti Aayog, GOI to provide an Innovation& promotion platform involving academicians in the country on 24th Feb 2016.
- **Self-Employment for Talent utilization (SETU):**
- The Program was launched by Niti Aayog, GOI on 4th March 2016 with aims to create around 01 lakh jobs to start-up in the country. This is a techno financial incubation & facilitation program to support all aspects of start-up business & other self-employment activities in technology-driven areas of the country.
- **Venture Capital Fund (VCF):**
- *Venture Capital* is long-term financial assistance provided to projects which are set up to introduce new products, inventions, Idea and Technology in a business from Enterprise. Venture capital fund is most suitable to risky businesses which consist of huge investments and provides results after 5 to 7 years.
- **NABARD** is central level apex financial institution set up in 1986 by GOI to promotes rural EDP in farm &non-farm sector of country. They provide necessary guidelines &support including financial grant assistance to facilitate in rural EDP.
- **E.MUDRA:** MUDRA bank has been set up on 8 April, 2015 to develop micro-units to encourage EDP in India. The Mudra bank has launched three products namely- Shishu, Kishore and Tarun to signify the stage of growth and funding needs of the entrepreneurs. For loans to micro units having loan requirement of Rs.50, 000 to 10 lacs.
- **Central Financial Institutions**: IDBI Bank, Industrial Development Bank of India, industrial Finance Corporation of India, industrial credit and Investment Corporation of India,

- **State level EDP Trg institutes:** EDI at various States promotes entrepreneurship in the country at different level, like-Commercial banks & state financial corporations, small industries service Institute (SISI) District industrial centre (DIC) at district, subdivision, block & village level. Finally, this can be concluded that for successful farm & non-farm based EDP a comprehensive knowledge through skill based CBP, Entrepreneurial venture with motivation along with technically viable & economically feasible Project financing are the essential criteria for sustainable & holistic entrepreneurship in the Country.

CONCLUSION:

Entrepreneurship is an innovative dynamic process for all round social and economic development through self-employment generation, poverty reduction, and improvement in nutrition, health and overall food security in the national economy of India. In the face of growing unemployment and poverty in rural areas, there is an urgency of entrepreneurship development through implementation of scientific agriculture, animal Husbandry, Fishery and allied farming practices for more effective productivity and profitability. Advanced integrated farming practices through combination of animal Husbandry and allied farming system extend the best possible solution of this complexity reducing the burden of agricultural sector, produce more employment opportunities for educated rural youths, control migration from rural to urban areas, boost national economy as well as sustain the rural economic development in holistic way in the country.

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ADVANCES IN HOLISTIC FARM MANAGEMENT OF LIVESTOCK BASED INTEGRATED FARMING SYSTEM (IFS) PRACTICE

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INTRODUCTION:

India is basically an agrarian country and livestock rearing is an important sub-sector of Indian agriculture. This sector plays a significant role in supplementing family incomes and generating gainful employment in the rural sector, particularly among the landless labourers, small and marginal farmers and women. It provides nutritious food through milk, meat and egg to the millions of people. Poor farmers can enhance their family nutrition status by allowing domestic consumption of these products. Most of the rural families belonging to socio-economically weaker sections of the society maintain different species of livestock like cattle, buffalo, sheep, goat, pig and poultry to supplement their income. While the land owners prefer cattle and buffaloes, the landless poor's prefer to keep goat, sheep and poultry. Livestock act as the best insurance against the crop failure and vagaries of nature like drought, famine and other natural calamities. The livestock sector not only provides nutritious food but also plays an important role in utilization of agricultural by-products. Livestock also provides raw material by-products such as hides and skins, blood, bone, fat, feathers *etc*. for various industrial uses.

LIVESTOCK POPULATION AND PRODUCTION:

India has vast resources of livestock and poultry. The total livestock population including cattle, buffalo, sheep, goat, pig, horses & ponies, mules, donkeys, camels, yak and mithun in our country is 536.76 million numbers, and total poultry population including chicken, duck, turkey and other avian species is 851.81 million numbers in 2019 (20th All India Livestock Census, 2019). The species-wise population of livestock and poultry in our country is given in Table 1.

Facts File

- India ranks first in respect of buffalo population, second in cattle and goat population, third in sheep, fourth in duck and fifth in chicken population in the world. India has 12.8% cattle, 54.4% buffalo, 13.4% goat, 6.0% sheep, 2.4% chicken and 2.8% duck in respect to world's population. (Source: Based on 20th All India Livestock Census data, www.dahd.nic.in; FAOSTAT production data 2019, www.faostat.org*).*

- India continues to be the largest milk producer country in the world, with current milk production during 2021-22 was 221.06 million tonnes. [*Source: BAHS 2022, Department of Animal Husbandry & Dairying, Govt. of India]*
- The milk production in India has witnessed a phenomenal increase in the last few decades (Table 2), taking per capita milk availability to 444 ml per day during 2021-22 from a meager 130 ml per day in 1950-51. Present per capita milk availability in our country is more than the nutritional requirement of 300 ml per day (Table 3A, 3B).
- India ranks third in the world in egg production with 4.96% of world share, after China (40.64% of world share) and USA (7.85% of world share). (Source: FAOSTAT production data 2010, *www.faostat.org*). Present egg production in India is 129.600 billion numbers in 2021-22 (Table 2), and with per capita availability of 95 eggs/annum (Table 3A, 3B).
- The estimate of wool production in India is 33.13 million kg in 2021-22. The wool production has increased through times. However, in recent years there was a slight decrease in growth rate in wool production in India.
- The total meat production in the country is 9.29 million tonnes in the year 2021-22, which marks a significant progress in the meat production. About 50.84% of meat production is contributed by poultry. Buffalo, goat, sheep, pig, and cattle contribute 17.97%, 13.78%, 10.04%, 4.06% and 3.31% of meat production respectively. [Basic Animal Husbandry Statistics 2021, DAHD].
- Livestock also contributes to the production of valuable manure, leather and pelts, besides its contribution to the draught animal power in agricultural operations. Small and marginal farmers depend upon bullocks for ploughing, carting and transport both for inputs and outputs. Considering the economic importance of draught power, draught animal power is included as one of the 14 sources of renewable energy by (Ramaswamy, 1998) theUN Conference in Nairobi on New and Renewable Sources of Energy. Pack animals likecamels, horses, donkeys, ponies, mules, mithun etc. also contribute for transportation of goods indifferent parts of the country in hilly terrains.
- According to the National Statistics Office's (NSO) detailed crop-wise estimates of the value of output from agriculture and allied sectors, during 2014-15, the contribution of milk alone (Rs. 4,95,841 crore) was higher than the total value of food grains (cereals

plus pulses), which stood at Rs 4,86,846 crore, and was way above paddy (Rs 2,26,481 crore) or wheat (Rs 1,28,998 crore). So, milk is considered as India's No.1 farm crop by value.

- Total earnings from exports of livestock, poultry and related products were Rs. 44883.63 crore in 2020.21. [*Source: DGCI&S, Kolkata; cited from Basic Animal Husbandry Statistics 2021, Department of Animal Husbandry and Dairying, Govt. of India]*

Impact of Livestock in the National Economy and in the Lives of Rural Poor:

Livestock plays a vital role in improving the socio-economic conditions of the rural masses as well as in the national economy of our country, which can be evidenced from the following facts.

- According to estimates of the National Statistical Office (NSO), M/o Statistics & Programme Implementation, Govt. of India, the Gross Value Added (GVA) of livestock sector at current price during 2020-21 is about Rs. 1114249 crore which is about 30.87% of the value of output from total agriculture and allied sector and 6.17% of total GVA of India. It indicates that there is a great impact of livestock sector in the domain of agriculture and in the total economy of our country. [Basic Animal Husbandry Statistics 2021, DAHD]
- Over the last few decades, share livestock sector in the country's Gross Domestic Products (GDP)/Gross Value Added (GVA) has increased with a current rate of 6.17%, while its share in the GDP/GVA from agricultural sector steadily increased from 26.71% (2016-87) to 30.87% (2020-21). Milk is the major contributor to the GDP from livestock sector. The GDP/GVA share of agriculture and livestock sector in the last few decades in our country is given Table 4.
- Animal Husbandry sector provides large self-employment opportunities. According to the National Sample Survey Organization (NSSO 68th Round Survey: July 2011-June 2012), 16.44 million workers as per usual status (principal status plus subsidiary status irrespective of their principal activity) were engaged in the activities of farming of animals, mixed farming, fishing and aquaculture. Farmers of marginal, small and semi-medium operational holdings (area less than 4 ha) own about 87.7% of the livestock.
- Livestock serves as moving bank and assets which provide economic security to the farmers during hardship. Livestock is considered as a source of capital and an insurance against crop production risks (Kochewad et al, 2017).

Table 1: Trend in livestock population in India

Species	17th Census, 2003	18th Census, 2007	19th Census 2012	20th Census 2019#	Growth rate (%) At 2019 over 2012
Total Cattle	185.181	199.075	190.904	193.46	1.34
Indigenous/ non-descript cattle	160.495	166.015	151.172	142.11	– 6.0
Exotic/ CB cattle	24.686	33.060	39.732	51.36	29.3
Buffalo	97.922	105.342	108.702	109.85	1.06
Yak	0.065	0.083	0.077	0.06	– 25.00
Mithun	0.278	0.264	0.298	0.39	30.00
Total Bovines[1]	283.446	304.764	299.981	303.76	1.26
Sheep	61.469	71.558	65.069	74.26	14.12
Goat	124.358	140.537	135.173	148.88	10.14
Pig	13.519	11.133	10.294	9.06	– 11.95
Total Livestock[2]	485.002	529.696	512.057	536.76	4.82
Fowl	457.399	617.734	692.646	807.89	16.64
Duck	29.959	27.643	23.539	33.51	42.37
Turkey+other poultry species	1.654	3.452	13.025	10.41	– 20.08
Total Poultry[3]	489.012	648.829	729.209	851.81	16.81

[1] Total Bovines = Cattle + Buffalo + Yak + Mithun (Figures in millions)

[2] Total Livestock = Cattle + Buffalo + Yak + Mithun + Sheep + Goat + Pig + Horses & Ponies + Mules + Donkeys + Camels

[3]Total Poultry = Fowl/Chicken + Duck + Turkey + Quail + Emu & other poultry species

The 20th All India Livestock Census was conducted on 15 October 2012 as reference date.

In 20th Livestock Census, out of the total livestock population there were **36.04% Cattle, 27.74% Goat, 20.47% Buffaloes, 13.83% Sheep, and 1.69% Pigs** in India. Mithun, Yaks, Horses, Ponies, Mules, Donkeys and Camels taken together contribute about 0.23% of the total livestock in India. The total Backyard Poultry in the country is 317.07 million in 2019, increased by 45.8% over previous Census. The total Commercial Poultry in the country is 534.74 million in 2019, increased by 4.5% over previous Census.

Source: Various All India Livestock Census, Department of Animal Husbandry, Dairying, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India.

Table 2: Trend in production of major livestock products – All India

Year	**Milk(million tonnes)**	**Eggs (Million nos.)**	**Wool (Million kg)**	**Meat + (Million tonnes)**
1950-51	17.0	1832	27.5	-
1960-61	20.0	2881	28.7	-
1980-81	31.6	10060	32.0	-
1990-91	53.9	21101	41.2	-
2000-01	80.6	36632	48.4	1.9
2010-11	121.8	63024	43.0	4.9
2020-21	209.9	122049	36.9	8.8
2021-22	221.06	129600	33.13	9.29

- Not Available

+ Meat production from commercial poultry farm is included from 2007-08.

Source: (i) Annual Report 2021-22, Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India, pp. 143-144; Website: www.dahd.nic.in

(ii) Basic Animal Husbandry Statistics 2022

Table 3A: Per capita availability and deficit of animal food items in India

Food items	Per capita availability (2021-22)*	ICMR dietary guidelines for Indians	Per capita deficit (2021-22)**
Milk	444 g/day	300 ml/day	(+) 144 g/day
Egg	95 nos./annum	180 nos./annum	(-) 85 nos./annum
Meat	6.82 kg/annum*	10.95 kg/annum	(-) 4.13 kg/annum

* Provisional estimates.

******Deficit is calculated on the basis of the difference between availability of food item and minimum requirement as recommended by ICMR. (+) indicates higher consumption than the recommended one.

Table 3B: Per capita availability of milk and egg in India since 1950-51

Year	Milk (million tonnes)	Per Capita Milk (ml/day)	Egg (million number)	Per capita Egg (nos/annum)
1950-51	17.0	130	1832	5
2000-01	217	217	36632	36
2010-11	121.8	281	63024	53
2020-21	209.96	427	122049	90
2021-22	221.06	444	129600	95

Source: Annual Report 2021-22, Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India

Table-4: Share of Agriculture & Livestock Sector in National GVA* (at current price)

Year	GVA-Agriculture**		GVA-Livestock Sector		
	Rs. in crore	% to total GVA	Rs. in crore	% to total GVA	% to Agriculture**
2016-17	2518662	18.0	672611	4.82	26.71
2017-18	2829826	18.3	785683	5.07	27.76
2018-19	3029925	17.6	882009	5.14	29.11
2019-20	3358364	18.3	977730	5.33	29.11
2020-21	3609494	20.0	1114249	6.17	30.87

*GVA - Gross Value Added.**It includes crops, livestock, forestry & fishing & aquaculture.

Source: National Accounts Division, Central Statistical Office, M/o Statistics and Programme Implementation, Govt. of India. [*Cited from Basic Animal Husbandry Statistics 2021 & Annual Report 2021-22, Department of Animal Husbandry & Dairying, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India*.]

Integrated Farming System (IFS)

Farming system can mean different things to different people. To avoid ambiguity and confusion both terms farming and system should be clearly understood. Farming is the process of harnessing solar energy in the form of economic plant and livestock products and system implies a set of inter related practices organized into a functional entity. A system consists of several components which depend on each other. A system is defined as a set of elements or components that are inter-related and interacting among themselves. Farming system is a decision making unit comprising the farm household, cropping and livestock system that transform land, capital and labour into useful products that can be consumed or sold (Fresco and Westphal, 1988).

In other words, farming system is a resource management strategy to achieve economic and sustained production to meet diverse requirement to farm household while presenting resources base and maintaining a high level environmental quality (Lal and Millar 1990).

Farming system consist of several enterprises like cropping system, dairying, piggery, poultry, fishery, bee, keeping etc. which are inter related. The end product and waste of one enterprise are used as inputs in others. The waste of dairying like dung, urine, refuse etc. is used for preparation of FYM, which is an input in cropping system. The straw obtained from the crops is used as roughages for cattle and cattle are used for different field operations for growing crops. Thus different enterprises of farming systems are highly inter related.

The major emphasis in the farming system is productive recycling of farm wastes. Different components of farming system work together in integrated farming system resulting in higher total productivity than the sum of their individual production. Farming system is a process in which the primary objective is the sustainability of production.

Integrated Farming System (IFS) is an interdependent, interrelated often interlocking production systems based on few crops, livestock and related subsidiary enterprises in such a way that maximize the utilization of nutrients of each system and minimize the negative effect of these enterprises on environment. The integrated farming system concept is that each sub-systems benefit each other, enhancing profitability of farming systems especially for small and marginal farmers on the basis of per unit land and per unit time. It also maintains environmental quality and ecological stability. Integrated farming systems offer unique opportunities for maintaining and extending biodiversity.

Unsustainable farming leads to environmental pollution and threatens the livelihoods of millions of small and marginal farmers. So strengthening agricultural production system for greater sustainability and higher income is a vital process for increasing income and food and nutrition security in India and developing countries. Therefore, IFS is a multidisciplinary whole farm approach and very effective in solving the problems of small and marginal farmers (Soni et al, 2014).

Benefits of Integrated Farming System:

1) **Productivity**:

   IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises.

2) **Profitability**:

IFS uses waste material of one component at the least cost. Thus reduction of cost of production and form the linkage of utilization of waste material, elimination of middleman interference in most inputs used. Net profit B/ C ratio is increased.

3) **Potentiality or Sustainability**:

Organic supplementation through effective utilization of by-products of linked components is done thus providing an opportunity to sustain the potentiality of production base for much longer periods.

4) **Balanced Food**:

Components of varied nature are linked enabling to produce different sources of nutrition.

5) **Recycling and Environmental Safety**:

In IFS waste materials are effectively recycled by linking appropriate components thus minimize environment pollution.

6) **Income Rounds the year**:

Due to integration of enterprises with crops, poultry, dairying, mushroom, apiculture, sericulture there will be flow of money to the farmers round the year.

7) **Saving Energy**:

To identify an alternative source to reduce our dependence on fossil energy source within short time. By effective recycling technique, the organic wastes available in the system can be utilized to generate biogas. Energy crisis can be postponed to the later period.

8) **Meeting Fodder crisis**:

Every piece of land area is effectively utilized. Plantation of perennial legume fodder trees on field borders also fixing the atmospheric nitrogen. These practices will greatly relieve the problem of non-availability of quality fodder to the livestock component linked.

9) **Solving Fuel and Timber Crisis**:

Linking agro-forestry appropriately, the production level of fuel and industrial wood can be enhanced without determining effect on crop. This will also greatly reduce deforestation, preserving our natural ecosystem.

10) **Employment Generation**:

Combining crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under-employment to a great extent. IFS provide enough scope to employ family labour round the year.

11) **Agro-industries**:

When one enterprise/product linked in IFS is increased to commercial level, there will be surplus value adoption leading to development of allied agro-industries.

12) **Increasing Input Efficiency**:

IFS provides good scope to use inputs in different components and increasing greater efficiency and benefit cost ratio.

Points to be considered while choosing enterprises for ifs practices:

1) Soil and climatic features of an area/ locality

2) Resource availability with the farmers

3) Present level of utilization of resources

4) Economics of proposed integrated farming system

5) Farmers managerial skill

6) Social customs prevailing in the locality

LIVESTOCK BASED INTEGRATED FARMING SYSTEM:

In India, in Asia and perhaps in most developing countries, along with crop farming, the livestock production system is a secondary, and mutually beneficial, component of mixed farming set-up. Livestock provide draught power and manure to crop farming, while crop farming provides crop products and by-products as feed for livestock.

Livestock based integrated farming system is a traditional practice in rural India among the small and marginal farmers. Diversification of agriculture with dairy, goatery, fishery, poultry, duckery, etc. is necessary for increasing the income of farmers (Ray *et al*., 2012).

Due to fragmentation in land holding of farmers, it is necessary to integrate land based enterprises like fishery, poultry, duckery, apiary, field and horticultural crops etc.within the bio-physical and socio-economiccondition of the farmers to make farming more profitable and dependable (Behera *et al.*, 2004).

Various Livestock Based Integrated Farming Systems:

The popular livestock based IFS are enlisted below (Kochewad et al, 2017). Besides these IFSs, several other farmer oriented IFSs may also be designed.

1. Crop-livestock farming system
2. Crop-livestock-fishery farming system
3. Poultry-fishery farming system
4. Crop-livestock-backyard poultry farming system
5. Small ruminant - Silvi pastoral farming system

6. Crop-livestock-horticulture farming system

1. CROP-LIVESTOCK FARMING SYSTEM

In this farming system, crop and livestock complement one another through mutual benefit. In livestock + crop system, the animal component is often raised on agricultural waste products while the animal is used to cultivate the land and provide manure to be used as fertilizer and fuel (Jayanthi *et al.,* 2000). Alam *et al.,* (2000) reported that the manure availability was 12 tonnes from a pair of draught cattle integrated with crop. Cow dung is used for the production of biogas which is a source of renewable, alternative and sustainable energy (Godi *et al*., 2013). Venkatadri *et al.,* (2008) reported that 98 per cent of the farmers opined that livestock rearing reduces vulnerability in drought years, 97 per cent of the sample respondents indicated that farmers suicides were less in dairy developed areas and commercial agriculture increased suicidal rate in Andhra Pradesh (96.%). Integrated farming system with six buffaloes generated 904 of mandays of employment against 400 man days in crop alone (Pandey and Bhogal, 1980).

2. CROP-LIVESTOCK-FISHERY FARMING SYSTEM

Livestock and Crop farming systems can be integrated with fish, raising the fish without any additional feed. Integrated Livestock + Crop + fish farming can be carried out for increasing returns from a limited land area and reducing risk by diversifying crops (Korikantimath *et al.,* 2008). The adult cattle produce about 4,000-5,000 kg dung, 3,500-4,000 liter urine annually. For a pond size of 1 ha of 5-6 adult cattle can provide adequate manure. In addition to 9,000 kg of milk, about 3,000-4,000 kg fish/ha/year can be produced in this system. This system will save labor for lifting the cow dung. The requirement of green and dry fodder for an adult cattle is 9- 10 and 2-2.2 ton respectively and will be met from crop component. The manure will be used for improving the fertility of soil (Kochewad et al, 2017). Mahajan *et al.,*(2012) reported that inclusion of dairy and poultry components in IFS, the net income have been increased to Rs 37,343/- per year as against Rs 26,511/- from field crops only.

3. POULTRY-FISHERY FARMING SYSTEM

Poultry+ fish farming system can be integrated to reduce the cost of fertilizers and feeds in aquaculture. Poultry can be reared near or over the fish pond and the poultry excreta will directly drop into fish pond and get recycled. Njoku and Ejiogu (1999) reported that 1000 chicken can be integrated with one hectare fish pond and provided the optimal water quality for fish survival and growth. Poultry-fish integration increases the resource use efficiency and proper utilization of space and eco-friendly. Sahoo and Singh, (2015) reported that, the fish-poultry farming system could generate maximum profit of Rs. 33664.06 per 0.025 ha yr^{-1} with B: C ratio of 1.09. Kalita *et al.*, (2016) reported that Fish+Poultry integration produced 4500 to 5000 kg fish, 70,000 eggs and 1000 kg (live weight) of chicken meat from 1.0 ha fish pond annually without any supplementary feed.

4. CROP-LIVESTOCK-BACKYARD POULTRY FARMING SYSTEM

Backyard poultry plays a significant role in the lives of rural people for generating income and nutritional security of the family (Mandal *et al.,* 2006). Backyard livestock comprising of sheep, goats, pigs and poultry provide emergency sources of income for family as reported by Devendra and Pezo (2002). Nirmala *et al*., (2012) reported that improved backyard poultry as a scientific intervention improved household income. Majority of the women (51%) earned 6-10 % of maximum household income from backyard poultry, with high income (11-20%)from 28 % of women and only 7 women members have earned 21-30 % income from poultry (Kochewad et al, 2017).

5. SMALL RUMINANT-SILVI PASTORAL FARMING SYSTEM

Small ruminants based integrated farming system will provide income to the farmers, helps in improving the soil fertility, weeds will be utilized as fodder by goat and incidences of diseases in crop will be minimized. Senthilvel *et al.* (1998) reported that the integration of Crop+Fruit trees+Goat in dry land resulted in a considerable increase in income of small and marginal farmers of Southern Zone of Tamil Nadu. Ramana *et al.*,(2011) reported that the performance of Nellore Zodpi ram lambs under horti-pastoral systems, that lambs with complementary grazing on established pasture supplemented with *L.leucocephala* foliage gained significantly ($p < 0.01$) higher live weight and higher average daily gain.

6. CROP-LIVESTOCK-HORTICULTURE FARMING SYSTEM

This system solves the problem of green fodder and reduces the cost of concentrated feed to animals during lean period. Ramana *et al.,* (2000) reported that the lambs and kids grazed on silvipasture gained in their body weight at the rate of 54.8 and 36.8 g (head/day), whereas on natural grassland showed 41.2 and 26.4 g weight gain (head/day) respectively in the total period of 478grazing days. The animals were able to gain body weight continuously on both the pasture without any supplementation of concentrate feed. Integrated farming system, sorghum + cowpea, *Leucaena leucocephala* + *Cenchrus ciliaris*, *Acacia senegal* + *Cenchrus ciliaris* with integration of goat generated an additional employment of 113 man days ha^{-1} annually in dry lands (Ramasamy *et al.*, 2007).

Different integrated farming systems in different climatic zones as identified in Odisha are given in Table 5 (Dash et al, 2015).

Table 5: Identified IFS in different agro climatic zones of Odisha

Agro climatic zone / District	**Farming System modules identified**
North Western plateau (Sunder Garh, Deogarh)	Crop (rice – mustard / green gram) – Dairy – Goatery – Poultry - Agro forestry
North Central plateau (Keonjhar,Mayurbhanja	Crop (rice / maize - pulse / mustard)
	– Dairy –Goatery –Poultry – Apiculture - Agro forestry
North Eastern Coastal Plain (Balasore, Jajpur, Bhadrak)	Crop (rice- pulse / oilseed)
	–Dairy Fish culture – Mushroom
East & South-Eastern Coastal Plain (Kendrapara, –Jagatsinhpur, Khordha, Puri, Nayagarh,Cuttack)	Crop (rice- pulse / oilseed / vegetable) Dairy – Fish culture - Mushroom
North East ghat (Kandhamal, Rayagada, Gajapati, Ganjam)	Crop rice/millets-pulse/oilseeds/ vegetables) – Goatery – Sheep - Poultry -Agro forestry
Eastern ghat Highland (Nawarangpur Part of Koraput)	Crop (rice / millets – niger / pulse) Goatery – Sheep -Agroforestry
South Eastern Ghat (Malkangiri, Part of Koraput)	Crop (rice / maize / ragi / til - vegetables)
	– Poultry – Goatery –Sheep - Agro forestry
Western Undulating Zone (Kalahandi, Nuapada)	Crop (rice / cotton –pulse / oilseeds) –
	Dairy –Poultry-Piggery - Goatery
Western Central Table Land Boudh, Sonepur, Jharsuguda, Sambalpur) (Baragarh, Bolangir,	Crop (rice / groundnut / arhar/ til-pulse / oilseeds / vegetable) – Dairy – Poultry – Piggery - Goatery
Mid-central Table Land (Angul, Dhenkanal)	Crop(rice/groundnut/arhar/til–pulse/ oilseeds)
	Poultry–Dairy–Apiculture-Goater- Mushroom

Comparative performance of economics& employment generation of different IFS models for small-marginal farmers in Eastern Himalayas are inscribed in Table-6(Kumar et al, 2018).

Table 6: Comparative performance of economics and employment generation of different IFS models (after 3 years)

Model	IFS components	Gross returns(`)	Cost of cultivatn (`)	Net incomes(`)	B:C ratio	Employ generation (man-days/yr)
Model-1	Horticulture	8170	8200	-30	-	170 (60*)
	Fishery	720	600	120		15
	Piggery	29250	21000	8250		45
	Vermicompost	-	-	-		10
	Total	45640	30800	14840	1.48	240
Model-2	Agriculture	16025	4100	11925		100 (60*)
	Horticulture	2425	930	1595		50
	Fishery	2400	1650	750		15
	Duckery	5330	8000	-2670		20
	Vermicompost	720	500	120		10
	Total	26900	15180	11720	1.78	195 (60*)
Model-3	Agriculture	7400	3900	3500		140(60*)
	Horticulture	12145	1741	10404		90
	Fishery	2040	1000	1040		25
	Piggery	19650	10800	8850		85
	Vermicompost	1050	450	600		10
	Total	42285	17891	24394	2.35	350 (50*)
Model-4	Agriculture	21350	5600	15750		150 (60*)
	Horticulture	7810	1055	6615		70
	Fishery	2730	2000	730		15
	Poultry	22360	14000	8360		35
	Mushroom	2550	5640	-3115		70
	Azolla	3000	500	2500		10
	Vermicompost	1800	600	1200		10
	Total	61600	29395	32040	2.11	360 (60*)

*Existing employment generation of the respective model following the traditional farming.

Economics of rice based farming system with animal and fish components for a marginal farmer in coastal region in India (Sarangi et al, 2016) is inscribed in Table 7.

Table 7: Economics of rice based farming systems for a marginal farmer (0.4 ha)

Component	Expenditure (000' Rs)	Gross return (000' Rs)	Net return (000' Rs)
Crop	33	60	27
Duckery	6	9	3
Fishery	4.5	10.5	6
Mushroom	15	18	3
Total	58.5	98.5	40
Conventional cropping	21	39	18

CONCLUSION:

Livestock based integrated farming system provides an opportunity of increasing economic yield per unit area per unit time through complementary enterprises and recycling of product, by-products and waste materials in small and marginal farmers in developing countries. Integration is aimed for long term sustainability, through improving productivity, profitability and employment round the year without any harm to the environment. The improved model of IFS may increase food security, enhance livelihood and reduce poverty of the resource poor farmers. Combining livestock with crop enterprises would increase the labour requirement significantly and helps in reducing the problems of under-employment to a great extent and enhancing proper utilization of family labours including women. Further advances of IFS with livestock components is going on with farmer specific and species specific enterprises for optimum livelihood generation of small and marginal farmers in India.

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ADVANCES IN FISHERY BASED INTEGRATED FARMING FOR BETTER LIVELIHOOD OF RURAL STAKEHOLDERS

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INTRODUCTION

Farmers work hard to earn a living. However, not all farmers make money, especially small family farmers. There is very little leftover after they pay for all their inputs (seeds, livestock breeds, fertilizers, pesticides, energy, feed, labour, etc.). However, the Integrated Farming Systems (IFS) has enabled farmers to develop a framework for an alternative development model to improve the feasibility of small sized farming operations. The "modern" technologies have been widely used to enhance the productivity per acre of land to ensure that there is enough food for the increased global population. Due to the indiscriminate and erratic use of chemical pesticides and fertilizers, our food and ecosystems have been poisoned. On the contrary, the integrated farming system uses the integrated approach to farming compared to monoculture approaches. It refers to agricultural systems that integrate agriculture with horticulture, livestock, fishery, agro-forestry, etc. and known as integrated bio-systems. In this system, an inter-related set of enterprises is used so that the "waste" from one component becomes an input for another part of the system. This reduces costs and improves production and/or income. Since it utilizes waste as a resource, farmers not only eliminate waste but they also ensure an overall increase in productivity for the whole farming system.

Integrated farming tries to imitate nature's principle, where not only crops but also varied types of plants, animals, birds, fish, and other aquatic flora and fauna are utilized for production. The basic principle is to enhance the ecological diversity:

- By choosing the appropriate cropping methodology with mixed cropping, crop rotation, crop combination and inter-cropping so that there is less competition for water, nutrition and space and by adopting eco-friendly practices

- By utilizing a multi-story arrangement so that the total available area is used effectively and there is a high level of interaction between biotic and abiotic components
- By integrating a judicious mix of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers can bring prosperity to the farming operations.

CONCEPT OF FARMING SYSTEM:

The term "system" is derived from the Greek word "synistanai," which means "to bring together or combine." Likewise, the farming system denotes a complex inter-related matrix of soil, water, plants, animals (livestock/fish), implements, power, labour, capital and other inputs those are controlled in parts by farming families. These are influenced to varying degree by economic, institutional and socials forces that operate at many levels. Therefore, farming system is the result of a complex interaction among a number of interdependent components. Farm activities interact with market forces (socio-economic) and ecosystem (biophysical) for purchasing inputs and disposing outputs by utilizing and degrading natural resources (land, water, air, sunshine etc.). A farming system has Inputs, Processes and Outputs.

INPUTS - these are things that go into the farm and may be split into Physical Inputs (e.g., amount of rain, soil, seeds, fertilizer etc.) and Human Inputs (e.g., labour, money etc.).

PROCESSES - these are things which take place on the farm in order to convert the inputs to outputs (e.g., sowing/stocking, weeding, farm management, harvesting etc.).

OUTPUTS - these are the products from the farm (i.e., rice, wheat, milk, egg, meat, fish, etc.) Depending on the type of farming (e.g., arable/pastoral, commercial/subsistence), the type and quantity of inputs, processes and outputs will vary. You need to make sure you are able to define and give examples of Inputs, Processes and Outputs in farming systems.

Farming systems research (FSR) originates from the inter-dependence and inter relationships of natural environment within the farming system. In FSR the farmers by participating in the research process help in the identification of the research problems as well as take part in testing the possible solution. In the past decades, farming system research has emerged as a popular and major theme in international agricultural research. ***FSR approach involves following principles.***

- Viewing the farm as a whole,
- Identifying the farming system, the interacting component and delineating boundaries,
- Systematic investigation of the nature and extent of interdependence among the enterprises and identifying constraint,

- Applying the modern technical know- how to the system so as to make it yield optimum results,
- Studying the equity gender income, employment and resources use efficiency, and
- Dealing with the issue at integration level through analysis and solution of problems towards sustainable farming system development.

The schematic presentation of farming system is illustrated below.

FARMING SYSTEM

(A Farm is a system with **Inputs**, **Processes** and **Outputs**)

Inputs (*what goes in to make it*)			**Processes** (*activities carried out to convert input to output)*		**Output** (*products from the farm)*
Climate -Amount of rain -Amount of sunshine -Length of growing season -Temperature Topography Soil & Water Drainage	Physical Inputs	→	Farm Activities -Ploughing -Rearing -Weeding -Harvesting -Milking -Other management Activities	→	Grains Vegetables Fruits Milk Egg Meat Fish Wool Fuel Fibre
Labour Rent Machinery Seeds Energy Fertilizer/pesticide Farm Infrastructure Govt. Control Market Demand	Human Inputs				

Output

	Output usually consumed by family (***Subsistence Farming***)		
	Output profit will be reinvested in farm (**C*ommercial Farming***)		
Possible Changes in the System	Physical Changes	→	Flood, Drought, Disease, etc.
	Human changes	→	Changes in demand, mkt. price, Govt. policy etc.

***Fig.1*: Schematic Presentation of Farming System**

INTEGRATED FARMING SYSTEM: KEY FEATURES & BENEFITS

The overarching feature of IFS is to ensure total utilization of land and water resources of the farm resulting in maximum and diversified farm output with minimum financial and labour costs. In IFS, the different enterprises interact eco-biologically, in space and time, are mutually supportive and depend on each other. Thousands of small and marginal family farmers in resource-poor regions in Asia and Africa are embracing this system to diversify farm production, increase cash income, improve the quality and quantity of food produced and the exploitation of unutilized resources. ***The benefits provided by IFS are summarized below:***

- **Productivity:** IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises.
- **Profitability:** Use waste material of one component at the least cost, thus reduction of cost of production and form the linkage of utilization of waste material, elimination of middleman interference in most input used. Working out net profit B/ C ratio is increased.
- **Sustainability:** Organic supplementation through effective utilization of by-products of linked component is done thus providing an opportunity to sustain the potentiality of production base for much longer periods.

- **Balanced Food:** We link components of varied nature enabling to produce different sources of nutrition.
- **Environmental Safety:** In IFFS waste materials are effectively recycled by linking appropriate components, thus minimize environment pollution.
- **Recycling:** Effective recycling of waste material in IFFS.
- **Income Rounds the year**: Due to interaction of enterprises with crops, eggs, milk, mushroom, honey, cocoons silkworm. Provides flow of money to the farmer round the year.
- **Adoption of New Technology:** Resources farmer (big farmer) fully utilize technology. IFS farmers, linkage of dairy / mushroom / sericulture / vegetable. Money flow round the year gives an inducement to the small/ original farmers to go for the adoption technologies.
- **Saving Energy:** To identify an alternative source to reduce our dependence on fossil energy source within short time. Effective recycling technique the organic wastes available in the system can be utilized to generate biogas. Energy crisis can be postponed to the later period.
- **Meeting Fodder Crisis:** Every piece of land area is effectively utilized. Plantation of perennial legume fodder trees on field borders and also fixing the atmospheric nitrogen. These practices will greatly relieve the problem of non-availability of quality fodder to the animal component linked.
- **Solving Fuel and Timber Crisis**: Linking agro-forestry appropriately the production level of fuel and industrial wood can be enhanced without determining effect on crop. This will also greatly reduce deforestation, preserving our natural ecosystem.
- **Employment Generation:** Combing crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under employment to a great extent IFS provide enough scope to employ family labour round the year.
- **Agro-industries:** When one of produce linked in IFS are increased to commercial level there is surplus value adoption leading to development of allied agro-industries.
- **Increasing Input Efficiency**: IFS provide good scope to use inputs in different component greater efficiency and benefit cost ratio.

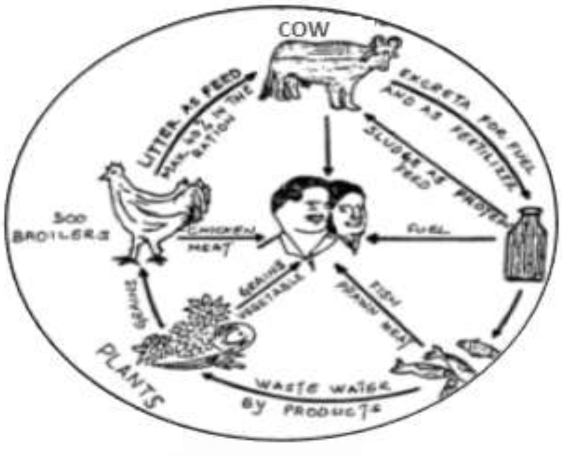


***Fig. 2*: Resource flow in IFS**

MICRO-LEVEL INTERLINKING AMONG THE COMPONENTS IN IFS

IFS is an integration of many sub-systems e.g., crop, livestock and fish which are linked to each other in such a way that the by-products/wastes from one sub-system become the valuable inputs to another sub-system and thus ensures total utilization of land and water resources of the farm resulting in maximum and diversified farm output with minimum financial and labour costs. The conceptual framework of micro-level interlinking in IFS is explained in the table given below.

Table 1: Conceptual Framework of micro-level interlinking in IFS

Micro-level attributes	Livestock component	Fishery component	Crop component
Space utilization	Use of pond dyke top for livestock shed	Use of pond water surface for duck, use of space over the pond water margin for growing creeper vegetable through hanging platform	Use of pond dyke (top, inner slope & outer slop) for crop production, use of top of the animal shed for growing creeper crop.
Recycling of nutrient	Recycling of crop byproducts / fodder for livestock production	Use of livestock waste as manure for fish production, use of crop byproduct / fodder for fish food	Use of livestock wastes in crop production, use of fishpond sediments and water for crop production
Nutrient concentration	Standardization of livestock number in integrated system to	Optimized addition of animal waste in fishery,	Study onrequirement of animal waste for crop production

	generate required quantity of animal waste for fish & crop system	method of addition of animal waste in fishpond	
Diversity	Increasing diversity of livestock may complement other farming system. For example, increased amounts of mono-gastric waste may be valuable for plankti-vorous fish	Efficiency of multispecies culture in exploiting the feed available in different aquatic niches	Diversification in crop variety may complement other farming system. For example, the fish like grass carp and ruminants may compete for limited amounts of grass
Environmental compatibility	Environment friendly disposal of animal waste	Efficient use of water for fishery, livestock and crop production	Promote organic farming through use of manure, control of pest due to free grazing of poultry & duck
Productivity	Increase in livestock production through crop byproduct and fodder	Increase in fish production through pond manuring	Increase in crop production due to sufficient water and manure.
Economic efficiency	Livestock as major source of cash in smallholder systems. Having a variety of livestock types improves versatility with respect to cash flow and risk aversion	Polyculture and perennial water increase opportunities for strategic marketing	Returns to labour are often attractive. Integration reduces market risk and improves flexibility

LIVESTOCK-FISH INTEGRATION

The basic principles of livestock-fish integrated farming system are the full utilization of livestock farm wastes and conversion of waste in to valuable fish protein. The manure from livestock helps in production of planktons which forms the feed for fishes in the pond. Further, the spilled over feed or undigested/semi-digested food derived from the livestock manure may also be utilized as direct feed for fish.

ADVANTAGES OF LIVESTOCK-FISH INTEGRATED FARMING ARE AS:

- Waste products of the animals are used for fish production.
- Feed residues can be eaten directly by the fish.
- Costs towards manure collection, storing and transportation are avoided.
- Saving of land otherwise needed for housing the livestock (if the housing is above the fishpond).
- Provide good solution to problems of environmental pollution caused by animal waste.
- Improve the environment for manure producing livestock.
- Saving of livestock feed cost due to the natural food, e.g., aquatic insect/worms/plants for ducks.
- Improve the operational efficiency of the farm through better use of manure, joint use of feed storage, processing and transportation facilities.

POPULAR LIVESTOCK-FISH INTEGRATED FARMING SYSTEMS ARE:

- Duck-fish integrated system
- Poultry-fish integrated system
- Pig-fish integrated system
- Sheep/Goat-Fish integrated system
- Cattle/buffalo-fish integrated system
- Rabbit-fish integrated system

The livestock manures contain major inorganic nutrients (N, P, K) as well other trace elements viz. Ca, Cu, Zn, Fe, and Mg. Waste output in the form of urine and faeces varies considerably in quantity and quality. Again, the distribution of nutrients (N, P, K) in faeces and urine also vary for different livestock. The nutritive values of different animal excreta are given below.

Table 2: Nutritive values of different animal excreta

Animal	Excreta	Moisture (%)	Organic Matter (%)	Nitrogen (%)	Phosphorus (P_2O_5) (%)	Potash (K_2O) (%)
Cattle	Faeces	80-85	14.0	0.3	0.2	0.1
	Urine	92-95	2.3	1.0	0.1	1.4
Pig	Faeces	85	15	0.6	0.5	0.4
	Urine	97	2.5	0.4	0.1	0.7
Goat	Faeces	10	-	2.7	1.7	2.9
Rabbit	Faeces	10	37	2.0	1.3	1.2
Poultry	Faeces	78	25.5	1.4	0.8	0.6
Duck	Faeces	81	26.2	0.9	0.4	0.6

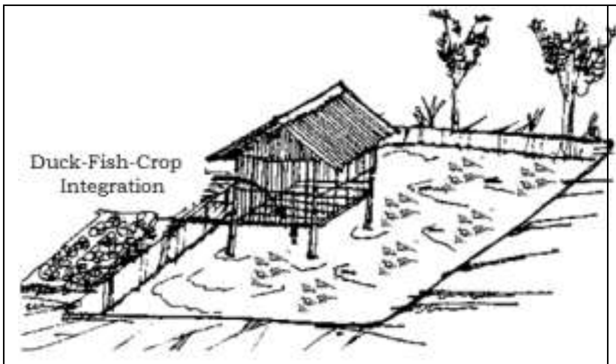
Table 3: Livestock units for integration with Fish Farming

Particulars	Cattle	Pig	Poultry	Duck	Rabbit	Goat
Qty. of dung/ha water area/yr. (tonne)	15-25	15-20	10-15	10-15	5-10	5-10
Qty. of dung/ animal/yr. (kg)	5000-10000	500-600	20-25	30-45	15-18	150-200
Nos. of animals to be reared for dung/ha/yr.	3-4	30-40	500-600	200-300	300-500	40-50
Stocking density of fish(no. of carps/ha)	5000-6000	5000-6000	5000-6000	5000-6000	5000-6000	5000-6000
Fish (tonne/ha/yr.)	4-5	4-5	4-5	4-5	4-5	4-5
Milk/Meatproduction (kg)	3000-5000	4000-5000	1240	500-750	900-1500	600-900
Egg production (nos.)	-	-	70,000	18,000	-	-

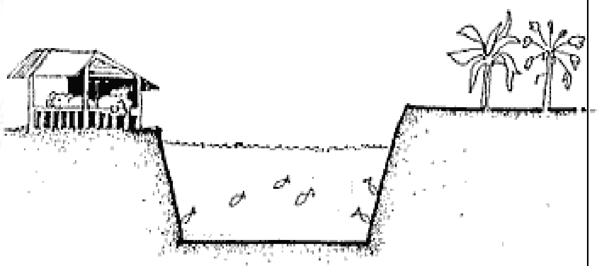
CHECKLIST FOR ANIMAL-FISH INTEGRATION

- Type of Animal and Fish?
- Consider religious and social taboos: demand for animals and/or their products marketing difficulties.
- Production cycle of animal and fish?

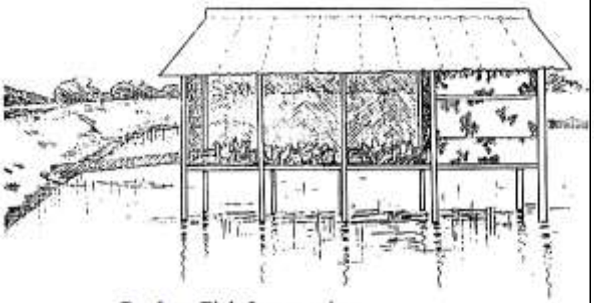
- Consider waste availability and requirements for fish, changing climate and ability of pond to use wastes.
- Feeding regime of animals?
- Quantity and quality of food to animals: amount of waste food available to fish, frequency of feeding, animal feeds grown on the farm or purchased.
- Is the animal waste fresh, diluted, well-rotted?
- Is some form of processing an advantage before use?
- Will the waste be sufficient to optimize fish production? If not are other fertilizer or feed supplements available?
- Effects of changing production of animal or fish on the management and profitability to the other?



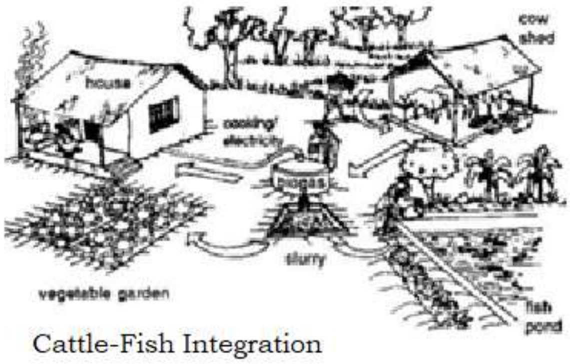
Duck-Fish-Crop Integration



Pig-Fish-Crop Integration



Poultry-Fish Integration



Cattle-Fish Integration

PADDY-FISH INTEGRATION

Paddy and fish are staple diets for the people and they are grown almost in all agro-climatic regions of India. Paddy-fish integrated farming can contribute to household income, contribute to food security and nutrition and contribute to improved sustainability of paddy production. The nature and type of integration vary largely depending upon the topography of land and other contexts like biophysical and technical considerations. Though paddy field fishery is recognised as traditional practice in the region, of late it is deliberately seen as a productive fishery. It is an extensive level of farming practice using low input technology. The cost and return evaluation showed that paddy-fish culture is more profitable than monoculture of rice. Generally, two production systems are recommended for culturing fish in the paddy fields. They are, Simultaneous or Concurrent Method and Alternate or Rotational Method.

In Paddy-fish integration, creation of fish refuge is an essential feature. Fish refuge is a deeper area provided for the fish within the Paddy field. This can be in the form of a trench or several trenches, a pond or even just a sump or a pit. The purpose of the refuge is to provide a place for the fish in case water in the field dries up or is not deep enough. It also serves to facilitate fish harvest at the end of the Paddy season, or to contain fish for further culture whilst the Paddy is harvested. In conjunction with the refuge, provisions are often made to provide the fish with better access to the Paddy field for feeding.

Paddy-Fish Integration offers following benefits.

- Additional food and income in the form of fish.
- Control of mollusks and insects which are harmful to rice.
- Reduced risk of crop failure resulting from integration of rice and fish.
- Continued flooding of the paddy and rooting activity of fish help control weeds.
- Fish stir up soil nutrients making them more available for rice. This increases rice production.

CROP-FISH INTEGRATION THROUGH LAND SHAPING:

In land shaping, different land situations like high land, medium land and low (original) apart from farm pond/ furrows/ trenches, were created in the low-lying and degraded coastal land. The rising of land levels and creation of water-harvesting facilities reduced the problem of drainage congestion. The high land/ridges/ dikes were also free from water logging during *kharif* season, which provided scope for growing high-value crops and facilitated early sowing of rabi crops.

Land Shaping for Deep Furrow & High Ridge Cultivation:

The 50% of farm land may be shaped into alternate furrows (3m top width × 1.5 m bottom width × 1.0 m depth) and ridges (1.5 m top width ×1.0 m height × 3m bottom width). The ridges remain relatively free from drainage congestion and low in soil salinity build up. Thus, ridges can be used for multiple crop cultivation and the furrows are useful for rainwater harvesting and fish cultivation along with rice (on remaining 50% of original low-land) during wet season. During dry season the ridges continued to be used for vegetable/fruit cultivation. The remaining original fields are used for low water requiring field crops with the rain water harvested in the furrows.

Land Shaping for Shallow Furrow & Medium Ridge Cultivation:

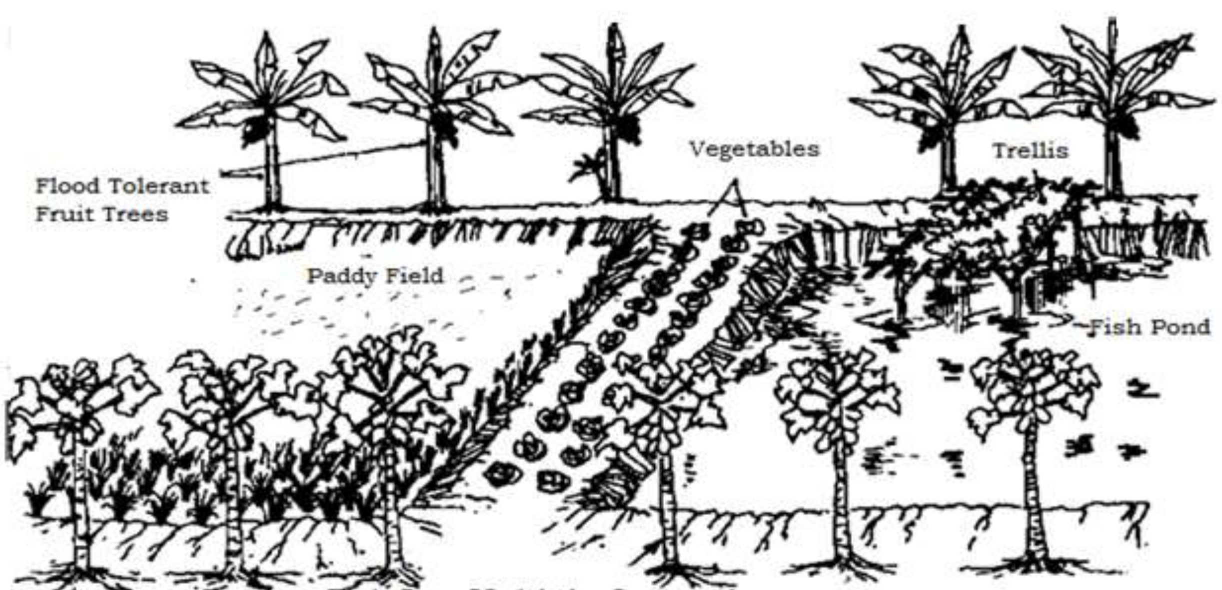
About 75 % of the farm land may be shaped into furrows (2.0m top width × 1.0 m bottom width × 0.75 m depth) and medium ridges (1.0 m top width ×0.75 m height × 2.0m bottom width) with a gap of 3.5m between two consecutive ridges and furrows. Thus, there will be three land situations viz. low land (medium furrow), midland (original farm land) and high land (ridge).The furrows can be used for rainwater harvesting as well as fish cultivation along with paddy in wet season. In dry season furrows can be used for rice cultivation. The ridges are free from water logging in wet season and suitable for cultivation of crops other than rice throughout the year. The original land is used for growing low water requiring.

Land Shaping for Farm Pond:

The water balance analysis shows considerable scope for conservation of excesses rain water in on-farm reservoir (OFR). Soil water balance model developed for rain-fed rice cultivation showed that about 20% of watershed/ farm area may be converted to OFR to harvest excess rain water for utilizing to grow crops in *rabi* /summer, supplemental irrigation in *kharif* and freshwater aquaculture. The dug-out soil was used to raise the land to form high and medium land situations for growing multiple crops.

Land Shaping for Paddy-cum-fish Cultivation:

Trenches of about 3 m width X 1.5 m depth are dug around the field with a ditch of 6m X 6m X 3m(depth) at one corner. The excavated soil is used for making dikes of about 3 m width X 1.5 m high around the field to protect the fishes to be grown in paddy-cum-fish cultivation. During *kharif* paddy-cum fish is grown on the original low land and vegetables on the dikes. During *rabi*/summer low water requiring field crops & vegetables are continued to be grown on the dikes, and low water requiring crops on the original land with live saving irrigation given with rain water harvested furrows. Otherwise, the original lands may also be used for brackish water fish cultivation. At the end of the summer season the brackish water is drained out with the help of pre-monsoon rains. The land is again used for Paddy-cum-fish cultivation.



Fish-Crop Multi-tier Integration

EFFECTIVE EXTENSION STRATEGIES FOR IFS

Farmers are often excellent "researchers" and "extensionists". The "Farmer First and Last" (FFL) model is an alternative to the "Transfer-of- Technology" (TOT) model and more suited for IFS. It is based in the farmer's perceptions and priorities rather than on the scientist's professional preferences, criteria and priorities. When the research is done on-farm, the process is faster and there is a "natural selection" of technologies and priorities. The starting point is the scientific learning from and understanding of the resources, needs and problems of the resource-poor farmers and that the research stations and laboratories play a referral and consultancy role. This model is characterized by the use of informal survey methods, research and development within the farms, and with the farmers, and evaluation through the technology adoption. The farming system must be fully integrated in order to optimize the use of locally "available alternative" resources.

The approach for effective extension strategies for IFS needs to follow through a series of sequential steps.

- Identification of target areas with the relevant authorities,
- Establishment of a local task force consisting of SMSs, researchers, extensionists and trainers who will be responsible for implementing the programme,
- Preparation of appropriate technical and extension messages,
- Undertaking of a training needs assessment of extension staff and arrangement of the necessary extension support materials,

- Initial training of participating extension staff covering basic concepts to provide a framework on required skills and knowledge
- Extending hand-holding support to the participating farmers at field on IFS and continuous monitoring of activities.

CONCLUSION:

Integrated farming systems offer unique opportunities for maintaining and extending biodiversity. The concepts associated with IFS are practiced by numerous farmers throughout the globe. A common characteristic of these systems is that they have a combination of crop and livestock enterprises and in some cases may include combinations of aquaculture and trees. It takes into account the concepts of minimizing risk, increasing total production and profits by lowering external inputs through recycling and improving the utilization of organic wastes and crop residues. There is a vast scope to improve the household profitability by judiciously utilizing family labour using innovative practices and ensuring multiple uses of various household resources. This is possible through women's empowerment through location specific trainings and critical need-based support. Developing women-centric IFS models is the need of the hour as men are migrating to rural non-farm sectors.

ORGANIC ANIMAL HUSBANDRY PRACTICES: A BOON FOR FUTURE SUSTAINABILITY IN IFS PRACTICES

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INTRODUCTION:

The world has witnessed COVID-19 pandemic which shattered every section of the society. A change in consumer attitude has also been observed where, more and more people are increasingly inclined towards foods that are produced under natural systems and are safe to consume. This change in consumer preference all of a sudden opening up the avenues for marketing of “Organic” food, where, the consumers are willing to pay more for natural and safe foods.

In India ”Organic” food categories were started with tea and spices but now available in form of Rice, flour, Dal, Vegetables, fruits ,Honey, Ghee, Baby foods and many more. Of late, consumer demands for organically produced Livestock products like milk, meat and eggs are also in the rise.

With increasing consumer perception towards Animal Welfare and Environmental issues consumers are looking for alternative livestock production system, where the issues of Animal Welfare, traceability of origin of product, food safety and food security are maintained in the highest level. This has led to the concept of “Organic” Meat, “Organic” Eggs and “Organic” Milk.

Although, the Organic crop production and certification is reasonably well established in India, the Organic Livestock and Poultry sector is in nascent stage of development. Organisation like APEDA (Agricultural and Processed Food Products Export Development Authority), FSSAI (Food Safety and Standards Authority of India) and BIS (Bureau of Indian Standards) along with ICAR (Indian Council of Agricultural Research) as well as Animal Husbandry Dept. of few States are now giving serious efforts to establish Standard Procedure for Production, its Certification and Marketing.

WHAT IS ORGANIC ANIMAL HUSBANDRY?

Organic animal husbandry is defined as a system of livestock production that promotes the use of organic and biodegradable inputs from the ecosystem in terms of animal nutrition, animal health, animal housing and breeding. It deliberately avoids the use of synthetic inputs such as drugs, feed additives and genetically engineered breeding inputs.

Unlike traditional or conventional systems of production, organic production systems are governed by a set of standards that must be strictly followed by producers. Compliance with these standards of Organic certification not only guarantees the quality of the product but also the quality of the production process verified by certification agencies authorised by respective governments. A farm may be classified as organic if it meets the criteria stipulated in a set of guidelines known as 'organic standards'.

The quality of production under organic management is ensured through certification procedures using internationally accepted standards.

The standards for organic production are basic requirement for organic production of crops, livestock, fisheries, etc. The certification bodies monitor the adherence to these standards by the organic producers. Therefore, most of the countries have national certifying body or agencies that certify the production management system as organic. Without their certification, products cannot reach the consumers as organic. A lot many organic standards exist at present. But, mainly 5 standards are important and have worldwide acceptance, viz.

1. EU regulation (1804/1999).
2. Organic Food Products Act (OFPA) of USA,
3. Draft Guidelines of Codex/WHO/FAO,
4. UKROFS of UK and
5. IFOAM Basic Standards.

Considering the regional importance, the Government of India (GoI) too has developed Indian National Standards for Organic Production (NSOP). These standards are published (NPOP, 2002) under the National Programme for Organic Production by the Agricultural and Processed Food Products Export Development Authority (APEDA).

ORGANIC LIVESTOCK STANDARDS: SCOPE

Livestock standards prescribed under these rules refer to any domestic and domesticated animal including bovine (including buffalo, Mithun and Yak), ovine, porcine, caprine, rabbits, poultry, insects and bees and/ or any other animal notified by the FSSAI from time to time, raised for food/fibre or in the production of food and fibre, their derivatives and by-products. The products of hunting or fishing or wild animals shall not be considered part of livestock standards.

GENERAL PRINCIPLES:

Organic livestock production in general is a land based activity and shall be an integral part of organic farm unit and management of livestock shall be in consistent with the principles of organic farming and shall be based on:

a. Natural breeding;

b. Protection of animal health and welfare;

c. Fed with organic feed and fodder;

d. Access to grazing in organic fields;

e. Freedom to express natural behaviour;

f. Reduction of stress and

g. Prohibition of use of chemically synthesized allopathic veterinary drugs, antibiotics, hormones, growth boosters, feed additives etc.

1. **CHOICE OF BREEDS, SOURCES/ORIGIN**

- Breeds adapted to the local conditions and resistant to diseases shall be used.
- Livestock those are used for Organic production must be brought from a source under continuous Organic management.
- In case if livestock has been sourced from non-organic source then they must qualify a minimum conversion period.
- Certification body may allow induction of non-organic animals under certain conditions such as:

a. Establishment of new livestock farm

b. Replacement of livestock breed/strain

c. Renewal of herd necessitated by catastrophic circumstances

d. Introducing breeding males

2. **ANIMAL IDENTIFICATION AND RECORD KEEPING**

a. Each animal/ herd/ batch shall bear unique identification number. Large animals including Bovine, Ovine, Caprine, Porcine etc. shall bear individual number in the form of tag, while poultry birds and small mammals shall be identified with herd/ flock/ batch;

b. Following data for each animal/ herd or batch shall be maintained and made available to the accredited certification body for verification during inspection:

i. Parent details;

ii. Source and purchase details;

iii. Animal details;

iv. Breeding details;

v. Feeding details;

vi. Health care details including details of vaccination, medication, and veterinarian Prescription and withdrawal period etc;

vii. Production details;

viii. Sale details and

ix. Any other relevant details

3. HOUSING AND MANAGEMENT

Livestock and poultry shall be maintained under natural conditions, as far as possible and shall have access to open air, grazing, runs, free range, organic feed and fodder and water. The housing and management of the animal including sanitation, hygiene and environment shall be planned to suit the specific behavioural needs of the livestock and poultry and shall provide for:

a. Sufficient space to ensure free movement and opportunity to express normal behaviour;
b. Housing conditions shall meet the biological and behavioural needs of the livestock and poultry by providing easy access to feeding and watering;
c. Plentiful natural ventilation and light to enter;
d. Confinement allowed only under inclement weather, to ensure health safety or welfare or to protect plant, soil and water quality;
e. The stocking density shall provide comfort and well-being of the livestock and poultry with regard to the species, the breed and the age; behavioural needs with respect to the size of the group and the sex of the livestock and poultry; sufficient space to stand naturally, lie down etc.

4. CONVERSION PERIOD

I. Simultaneous conversion of livestock and poultry and land should be a preferred approach. Land to be certified organic as per the provisions of crop production;
II. When a livestock production unit, with entire herd, or flock is in transition to organic, pasture and feed produced on the land undergone a minimum period of 12 months of conversion period may be considered organic for feeding to organic livestock;
III. The conversion period shall be accounted from the date of first inspection;

5. LIVESTOCK AND POULTRY FEED

Livestock and poultry diet shall be from feedstuffs produced as organic. Agricultural processed residues of organic origin shall be permitted for feeding, provided overall feeding practices satisfy the daily energy and nutrient requirements.

I. The agriculture land used for feed / fodder production shall be organic.

II. Any synthetic chemicals such as antibiotics, coccidiostat, medicine, growth promoters or any other substance supplemented for purpose to stimulate growth or production shall not be fed to the organic livestock & poultry.

III. Substances shall be permitted as per Standards and should significantly satisfy feeding requirements and such substances should not contain genetically engineered/modified organisms and products thereof; and are non-synthetic and are primarily of plant, mineral or animal origin.

   i. The feedstuffs should not be prepared by using chemical solvents and chemical treatment and should be from organic sources. In case of shortage, well-defined analogic substances may also be used (Annex 3 of Appendix 2 of NPOP).

   ii. Feedstuffs of animal origin, with the exception of milk and milk products, fish, other marine animals and products derived thereof shall not be used. Synthetic nitrogen or non-protein nitrogen compounds shall not be used.

IV. Specific criteria for additives and processing aids

   i. The supplements should be from natural sources.

   ii. Feed processing aiding supplements like binders, anti-caking agents, emulsifiers, stabilizers, thickeners, surfactants, coagulants Colouring agents (including pigments), flavours, odour masking agents and appetite stimulants if used should be from natural sources.

V. Probiotics, enzymes and microorganisms are allowed; but should not be from genetically modified sources.

6. HEALTH CARE

The organic livestock & poultry, in general, should follow the basic principles of preventive health and productivity management wherein the focus would be on preventing diseases, detecting underlying fertility and production problems and its correction primarily on correcting management, nutrition and sanitation.

The health care shall be based on the following broad principles:

a. The choice of appropriate breeds or strains of animals that can acclimatize, adapt to environment;
b. Setting up of animal husbandry practices appropriate to the requirements of each species and should focus on encouraging strong resistance to disease and prevention of infections;
c. Appropriate stocking density of livestock & poultry so as to avoid overcrowding and spread of infections or competition to feeding.
d. The farm should have an established system of detection of sub-clinical, sick or injured animals and if, so detected, must be treated immediately. In cases where isolation is necessary it will be so carried out in suitable housing areas. The paramount interest in case of sickness would be animal welfare and mitigating pain and suffering, and hence the producer shall not withhold medication even if the use of such medication will cause the animal to lose its organic status.
e. The use of veterinary medicinal products in organic farming shall comply with the following principles:
a. All vaccinations required by law of the land shall be permitted. In case there is no alternative permitted treatment or management practice exist, use of parasiticides, or therapeutic use of veterinary drugs are permitted under prescription and supervision of a registered veterinarian, provided that the mandatory withdrawal periods as provided under these guidelines are observed.
b. For purpose of treatment and prevention of diseases and under-performances, herbal/ phyto-therapeutic (excluding antibiotics), homeopathic or Ayurveda products shall be preferred to allopathic veterinary drugs or antibiotics, provided that their therapeutic effect is effective for the species of animal and the condition for which the treatment is intended;
c. In case alternative therapeutic or preventive measures are unlikely to be effective in combating illness or injury, allopathic veterinary drugs or antibiotics may be used under the responsibility and supervision of a veterinarian
f. The use of allopathic veterinary drugs or antibiotics or drugs derived from genetically modified source for preventative treatments and for enhancing productivity or fertility is prohibited.
g. Hormonal treatment may only be used for therapeutic reasons and under veterinary supervision.

h. Growth stimulants agents or substances used for the purpose of stimulating growth or production shall not be permitted.

7. BREEDING METHODS

Livestock and poultry breeding methods shall be in accordance with and in compliance with the principles of organic farming and shall take into account:

a. Breeds suited to local conditions.

b. Reproduction through natural methods. Artificial insemination allowed.

c. Embryo transfer techniques and use of hormones not allowed.

d. Breeding techniques employing genetic engineering not allowed.

Mutilations not allowed. Certification bodies may grant some exceptions keeping in view of the health and welfare of the livestock and poultry. Physical castration is allowed to maintain the quality of products and traditional practices.

8. MANURE AND EXCRETA MANAGEMENT

The livestock farm shall have proper facilities for management of urine and excreta in a manner that:

• Minimizes soil and water degradation;

• Does not significantly contribute to contamination of water

• Optimizes recycling of nutrients; and

• Does not include burning or any practice inconsistent with organic practices.

All manure storage and handling facilities including composting facilities shall be designed, constructed and operated to prevent contamination of ground and/or surface water and shall be in accordance with the national standards established for the purpose.

9. TRANSPORT

During transport, the producer shall prevent stress, injury, hunger, thirst, malnutrition, fear, distress, physical & thermal discomfort, pain, disease during the transport:

- Minimize length of the journey and Water, feed and rest must be offered to the animals at suitable intervals.
- Animals must be fit for the intended journey
- Means of transport as well as the loading and unloading facilities must be designed, constructed, maintained and operated so as to avoid injury and suffering and ensure the safety of the animals. Sufficient floor area, height and other spacing requirements must be provided for the animals, appropriate to their size and intended journey.
- Efforts must be made to avoid or reduce all types of stress.

- Use of electric stimulation or allopathic tranquilizers is not permitted

10. SLAUGHTER OF ANIMAL

The slaughter of livestock and poultry shall be undertaken in a manner, which minimizes stress and suffering;

a. The slaughter, evisceration and packing of poultry should be conducted in such a manner as will result in hygienic processing, proper inspection and preservation for the production of clean and wholesome poultry and poultry products.

b. Separate rooms should be provided for:

- Live poultry receiving and holding
- Washing and disinfection of coops.
- Slaughter and bleeding
- Feather removal
- Evisceration, chilling and packing
- Inedible products room

c. **Water Supply:** The quality of water should satisfy the requirements of potable water;

d. **Ventilation:** Particular attention should be given to ventilation. Illumination should be sufficiently strong, properly situated and should not cause glare;

e. **Personnel hygiene:** Personnel should wear special working clothes of washable material. Proper training shall be given regarding hygiene, frequent hand washing, disinfection etc. and

f. Activities such as stunning, bleeding, scalding, plucking, feet removal, evisceration and chilling, draining, grading etc. shall be done in accordance with the applicable rules framed for the purpose.

IS ORGANIC LIVESTOCK FARMING A SUSTAINABLE APPROACH?

One of the talking points about organic livestock farming in recent years has been its long-term sustainability in terms of production and productivity. In fact, in the last few decades, the organic livestock farming sector has undergone an impressive surge at various levels of research and scientific implications. However, doubt still exists among the farming community about adopting organic livestock farming. In order to harvest the best possible return from organic livestock farming, one must ensure a profound balance between the soil and livestock. Failing to do so often results in creating a sense of insecurity among the potential farmers.

Is organic livestock farming really worth adopting? Well, the answer should be yes. Organic livestock farming is a holistic farming approach in many ways. It allows the farmers to work under a safe socio-economic environment. Minimising the exposure to hazardous chemicals and persistent monitoring on the growth of organic produce have brought in a significant influence on improving the consumer health index. Organic livestock production aims at producing environmentally safe and chemical-free food products through cultural, biological and mechanical practices.

Traditionally, the comparison between organic livestock farming and the conventional one is made upon various demanding aspects such as environmental impacts, influence on public health, market potential, safety and nutritional standards, animal health welfare and social sustainability. Organic prices are generally stated high over the conventional produce in the market, solely because of their nutritional quality and freshness of the produce. However, the price label has never really impacted the long term run of the organic market at global scale.

The rate of consumption of organic products and the demand for supply is growing ever so high. Retail chains around the globe are seizing this opportunity to expand their trade market and revenue. Organic livestock production is often regarded as an important pillar of sustainable rural development. This is because; the organic production model generates more positive and sustainable externalities than the conventional model. The Organic production system not only creates an income, but it also promotes the conservation of agro-ecosystems on a long-term perspective.

Efficient utilisation of water resources on the farm is another vital parameter to look into. A lot of farming practices are carried out at rural level where the water availability is often at stake. Organic farming models have proven more water efficient in terms of usage and retention on the field which leads to develop resistance against drought. Moreover, the low input farms experience minimum issues related to soil-land degradation. Many authors and research experts have claimed that organic agro-ecosystems possess greater agro-biodiversity. As a result, they exert more resilience to various ravaging pests, diseases and climate change.

The potential to preserve biodiversity is really what separates organic livestock farming systems from the conventional ones. Reduced use of external inputs, enhanced nutrient cycling, precise and active dependence on non-renewable resources have built in a stronger backbone to this system.

Food security and sustainability are the two main concerning challenges ahead for us to combat in the near future. Therefore, turning to organic farming would be the ideal way to overcome the obstacles pertaining to global food security and sustainability in the days to come.

Now, if we compare the milk production and feeding ratio from the organic livestock farming to the conventional one, sources show that greater milk production is observed in organic farms with low feed supply to the animals.

For instance, organic livestock are observed with low calf mortality rate, less reports of mastitis, and abortions. In addition to this, pigs raised under the organic system respond with low respiratory issues and tail wounds. Organic livestock systems (when pasture-based and low-input) are more socially and environmentally reliable.

CONCLUSION:

In the past few years, particularly during and after the Pandemic there has been a significant surge in natural chemical-free products in almost all industries including — wellness, drinks, beverages, cosmetics, apparel, etc. But its highest growth was witnessed in the organic food segment. Today, people are strong believers in “we are what we eat”. They want to consume food wisely and go for naturally produced products that ensure overall nutrition to their body and soul. Also, the growing consciousness of saving the environment and animal welfare among people has given a much-needed boost for Organic Animal Products to grow.

There is tremendous scope of growth of Organic Animal Husbandry in India if the we can overcome the challenges of:-

Lake of Knowledge’s among common farmers about organic production practices, animal welfare issues and requirement of the organic certification agenises. Most of the available materials in print media or in internet are in English, which is inaccessible to large portion of small –scale farmers.

Small Farm Holding and problem of small farm certification- in India land less animal husbandry is very common, which is not allowed under Organic system of livestock production and small land holding is also not suitable due to small volume and dependence on others for feed and fodder. Therefore, both technical and policy intervention from Govt. is required to resolve this issue. Govt. should support with incentives for sustainable production and support for small scale certification, where a group of small farmers together can market the product with proper certification.

Moreover, increased distribution channels, and rise in income levels of the people, and farmers’ increasing adoption of organic farming are channelizing the growth of this industry for the future.

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ADVANCES IN GOAT & SHEEP MANAGEMENT IN LIVESTOCK BASED INTEGRATED FARMING SYSTEMS (IFS) PRACTICE

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INTRODUCTION:

Livestock plays a significant role in rural economic progress by supplementing family income and generating lucrative employment, especially for landless laborers, smallholders, and marginal farmers (Ali, 2007). Historically, livestock rearing has been recognized as an integral element of the agricultural sector, and it has been observed that combining livestock with other farming systems such as fisheries, apiculture, horticulture, agro-forestry, etc. can be more productive and sustainable than specialized and intensive systems. This system of combining livestock with different farming systems termed as Integrated livestock farming system (ILFS) which helps in efficient utilization of natural resources and wastes/organic residues and involve recycling of bio resources. For example paddy straw a by-product from rice crop can be used as a valuable input for mushroom cultivation or as a source of dry fodder for dairy animals. Similarly, spent of mushroom cultivation (used straw) can be used as a raw material in compost or vermin-compost pits and by-products from dairy unit like dung can be used as fish feed or raw material for vermin-compost unit (Fazaeli and Masoodi, 2006). In this way an integrated approach to farming can becomes more beneficial than monoculture and specialized farming and it can generates employment around the year along with additional income.

CONCEPT OF IFS:

Integrated farming system (IFS) is a broadly used term to explain the suitability of a more integrated approach towards farming over monoculture approaches. In this system an interrelated set of enterprises are maintained and by-products or wastes from one production system becomes an input for another production system, which reduces cost and improves production and/or income (Patra, 2016). Thus, IFS works as a system of systems (Soni et al., 2014). FAO (2017) stated that ‘there is no waste’, and ‘waste is only a misplaced resource which can become a valuable material for another product' in IFS. For example, paddy straw, by-product from rice crop can be used as a valuable input for mushroom cultivation or dry fodder for dairy animals. Similarly spent of mushroom cultivation (used straw) can be used as a raw material in compost or vermin-compost pits and by-products from dairy unit like dung can be used as fish feed or raw material for vermin-compost unit. The farming system is essentially cyclic, organic resources – livestock – land – crops.

Therefore, management decisions related to one component may affect the others. The integrated livestock-farming system not only provides ecological sustainability and economic viability but also improves agricultural productivity to some extent. Lal and Miller (1990) defined farming system as a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of environment quality. On the other hand, a farming system is the complex interaction of a number of inter-dependent components, where an individual farmer allocates certain quantities and qualities of four factors of production, viz. land, labour, capital and equipment's to which he has access (Mahapatra, 1994).

BASIC PRINCIPLE OF LIVESTOCK BASED INTEGRATED FARMING SYSTEM:

- Integrated farming system when agriculture was done jointly with livestock, land, water, and plants were fully utilized. An integrated farming system is a commonly used term to describe a more integrated approach to farming than one-way farming methods. This refers to agricultural systems that coordinate the production of livestock and crops, or fish and livestock, and are sometimes referred to as integrated bio systems.
- In this system, an interconnected set of enterprises is used to input "waste" from one component to another part of the system. This reduces costs and improves productivity and /or income. Because it uses waste as a resource, farmers not only eliminate waste but also ensure an overall increase in the productivity of the entire farming system.
- New integrated methods include improved farming technologies such as integrated nutrient management, site-specific nutrient management, conservation technology, use of bio-fertilizers, crop rotation, zero tillage, and the use of agricultural systems which help farmers track their activities to production capacity and profitability of farms as well as entire farms.
- The basic principle for an integrated farming system is to enhance ecological diversity: By selecting the appropriate crop method with crop rotation, crop mixing, and intercropping

so that there is less competition for water, nutrition, and space and adopting environmentally friendly methods.

- By using a multi-story layout so that the total available area can be use defectively and has a high level of interaction between biological and abiotic components.

OBJECTIVES OF INTEGRATED FARMING SYSTEM:

The overall objective of integrated farming systems is to evolve technically feasible and economically viable farming system models by integrating cropping with allied enterprises for irrigated, rain fed, hilly and coastal areas with a view to generate income and employment from the farm. The major objectives of integrated farming systems can be listed as below (CARDI, 2010; Behera, 2013).

- Maximization of yield of all component enterprises to provide steady and stable income at higher levels.
- Rejuvenation/amelioration of system's productivity and achieve agro-ecological equilibrium.
- Control the buildup of insect-pests, diseases and weed population through natural cropping system management and keep them at low level of intensity.
- Reduction in the use of chemical fertilizers and other harmful agro-chemicals and pesticides to provide pollution free, healthy produce and environment to the society at large.
- Utilization and conservation of available resources and effective recycling of farm residues within system and to maintain sustainable production system without damaging resources/environment.

INTEGRATED GOAT & SHEEP FARMING SYSTEMS (IFS) PRACTICE

Goats and sheep are two popular livestock species that have been domesticated for thousands of years and play significant roles in agriculture and rural livelihoods around the world. Both goats and sheep have unique characteristics, and their versatility in terms of adaptability, product diversity, and land management benefits make them valuable livestock species in various agricultural systems.

- **GOAT:**
  - Goats (Capra aegagrus hircus) are small to medium-sized animals and are known for their agility and adaptability to various environments.

- They are ruminants, meaning they have a four-chambered stomach that allows them to efficiently digest and utilize fibrous plant material.
- Goats are browsers by nature, meaning they prefer to eat leaves, shrubs, and tree foliage. They have a diverse diet and can consume a wide variety of plant species.
- They are known for their browsing behaviour, often reaching for higher vegetation compared to other livestock species.
- Goats are generally hardy and can thrive in harsh and dry conditions where other livestock may struggle.
- They are known for their reproductive efficiency, with the ability to breed throughout the year and have multiple offspring in a single gestation period.
- Goats are reared for various purposes, including meat, milk, fibre (such as mohair and cashmere), and as pack animals.

➢ **SHEEP:**

- Sheep (Ovis aries) are herbivorous livestock animals that have been selectively bred for specific traits such as wool production, meat quality, or both.
- They are docile animals and are often found in flocks, displaying social behaviour and flocking instincts.
- Sheep are grazers, primarily consuming grass and other herbaceous vegetation. They have a specialized digestive system that allows them to efficiently extract nutrients from fibrous plant material.
- Wool production is one of the notable characteristics of sheep, with different breeds producing various types of wool, such as fine wool, medium wool, or coarse wool.
- Sheep meat, commonly known as lamb or mutton, is consumed globally and is a significant source of animal protein in many diets.
- They are well-adapted to a wide range of climates and can be found in diverse geographical regions.
- Sheep farming also contributes to land management and conservation efforts, as their grazing behaviour can help maintain pasture health and control vegetation growth.

SHEEP FARMING IN INTEGRATED FARMING SUITABLE FOR WETLAND: In one acre of land goats can grow up to 30 to 35 numbers. The forage crops of cumbu Napier CO-4 (40 cents), Hedge lucerne - (30 cents), fodder sorghum CO.F.S. 29 - (30 cents) these crops can ensure supply of fodder throughout the year. In this CO 4 grass is high forage yielding one. It had high tillering capacity, lean stems with more leaves, easy palatability and not having spines attracts sheep. Further, it has easy digestibility. The intercrop CO-4 variety are fed into small pieces will increase the body growth rate. Buffel grass varieties viz., blue, white and black can withstand the drought and weed infestation. This kind of grass was suitable for pastures. These grasses cultivated with legume fodder such as Stylo in 3:1 proportion in dry land pastures would increase the productivity of goats. Produced forages are cut in to small pieces and fed to the sheeps. Generally, sheep produce three lambs in two years. This will give more profitable than other livestock. Moreover, green fodder given to goats about 2 to 3 kg per day would be sufficient.

GOAT REARING IN DRY LAND IFS:

In integrated farming, suitable for dryland of 1 hectare land with crop cultivation and goat rearing (20 females: 1 male) by doing this, three times production, net profit and increasing employment chances. From 20 sheeps we can get 45 lambs in a year. Moreover, from sheep manure we get 200 kg N, 106 kg P and 91 kg K. it also gives 40 to 50 thousand rupees additional income. In our country, sheeps are largely dependent on Grazing land because of this sheep's productivity is low. Solving this problem tree kind fodder leaves, agri related products as daily feed will increase the productivity. Thus groundnut leaves, red gram bran, black gram bran and such as the feeding of the wood leaves like Agathi, Barnyard, neem, Tamarind, Supapul, Desmanthus, Portia, surrogates such as tree leaves Acacia, Kutaivelan, Velikattan and Raintree pods will give required nutrient-rich forage to the sheep. It removes fodder demand, increase meat production leads to getting additional income. During rainy season, sheep's get enough amount of green grass through the pasture. So allow 6 to 8 hours daily for grazing is enough for sheep. During summer (March to August) green grass not available. Therefore, in the Cause of mixed ration (Concentrate) giving to sheep's is necessary. In this concentrated fodder include cereals, cakes, rice or wheat bran, mineral Mixture and normal saline. Usually for sheep's, groundnut cake, sesame or mixed soya cake mixed with mixture fodder may fed to the sheep. During non-availability of mixture fodder, red gram bran, black gram bran, Bengal gram brans to be given as fodder.

AGRO FORESTRY AND GOAT FARMING:

Practicing agriculture with livestock farming is more profitable than doing agriculture alone. In addition to goat rearing in agriculture, growers growing goats 20 to 30, per year will give minimum 40 to 50 thousand rupees as additional profit. Agroforestry and goat rearing doing together may give many benefits to the farmers.

- Fallow land and dry land may be exclusively used for this project.
- In this method, the amount of water needed is very low.
- In this method, from the goat dung and leaves heap decomposition used as fertilizer for agriculture, the opportunity to increase soil fertility.
- Fifth year onwards, get more profit from well grown tree.
- Above all, farmer will get the employment opportunity throughout the year.

AGRO-FORESTRY AND KENNEL METHOD OF GOAT REARING:

- New forage variety hedge lucerne in 25 cents and kollukattai grass in 25 cents should be cultivated.
- For an acre based on water facility available at least 25 cents fodder maize CO.F.S.29, 5 cents of land used to build fences and set up kennel method shed in the centre.
- In the remaining land, Agathi, Soundal, Gliricidia trees could be planted in the border.
- Three to four months prior to the purchase of goat starts cultivating forage crops and kept ready.
- Goat rearing in kennel method

CONSTRUCTION OF SHED

- 10 to 15 square feet of space is needed for one goat.
- Put shed with coconut palm leaf or tiles set
- Aluminium plates on one side of the barn to feed and keep
- Water supply with automatic tool
- Kennel should be set at a height of about 3 feet above ground level.
- Mixed forages 50g for younger ones, 100 g for grown and 200g for pregnant sheep per day. For goats, requires 1-3 litres of water per day. It also fed with 1 to 2 kg of forage sorghum and 250 to 300 grams of tree leaves per day.

INTEGRATED SHEEP REARING:

Sheep farming in dry lands under integrated farming system is profitable business. In these lands crop cultivation with fodder trees are fed to the sheep. It has rich in proteins and minerals. These include Agathi, neem Supapaul, Acacia sp, kalyanamurungai, Gliricidia and Raintree are important one. Tree leaves are rich source of nutrients than other fodder. Instead of giving tree fodder alone it can be mixed with cereal or legume fodder will reduce the feed cost of fodder sorghum and increase the productivity of sheep. It's not just giving maravakait tivanankalait separately mixed with cereal grains or forages pulvakait, sheep concentrate mixture of corn, cut through the green, can increase productivity. Sheep farming income depends on the ability of production of lamb. To make the sheep farming profitable one breeding management practices to be followed in right time. Goats are usually produces their offspring's around the year and also get into lactation 60 to 90 days after give berth. Tamil Nadu is categorized according to three oestrus periods.

March to April - July to August - September to October

Goats become enter into oestrus period during March to April give birth to lamb in July to August. From the beginning of June, due to start of south-west monsoon both sheep and lamb got good fodder. The sheep had good milk production capacity increase the growth of lamb. During the months of July and August those sheep eve lambs in November and December. In some areas there is severe cold and snowfall caused growth and health of lambs. Similarly, in places that are dependent on rainfall areas fodder shortages are likely to occur. Separated from the mother the offspring not provided sufficient amount fodder will cause growth of the younger ones. The increase in mortality of the offspring. Rain fed crops harvested in the months of December and January may be used as feed for mother to increase the milk yielding capacity. If they do get to keep the mother sheep by products of agricultural products can be corrected by maintaining milk production.

METHODS TO INCREASE FODDER PRODUCTION

- Grow high yielding varieties and technologies.
- Area for forage production is very low. So we can increase the size of the area planted forages as possible.
- Legume fodder may inter cropped with other crops to increase the production.
- Social forestry and Agroforestry system forage crops can be grown. For example, between the trees supapaul kolukattai grass and stylo can be grown in 3: 1 proportion.
- Fallow land, lake, forage or fodder trees can be grown in places like roadside land.
- Agricultural lands, fruit tree mango, sapota, guava, lemon, coconut and tamarind intercrop forages grown between the trees.
- Grow good grass pastures in poor condition land Marvel grass, kolukattai grass and legume fodder like Stylo and ciratro can be sown.

BENEFITS OF INTEGRATED FARMING SYSTEM

- Productivity improvement
- Net profit growth and fixed income
- Sustainable growth in agriculture

- Balanced diet
- Pollution free Environment
- Recycling of farm residues
- Increase in employment
- High standard of living

Therefore, future agriculture depends on planned farming of marginal and small farmers. Farm holders according to their resource availability if integrated farming system is followed they can improve their livelihoods and standard of living.

SOME KEY ASPECTS OF INTEGRATED GOAT AND SHEEP FARMING:

Integrated Farming Systems (IFS) involve the integration of various agricultural practices to optimize resource utilization and improve sustainability. When it comes to goat and sheep management within livestock-based IFS, several advances have been made to enhance productivity, animal welfare, and environmental sustainability. Here are some key advances in goat and sheep management within livestock-based IFS practices:

Grazing management: Advanced grazing management techniques have been developed to ensure optimal forage utilization and pasture productivity. This includes rotational grazing, strip grazing, and cell grazing systems, which involve dividing pastures into smaller paddocks and strategically rotating animals to maximize forage intake, reduce overgrazing, and allow for better pasture recovery.

Fodder production and preservation: The cultivation and preservation of high-quality fodder play a crucial role in goat and sheep management. Advances have been made in the production of improved forage varieties, such as high-yielding grasses and legumes that provide better nutrition for livestock. Additionally, techniques like silage and haymaking have been refined to preserve forage for use during periods of scarcity or unfavourable weather conditions.

Genetic improvement: Selective breeding programs and advanced reproductive technologies have contributed to genetic improvement in goats and sheep. This includes the selection of animals with desirable traits such as higher milk or meat production, disease resistance, and adaptability to specific environments. Artificial insemination, embryo transfer, and genomic selection are some of the techniques used to accelerate genetic progress and enhance the overall productivity of the herds.

Health management: Advances in goat and sheep health management have helped in preventing and controlling diseases, reducing mortality rates, and improving overall herd productivity. Vaccination programs, parasite control strategies, and regular health monitoring have been implemented to minimize the impact of diseases and improve animal welfare.

Nutritional management: Optimal nutrition is essential for the growth, reproduction, and overall health of goats and sheep. Advances have been made in formulating balanced diets that meet the specific nutritional requirements of different age groups and production stages. This includes the utilization of locally available feed resources, such as crop residues, agro-industrial by-products, and improved feed formulations containing essential minerals and vitamins.

Integrated pest management: Effective pest control is crucial in livestock-based IFS practices to prevent losses and improve animal well-being. Integrated pest management techniques combine various strategies, including biological control, cultural practices, and judicious use of pesticides, to minimize the impact of pests such as flies, ticks, and internal parasites.

Waste management and nutrient recycling: Livestock waste management is an important aspect of sustainable livestock-based IFS practices. Advances have been made in developing systems for the efficient collection, storage, and recycling of animal waste, such as manure. Techniques like composting, vermi-composting, and biogas generation from animal waste not only help in waste management but also provide valuable organic fertilizers and renewable energy sources for the integrated farming systems.

These advances in goat and sheep management within livestock-based IFS practices have contributed to improved productivity, profitability, and environmental sustainability. By integrating these advancements, farmers can optimize resource utilization, minimize negative environmental impacts, and enhance the overall efficiency and resilience of their farming systems.

ADVANTAGES OF INTEGRATED FARMING SYSTEM:

- **Productivity:** IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises especially for small and marginal farmers.
- **Profitability:** Cost of feed for livestock is about 65-75% of total cost of production; however use of waste material and their by-product reduces the cost of production, conversely it is same for the crop production as fertilizer requirement for crop is made available from animal excreta no extra fertilizer is required to purchase from outside farm as a result the benefit cost ratio increases and purchasing power of farmers improves thereby.

- **Sustainability:** In IFS, subsystem of one waste material or by product works as an input for the other subsystem and their by product or inputs are organic in nature thus providing an opportunity to sustain the potentiality of production base for much longer periods as compare to monoculture farming system.
- **Balanced Food:** All the nutrient requirements of human are not exclusively found in single food, to meet such requirement different food staffs have to be consumed by farmers. Such requirement can be fulfilled by adopting IFS at farmer level, enabling different sources of nutrition.
- **Environmental Safety:** In IFS waste materials are effectively recycled by linking appropriate components, thus minimize environment pollution.
- **Recycling:** Effective recycling of product, by products and waste material in IFS is the corner stone behind the sustainability of farming system under resource poor condition in rural area.
- **Income Rounds the year:** Due to interaction of enterprises with crops, eggs, meat and milk, provides flow of money round the year amongst farming community.
- **Saving Energy:** Cattle are used as a medium of transportation in rural area more over cow dung is used as such a burning material for cooking purpose or utilized to generate biogas thereby reducing the dependency on petrol/diesel and fossil fuel respectively, taping the available source within the farming system, to conserve energy.
- **Meeting Fodder crisis:** By product and waste material of crop are effectively utilized as a fodder for livestock (Ruminants) and product like grain, maize are used as feed for mono gastric animal (pig and poultry).
- **Employment Generation:** Combining crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under employment to a great extent IFS provide enough scope to employ family labour round the year.

LIMITATIONS OF LIVESTOCK BASED INTEGRATED FARMING SYSTEM:

- A lower digestibility and protein content of crop residues leads to lower nutritional benefits. It is technically possible to increase the structure and functionality of crop residues by physical or chemical treatment, but it is not feasible for small, poor farmers because it requires machinery and chemicals that are expensive or not readily available.
- Crop residues have the primary role of regenerating soil; however they are neglected too often or misapplied.

- Intensive recycling can cause nutrient losses.
- If manure fertilizer use efficiency cannot be improved, production and transportation costs will raise, as well as the surpluses lost to the environment.
- Chemical fertilizers are preferred over manures for their quicker and easier uses.
- Manure transportation is an important factor in manure use because mixed farms tend to use more manure in comparison to crop farms. Investments are required to improve the intake and digestion of crop residues.

OPPORTUNITIES OF LIVESTOCK BASED INTEGRATED FARMING SYSTEM:

- Intensification of agriculture which is currently occurring in most farming systems favours' livestock based integration.
- Poor soil fertility, unavailability or increases in prices of fertilizers, and labour shortages, have forced farmers to rely on alternatives such as manure and traction.
- Farmers can grow crop in the wet season and engage in livestock enterprises in the dry season.
- Livestock enterprises are more lucrative than crop farming so it is advantageous to integrate livestock into farm activities.
- Many indigenous, emerging and developed technologies are available to support sustainable crop–livestock integration.

CONCLUSION:

It is important for farmers engaging in integrated goat and sheep farming to consider factors such as breed selection, nutrition, housing requirements, healthcare, and market demand. Proper management practices, including regular monitoring and sound decision-making, are crucial for the success of the integrated system. In recent years, food security, livelihood security, water security as well as natural resources conservation and environment protection have emerged as major issues worldwide, Developing countries struggling to deal with these issues and also have to contend with the dual burden of climate change and globalization. It has been accepted by everyone across the globe that sustainable development is the only way to promote rational utilization of resources and environmental protection without hampering economic growth. Livestock Based Integrated Farming System is the most promising option for small and marginal farmers. It not only enhances the nutritional and economic status of farm families but also increases employment opportunities and makes optimal use of farm resources. There are many models developed by researchers in different corners of our country but there is immense need of proper documentation and dissemination for the betterment of poor and prosperity of our country both in rural and urban sector.

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CONSERVATION AND EXTENSION OF THREATENED SMALL ANIMALS IN LIVESTOCK BASED IFS PRACTICES

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INTRODUCTION:

The small and marginal farmers are the core of the Indian rural economy constituting 85% of the total farming community. Integrated farming system (IFS) is recognized as a solution to the continuous increase of demand for food production, providing stability to the income and nutritional security particularly for the small and marginal farmers with limited resources. IFS is a mix of farm enterprises such as crop, livestock (like Cattle, Sheep, Goat and Pig etc.), poultry, aquaculture, sericulture, horticulture and agroforestry to achieve economic and sustained agricultural production through efficient utilization of resources. About 95 % of nutritional requirement of the system is self-sustained through resource recycling of farm and animal wastes in the integrated system*(Thakur,2004; Jayanth et al 2002).*

The small animals are grazing mammals (such as sheep, goats and pig) make a very valuable contribution, especially to the poor in the rural areas. The small ruminants, predominantly sheep and goats were among the first livestock to be domesticated for food and fibre. Their contributions range from precious animal proteins (meat and milk) to fibre and skin, draught power in the highlands, food security and stable households. They are closely linked with the poorest people in pastoral systems and complex crop livestock systems, and convert low-quality resources to high quality protein. They are considered to be efficient and uncomplicated livestock in terms of their economics and management in the rural livelihood systems. They also act as live savings in case farmers have urgent cash requirements, have socio-economic relevance and socio-cultural roles.

India is a rich repository of small animal genetic resources having 44 well-recognized sheep breeds, 37 well-recognized goat breeds and 13 well-recognized pig breeds (ICAR-NGAGR). These breeds have evolved through natural selection and selective breeding by rearers for adaptation to specific agro-ecological conditions. The recognized breeds of Indian small animals population are facing a greater threat due to lack of enforcement of proper breeding policy, inadequate number of breeding males, indiscriminate crossbreeding and intermixing among breeds with local animals etc. As the indigenous small animal breeds of India display great variation in adaptability, productivity, feed utilization, disease resistance, etc. so conservation for unique characteristics of indigenous breeds are of great importance.

Livestock extension involves systematic and organized communication with livestock owners with a view to helping them in such a way that the livestock owners to help them form sound opinions and make good decisions. But, livestock extension is poorly developed in developing countries like India and its strengthening is a major issue. Extension of knowledge, technology and service through extension education to the grass root level is of paramount importance for the growth of the livestock sector. However, compared to crop sector, extension education for livestock production has so far been a non-starter severely hampering its growth. The sector is still considered as subsidiary to crop sector and the extension format and methodology developed for crop production are considered to take care of the livestock extension needs (Chander *et al.,* 2010, Anonymous. 2005). The Government of India (GOI, 1998) spends below 10 % on livestock extension activities. The State Departments of Animal Husbandry (SDAH) – the major stakeholders for the livestock development in India is mostly dominated by animal health concerns with negligible attention to production related advice to farmers. Moreover, their spending on livestock extension activities is only around 1-3 % of their total budget (Ravikumar, 2005).

There is need for conservation of the genetic diversity, a unique resource, to present and future needs of livestock production and human needs. Among domesticated population, one to two breed lost every week (Schearf, 2003). Considering the current population size, declining rate of population, loss of habitat and introduction of other breeds in the area, several breeds are threatened condition and the positions of several breeds are more or less vulnerable in their breeding tracts. Now, efforts have been made to conserve the indigenous breeds for their unique characteristics in their home tracts through in-situ and ex-situ conservation in different agro-climatic regions of India.

BENEFITS OF INTEGRATED FARMING SYSTEM (IFS):

- It facilitates a sustainable increase in per unit area productivity by virtue of intensification of crops, livestock and allied enterprises.
- It enhances resilience and reduces greenhouse gases where possible.

- It enhances nutritional security for human and livestock
- It increases soil fertility through organic bio-resource recycling
- There will be diversification of the production through the integration of livestock and tree species (like intensive silvi-pastoral system that combines fodder shrubs planted at high densities, with trees and improved pastures).
- It increases more profitability by reducing input costs.
- There is a regular stable income through the products (like egg, milk, meat, mushroom, vegetables, honey and silkworm cocoons) from the linked activities in integrated farming and socioeconomic improvement of farmers.

STATUS OF LIVESTOCK EXTENSION IN INDIA

Livestock is an integral part of Indian agriculture and contribute 26 percent of agricultural GDP. About 75 percent of the Indian rural households are keeping the livestock out of which the resource poor farmers own nearly 80 percent of the livestock so extension of livestock information has become an important component for rural development but livestock extension has not much developed in our country. The NSSO survey revealed that only 5.1 % of the farmer households in India were able to access any information on animal husbandry against 40.4 % of the Indian households accessing information on modern technology for crop farming. The Government of India spends below 10 % on livestock extension activities. Public livestock extension delivery institutes include directorate of extension, I.C.A.R, N.D.D.B, K.V.Ks, S.D.A.H and private extension service delivery institutes include N.G.Os, Agri-clinics and Agribusiness Centers, Pashu Sakhi etc. The public extension has faced many limitations in transfer of services so private extension organizations came into existence to overcome the short comings. But private extension service should are also reluctant to deliver their services to resource poor farmers so income guarantee should be provided to them. Extension plus, partnership, experimentation, reflection and learning are the lesson which public sector can learn from private sector for efficient service delivery (DAC, 2000; Joshi P., 2017).

ROLE OF SMALL RUMINANTS IN INTEGRATED FARMING SYSTEMS

Small ruminants like goats and sheep form an important economic and ecological niche in Asian mixed farming systems. Approximately, 60% of goats and 20% of sheep population are in Asia. The sale of goats contributes 30 % of the total farm income in India. Reports state that for farm households, the average net income is shared between crops and livestock in the ratio of about 3:1. Owing to their small stature and versatility, small animals were, and still are, an important food source in dry, remote regions of the world that lack electricity and have limited grain or roughage. They are also efficient convertors of low-quality feed materials to high-quality protein. They not only contribute to the household livelihood and nutrition security, but are also a hedge against the losses in agriculture consequent upon the vagaries of nature, and the adversities faced by these families in the absence of adequate health and social security systems. In India, they provide livelihood security to two-third of rural community (Jayanth *et al.*2002; Bhatia and arora,2005; Thakur, 2009).

INDIAN BREEDS OF SMALL ANIMALS

So far, India has 37, 44 and 13 recognized breeds of goat, sheep and pig respectively (ICAR-NBAGR); but still more than 75 percent of goat, sheep and pig population is categorized as non-descript.

INDIAN BREEDS OF SHEEP:

BREEDS OF SHEEP	HOME TRACT
Balangir, Ganjam, Kendrapada	Orissa
Bellary, Hassan, Kenguri, Mandya	Karnataka
Bhakarwal, Changthangi, Gurez, Karnah, Poonchi	Jammu and Kashmir
Bonpala	Sikkim
Chokla, Jaisalmeri, Magra, Malpura, Nali, Pugal, Sonadi	Rajasthan
Coimbatore, Kilakarsal, Madras Red, Mecheri, Nilgiri, Ramnad White, Tiruchi Black,Vembur, Katchaikatty Black, Chevaadu	Tamilnadu
Chottnagpuri	Jharkhand
Deccani	AP and Maharashtra
Gaddi, Rampur Bushair	Himachal Pradesh
Garole	West Bengal
Jalauni	UP & Madhya Pradesh
Kajali	Punjab
Marwari	Rajasthan and Gujarat
Muzzafarnagri	UP and Uttarakhand
Nellore	Andhra Pradesh
Patanwadi, Panchali	Gujarat

Shahbadi	Bihar
Tibetan	Arunachal Pradesh

Source: https://nbagr.icar.gov.in/en/registered-goat/

INDIAN BREEDS OF GOAT:

BREEDS OF GOAT	HOME TRACT
Attapady, Malabari	Kerala
Barbari	Uttar Pradesh and Rajasthan
Beetal	Punjab
Black Bengal	West Bengal
Changthangi, Bhakarwali	Jammu and Kashmir
Chegu, Gaddi	Himachal Pradesh
Ganjam	Orissa
Gohilwadi, Kutchi, Mehsana, Surti, Zalawadi, Kahmi	Gujarat
Jakhrana, Marwari, Sojat, Karauli, Gujari	Rajasthan
Jamunapari, Rohilkhandi	Uttar Pradesh
KanniAdu, Kodi Adu, Salem Black	Tamilnadu
Osmanabadi, Sangamneri, Konkan Kanyal, Berari	Maharashtra
Sirohi	Rajasthan and Gujarat
Pantja	Uttarakhand and UP
Teressa	Andaman & Nicobar
Sumi-Ne	Nagaland
Assam Hill	Assam and Meghalaya
Bidri, Nandidurga	Karnataka

Source: https://nbagr.icar.gov.in/en/registered-goat/

INDIAN BREEDS OF PIG:

Breeds of Pig	Home tract
Ghoongroo	West Bengal
Niang Megha, Wak Chambil	Meghalaya
Agonda Goan	Goa
Tenyi Vo	Nagaland

Source: https://nbagr.icar.gov.in/en/registered-goat/

Nicobari	Andaman & Nicobar
Doom	Assam
Zovawk	Mizoram
Ghurrah	Uttar Pradesh
Mali	Tripura
Purnea	Bihar and Jharkhand
Banda	Jharkhand
Manipuri Black	Manipur

STATUS OF INDIAN BREEDS OF SMALL ANIMALS

The recognized breeds of Indian sheep and goat population are facing a greater threat of becoming endangered due to various reasons such as lack of proper breeding policy, inadequate number of breeding males, indiscriminate breeding and intermixing among breeds with local animals, etc. The other factors such as dispersed home tract of sheep and goat in two or more district/states, migration of flocks, higher slaughter rate of fast-growing animals and the increase of ratio of non-descript to descript animals in different parts of home tract of recognized breeds make it difficult to assess the exact population size of particular breed to plan for their improvement in population size or to declare as endangered one. A sound conservation programme of goat breeds that are adapted to high altitude, harsh environment and marginal agricultural regions has been perpetually neglected. They have not been adequately maintained in their habitat for obtaining their maximum productivity. No attention has been given to valuable traits, such as fecundity, disease resistance, grazing habit, cheese quality, meat quality, fibre quality, skin characteristics, although these are crucial for the development programme of goats and sheep. Moreover, India is facing major environmental problems due to depletion in fallow land, increase in agricultural land, increase in human population, apathy for rangeland management and reservation of forests for wildlife protection, etc. (Mandal *et al.*, 2014)

VULNERABILITY OF A BREED

According to FAO Panel on preservation of Animal Genetic Resources (FAO,1995) proposed, whenever the population size of a breed reduces to 5000, appropriate action should be initiated for its preservation. Under Indian condition following classification has been suggested.

STATUS	POPULATION SIZE	NO. OF ANIMAL

Normal	Population is not in danger zone. No visible changes are seen in population size.	More than 50,000
Insecure	Population numbers are decreasing rapidly.	30,000 to 50,000
Vulnerable	Some disadvantageous effects on the existence of the population. Prevent further decline in number.	15,000 to 30,000
Endangered	Population is high in inbreeding and size is reduces. Need to initiate conservation action.	8,000 to 15,000
Critical	Close to extinction. Genetic variability is reduced. Action to increase the population size is essential.	Less than 8,000

Considering the current population size, declining rate of population, loss of habitat and introduction of other breeds in the area, the threatened goat breeds are Jamunapari, Beetal, Jakhrana, Surti, Sangamneri, Osmanabadi, Malabari, Attappady Black, Ganjam Chegu and Changthangi and the threatened sheep breeds are Bhakarwal, Gurej, Karnah, Poonchi, Changthangi, Rampur Bushair, Tibetan, Bonpala, Muzaffarnagari, Malpura, Chokla, Pungal, Jailsalmeri, Nilgiri, Kilakarsal and Mandya. Furthermore, the positions of several breeds are more or less vulnerable in their breeding tracts (Roy et al.,1982; Devendra and Burns,1983; Mondal *et al. 2014*)

NECESSITY OF LIVESTOCK CONSERVATION

Conservation is the act of protecting Earth's natural resources for current and future generations. It is the protection, preservation, management of wildlife and natural resources such as forests and water. The concept of the Law of Conservation was discovered by Antoine Lavoisier in the year 1789.

The market competition created through introduction of exotic breeds, difficulties associated with low production potential of indigenous breeds and changes in the farming system have resulted in either steady decline in the number of purebred sheep and goats or dilution of the genetic material.

The conservation of small animals (particularly sheep and goat) genetic resources is essential and is of paramount importance in recent times owing to their wide spread destruction, over exploitation and degradation by mankind all over India.

The conservation of animal genetic resources should now be a multidimensional activity, which has to encompass not only preservation and maintenance of existing breeds, but also their proper management and improvement. The overall aim is sustainable utilization, restoration and enhancement of resources so as to meet the needs of mankind for the present as well as for the future generations. There has been awareness for conservation of natural resources with various types of flora and fauna since a long time. However, the livestock species such as goat gained attention only recently, when it was realized that the production-oriented propagation of goat through crossbreeding and upgrading did not work in the long term and this approach is eroding the existing genetic architecture of breeds and/or genetic variability in indigenous goat germplasm (Mandal *et al.*, 2014).

Goats are fundamental and having close bondage to most agro-ecosystems in India and it is considered as the important genetic material for each production system. This material is critical for system resilience and flexibility and enables production and productivity to be increased.

Food production will only be achieved and maintained by utilizing appropriate genetic resources. The type of genetic material required to meet these challenges must be determined by the nature of the production environment, which differs greatly within zones/regions.

Climatic conditions, the type and availability of feed resources, including palatability and digestibility of feeds, fodders and grasses, disease stress, level of management and the kind and quality of products required must all be taken into consideration while taking up conservation programs.

CONSERVATION METHODS OF SMALL ANIMALS

Conservation methods involve using resources and environments to attain sustainable yields whilst maintaining environmental quality; including maximum biodiversity of genetic resources, minimal pollution and optimum aesthetic appeal. Generally two approaches, i.e. *in-situ* and *ex-situ* methods of conservation may be adopted for the sheep and goat breeds in India. The embryos are considered to be the best material for *ex-situ* conservation because they store all genetic material in a single entity, which can give rise to new progeny. Sperm and embryos of goats like other farm animal species can be frozen and subsequently used to produce a normal offspring. Moreover, cryogenic storage of DNA of different goat breeds may be done as an alternative approach for conservation of goat genetic resources in India (Baker and Gray, 2004).

IN-SITU **CONSERVATION**:

The conservation of habitats, species and ecosystems where they naturally occur is referred to as *in-situ* conservation. The major advantages of *in-situ* conservation is live animals can be evaluated and improved over the years, genetic defects can be detected and eliminate

(Bodo,1989: Henson,1992). They are always available for immediate use; act as a gene bank for future use.

- Establishment of live sheep, goat and pig breeding farms and their maintenance.
- Establishing and implementing breeding goals and strategies for animal sustainable production systems.
- Conservation of the breeds/populations, cryopreservation of semen, ova, embryos, skin, blood, DNA fragments, etc. These methods are relevant when the breed is rare or near extinction.

EX-SITU CONSERVATION:

The conservation of elements of biodiversity out of the context of their natural habitats is referred to as *ex-situ* conservation. *Ex-situ* conservation is comparatively more convenient, economical, and easy with the application of modern reproductive technologies (Acharya *et al*., 1982).

- *Ex-situ* conservation includes cryogenic preservation of threatened species to maintain populations without genetic change.
- Cryogenic preservation includes preservation of frozen seen, oocytes, embryos, ovaries, embryonic stem cells or blastomere, production of embryos in vitro, embryo splitting etc.

CONSERVATION VIS-A-VIS EXTENSION ACTIVITIES IN IFS DEVELOPMENT MODEL

The emphasis on "breeds" in the context of conservation or improvement programs needs to be reconsidered. Instead of emphasizing "breed purity", it is important to improve the existing adapted populations of various breed types in different parts of the country (SA PPLPP, 2012). There is no better way to conserve a breed for future generations than to consistently keep the breed or population viable by using an efficient, demand-driven, long-term breeding programme suitable to commercial and cultural needs of livestock owners (Phillipson *et al.,* 2011). *In-situ* conservation is, therefore, the most effective method of conservation, provided it is economically viable for livestock keepers.

The extension is the process of working with rural people in order to improve their livelihoods. This involves helping farmers to improve the productivity of their agriculture and also developing their abilities to direct their own future development. Livestock extension involves systematic and organized communication (like household/individual approach; group approach: meetings, field days, demonstrations, support to groups; school approach, mass extension methods) to livestock owners with a view to helping them in such a way that livestock owners to help them form sound opinions and make good decisions. Animal husbandry extension plays an important role in changing the knowledge regarding animal husbandry management, skill in animal rearing practices and attitude towards newer technology of livestock owner which can lead to an increase in per animal production (Chander and Rathod, 2015; Joshi, 2017).

Smallholder livestock keepers should be supported to continue to maintain the breed. Such support could be in the form of -

- Training of community animal health workers (preferably women) from the villages where livestock are maintained, in livestock management (health, feed, shelter) so as to improve the sustainability of the livestock keeping enterprise.
- Ensuring the availability and delivery of vaccines and essential livestock medicines.
- Strengthening livestock feed resources and feeding practices in the villages where the livestock are maintained by providing fodder tree seedlings and pasture development on community and private land.
- Promoting improved but inexpensive housing for small ruminants, using locally available material.
- Strengthening organizations of livestock keepers and encouraging them to establish identification and basic recording of their livestock.
- Develop semen freezing and AI technology for field use.
- Strengthening credit facilities to livestock keepers to expand their flocks.
- Ensuring that the livestock keepers obtain remunerative prices for the sale of their animals and are not exploited by middlemen. Support for the creation of collectives of smallholders could facilitate better bargaining and economies of scale for small ruminant rearers as compared to accessing markets (often located at a distance from their rearing base) as individual rearers selling one or two heads of livestock.
- Subsidies or cash payments to livestock keepers for rendering a service to society by conserving livestock with special attributes for the future could also be considered, provided an efficient system of making such payments and monitoring livestock rearing is worked out. It would, however, be better to develop sustainable local institutions to inculcate the principles and practices of genetic improvement and the related synergistic

husbandry interventions into the daily management of flocks to contribute to the livelihoods of livestock keepers.

Steps are initiated by the Central and State Government agencies, non-governmental organizations to conserve certain breeds of goat, sheep and pig as *in-situ* as well as *ex-situ* conditions. ICAR-NBAGR, ICAR-CIRG and ICAR-CSWRI have made attempts in this line (Mandal *et al*., 2014). Further financial support to the native rearers will help them to maintain the population without dilution.

CONCLUSION:

In a nutshell, an integrated farming system fulfils the multiple objectives of making farmers self-sufficient by ensuring the family members a balance diet, improving the standard of living through maximizing the total net returns and provides more employment, minimizing the risk and uncertainties and keeping harmony with environment. India has the rich diversity of livestock, poultry, crops and horticulture. Conservation and utilization of our national resources efficiently is very much important for sustainable development. Thus, this system of farming is very promising for improving overall farm productivity, profitability, generating employment opportunities, conserving natural resources and crop diversity, conserving livestock (particularly sheep, goat and pig) and poultry, and maintains the sustainability of agro-ecosystem by effective recycling the farm by-products and efficient utilization of available resources.

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CLIMATE RESILIENT FARMING: ADAPTATION AND MITIGATION STRATEGIES FOR LIVESTOCK BASED IFS PRACTICES

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INTRODUCTION:

Indian agriculture system mainly depends on small and marginal farmers with crop-livestock integrated farming having large no. of ruminants and non-ruminants. Large animals are integral part of agriculture and contribute in terms of milk, meat and draught power. India's livestock sector is one of the largest in the world. In India Agriculture and allied sectors contribute nearly 18.3 per cent of India's GDP (2022-23). India's livestock sector is one of the largest in the world. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 % of the population in India. India has vast livestock resources. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP. Milk production during 2020-21 and 2021-22 is 209.96 million tonnes and 221.06 million tons respectively showing an annual growth of 5.29%. The per capita availability of milk is around 444 grams/day in 2021-22

Different environmental factors affect animal's production and health in complex ways. Animal live-weight is a major expression of this combined effect because many features such as growth and development, fertility and birth, productivity, resilience and adaptive capacity depend on change of animal's weight. Since, animal live-weight is dynamic in relation to availability of pasture and climatic conditions that prevail animal weight change serves as an integrated indicator of climate and ecosystem change. Climate variability and extreme climatic conditions affect animal growth, productivity, and the economic efficiency of animal husbandry.

Maintenance of homoeothermic and homeostasis is mandatory for animals to survive, produce and reproduce. The animals are not able to maintain their optimum production even in the whole range of environmental temperatures of zone of homoeothermic because some energy is wasted in using the thermoregulatory mechanisms. The animals can express their full genetic production potential only within a narrower range of environmental temperature i.e. zone of thermo-neutrality, within which metabolic rate is independent of environmental temperature. Environmental temperature is the most important climatic factor followed by humidity, radiation and wind velocity in imposing stress and direct impact on livestock production.

CLIMATE CHANGE SCENARIO IN INDIA

Annual mean temperature for the country as a whole has risen to 0.51°C over the period 1901-2005 *(Rupa kumar et al, 2006; Kothawale, and Rupa Kumar, 2005).* The annual mean temperature has been consistently above normal (normal based on period, 1961-1990) since 1993 and warming is primarily due to rise in maximum temperature across the country. However, since 1990, minimum temperature is steadily rising and rate of its rise is slightly more than that of maximum temperature. Spatial pattern of trends in the mean annual temperature have shown significant positive increasing trend over most parts of the country except over parts of Rajasthan, Gujarat and Bihar, where significant negative decreasing trends have been observed. Season-wise, maximum rise in mean temperature has been observed during the Post-monsoon season (0.7°C) followed by Winter season (0.67°C), Pre-monsoon season (0.50°C) and Monsoon season (0.30°C). During the winter season, since 1991, rise in minimum temperature is appreciably higher than that of maximum temperature over northern plains with frequent occurrences of fog. Upper air temperatures have shown an increasing trend in the lower troposphere, and this trend is significant at 850 hPa level, while decreasing trend (not significant) was observed in the upper troposphere. All India summer monsoon season (June to September) rainfall as well the rainfall for all the four monsoon months does not show any significant trend. During the season, three subdivisions viz. Jharkhand, Chattisgarh, Kerala show significant decreasing trend and eight subdivisions viz. Gangetic West Bengal, West Uttar Pradesh, Jammu & Kashmir, Konkan & Goa, Madhya Maharashtra, Rayalaseema, Coastal Andhra Pradesh and North Interior Karnataka show significant increasing trends. June rainfall has shown significant increasing trend for the western and south-western parts of the country, whereas significant decreasing trend is observed for the central and eastern parts of the country. July rainfall has significantly decreased for most parts of the central and peninsular India but has increased significantly in the North-eastern parts of the country. The summer monsoon accounts for 70-80 per cent of the annual rainfall over major part of India. Due to large variability in the monsoon pattern, India experiences drought or floods in certain agro-climatic zones between Junes–September. During past 100 years India experienced eighteen large-scale droughts in 1095, 1911, 1915, 1918, 1920, 1941, 1951, 1965, 1966, 1972, 1974, 1979, 1982, 1986, 1987, 1988, 1999 and 2000. These droughts are due to failure of rains from southwest monsoon.

CONTRIBUTION OF LIVESTOCK SECTOR TO GHG'S

The livestock sector is one of the main contributors to Green House Gases emission in India. Enteric Methane Emission of 160.495 million Indigenous Cattle, 24.68 million Crossbred cattle, 97.92 million Buffaloes (GOI. 2003) has been estimated using Tier 2 methodology of IPCC. Tier 1 methodology of IPCC and default factors were used for estimating enteric methane emission for Sheep, Goats, equines, Pigs and other animals. The total methane emitted due to enteric fermentation and manure management of 485 million heads of livestock has been worked out at 9.37 Tg/annum for the year 2003 *(Upadhyay, et al 2007a, 2008a).* The major contributors to methane emission were Indigenous, Crossbred Cattle and Buffalo accounting 40%, 8%, and 40%, respectively. Lactating animals comprising of buffaloes and cattle contributed 3.42 Tg with a major share of 2.04 Tg from lactating buffaloes. Draught animal's contribution to global warming is significant and they emit about 1.2 Tg methane /annum *(Upadhyay et al 2008b*). Working bullock on an average produces 40-50 gm methane per day but considering the population size and on annual basis the emissions are high. Analysis of draught animal contribution to farm power and global warming through enteric fermentation in relation to production efficiency indicates that methane emission by enteric fermentation from cattle and buffaloes is 90-100 g /hp/day or 35-40 kg/ annum for an average bullock. Working buffalo males produce about 7-10kg/ annum more methane than indigenous bullocks. An assessment of the current and projected trends of GHG emission from India and some selected countries indicates that though Indian emissions grew at the rate of 4 per cent per annum during 1990 and 2000 period and are projected to grow further to meet the national developmental needs, the absolute level of GHG emissions in 2020 will be below 5 per cent of global emissions and the per capita emissions will still be low compared to most of the developed countries as well as the global average (Sharma et al, 2006). The emissions from livestock sector are also low per head considering multi-utility of Indian livestock for milk, meat and work, but the sizable number of nondescript cattle maintained primarily for draught power need to be reduced in present context of climate change due to methane emission per head of livestock.

CLIMATE CHANGE AND INCREASE IN THERMAL STRESS

Ambient temperature higher than 25°C with relative humidity greater than 50% has a negative impact on animal productivity. Different livestock species and breeds have different tolerance level for temperature and humidity. Temperature Humidity Index (THI) has been used to relate animal stress. Animals are comfortable at THI between 65 and 72, under mild stress from 72 to 78 and under severe stress above 80. THI levels during different parts of the year in India indicate predominance of indigenous or non -descript animals in high THI zones due to their better adaptive capacity and ability to cop up with feed scarcity/harsh environmental conditions.

IMPACT OF CLIMATE CHANGE

Inadequate vegetation and drying of water resources stress livestock species during summer and prolonged period of summer severely impacts productivity, growth and reproductive capacity. Increased number of stress days due to climate change is likely to impact livestock body weight gain, productivity and other physiological functions. Indian native breeds of livestock have inherent adaptive capacity to the extremely harsh environmental conditions, and resistance to various kinds of tropical diseases. Nevertheless, a small population of animals dies each year because of severe climatic conditions in winter and summer. More than 3600 cattle died due to floods during 2002 and from 1953 to 2002 deaths were more than 91 thousand in cattle indicating substantial annual losses to farmers on account of floods alone. Death of livestock also occurs during natural disasters like the summer drought, floods, and strong dust storms. The pastoralists and animal herders are vulnerable to a myriad of such extreme climate-induced events. Among all of these natural disasters, flood and drought are the most risky to livestock production because the damages due to these are incomparably higher than others causes. Therefore, vulnerability of livestock to extreme events due to climate changes particularly drought and floods is high. Hot and hot-humid conditions that prevail from April to October in most agro-climatic zones of India impact livestock productivity due to direct and indirect effects. Thermal heat load and direct solar exposure during summer make livestock more vulnerable and as the temperature of the day increases animals experience stress. High producing cows, pregnant cows, working bullocks and growing animals due to higher metabolic activity are more vulnerable to rise in temperatures. A rise in ambient temperature of 2-4.5 °C due to climate change will make summer more intense and highest temperature will exceed maximum tolerable limits for some livestock species. The impact on milk production of European cattle, crossbreds and buffaloes maintained for milk production will be alarming. Further, non-availability and shortage of water will make animal production system more vulnerable to greater production losses. During this period of the April to July due to low body conditions and depressed immune status many bacterial, viral and parasitic diseases affect livestock and their production performance. The rise in temperature in different agro-ecological areas will have different impacts in relation to rainfall and ground water availability thus affecting sustenance of livestock production and livelihood of farmers under different farming systems in different agro-climatic conditions. The situation may be akin to hot humid periods experienced from July to September when THI is higher than 80; both animals and humans are uncomfortable and experience different degree of stress. High producing crossbred cows are distressed maximum. Distressed animals increase respiratory frequency, pant with open mouth and protrude tongue with excessive frothing. Temperature rise due to climate change could prove to be a threat to the existence of some livestock species not well adapted to tropical stress particularly under limited mitigation measures. However, buffalo due to their good feed conversion efficiency particularly of low quality roughages, will be able to sustain better than crossbreds or exotic cattle in most agro-climatic zones.

MILK PRODUCTION

The potential direct effects of possible climate change and global warming on milk production of Indigenous, crossbred cattle and buffaloes have been evaluated using widely known global circulation model UKMO to represent possible scenarios of future climate *(Ruosteenoja et al., 2003).* The studies indicate that production of livestock is greatly impacted by temperature variations and rise in temperature. Livestock functions and milk production of Indigenous, crossbred cattle and buffaloes will be impacted. Based on widely known global circulation model UKMO used to represent possible scenarios of future climate, a temperature rise of 1.0 or 1.2°C with minor change in precipitation during March – August for India (Region 23- HADCM3 A2/B2 scenario) will marginally affect milk production and during other months productivity will remain relatively unaffected. A small rise in temperature due to climate change is not likely impact physiological functions of animals due to their adaptive capacity. But physiological functions like milk production and reproductive will be adversely impacted by projected temperature rise of more than 4° Cover existing temperatures for time slice 2070-2099. The negative impact of temperature rise on total milk production for India has been estimated about 1.6 million tonnes in 2020 and more than 15 million tonnes in 2050. The Northern India is likely to experience more negative impact of climate change on milk production of both cattle and buffaloes due to rise in temperature during 2040-2069 and 2070-2099 *(Upadhyay et al, 2007b, 2008a,*). A sudden changes in temperature, either a rise in T max during summer i.e. heat wave or a fall in T min during winter i.e. cold wave; cause a decline in milk yield. Both increase in T max (>4°C above normal) during summer and decline in T min (>3°C than normal) during winter negatively impact milk production of crossbred cattle and buffaloes. The decline in yield varies from 10- 30% in first lactation and 5-20% in second and third lactation. The extent of decline in milk yield occurs less at mid lactation stage than either late or early stage. The negative impact of cold wave or heat wave on milk yield of buffaloes are not only observed on next day of extreme event but also on the subsequent day(s), thereby indicating that heat and cold waves cause short to long term cumulative effect on milk yield and production in cattle and buffaloes. The return to normal milk yield takes 2-5 days normally, however a variable response may also be observed in individual animal depending on stage of lactation. The decline in milk yield and return to normal after an extreme event was also influenced by subsequent day(s) T max and T min. Therefore, global warming due to climate change with increased number of stressful days (THI more than 80) and increase in frequency of warm days will impact yield and production of cattle and buffaloes (Upadhyay, 2007 b).

ANIMAL REPRODUCTION

Reproductive functions of livestock are adversely affected by rise in temperature during summer. Both female and males are affected adversely. The livestock species more vulnerable to climate changes are cattle and buffaloes than sheep and goats. In most agro-climatic zones of India the average temperature throughout the year is in the range of mild to moderate stress of THI range. Temperature Humidity Index levels during the year indicate that animals are under constant stress from March to October at about 200 locations spread all over India except high altitudes. Animals maintained under open housing conditions in rural sector exhibit seasonality in breeding and reproductive rhythm and in some cases the marked seasonal variations are observed. Frequency of oestrous is pronounced during cooler periods around equinox and from March to July in Zebu and their exotic crossbreds. The period from March to July is hot dry or hot-humid period when THI value throughout India exceeds 80 on the scale. The pattern of oestrus in buffalo is different from cattle and majority of animal exhibit signs from October to March when THI value is less than 70. This indicates that not only temperature but also humidity and solar radiation profoundly affect reproduction in buffaloes. The incidence of calving is predominant in a precise period from October to March. This facilitates upbringing of offspring’s and availability of feed resources. The climate change scenario leading to a rise in temperature with higher intensity of radiant heat load is likely to impact reproductive rhythm through pineal- hypothalamic- hypo-physeal – gonadal axis. The effects may be more pronounced in animal species like buffaloes, which due to higher thermal loads and limited capacity to dissipate heat may be severely stressed. Scarcity of water resources may further compound effects on production. The higher thermal loads, if persisted for longer periods due to either non dissipation or uncomfortable environment conditions, will impact reproduction and health on long term basis. Therefore mitigation measures and strategies need to be adopted not only to reduce stress on animals but also to curtail fertility losses and other health consequences thereof. Estruses behaviour exhibit diurnal patterns and some of the domestic species under confinement express heat symptoms during particular part of the day. Domestic buffaloes of Murrah breed exhibit estrus signs between 6 PM and 6 AM and about 60 % buffaloes exhibit estrous between 10 PM and 6 AM (Madan and Prakash, 2007). Due to high incidence of silent heat large numbers of buffaloes are left un-bred. The overall mean service period in buffaloes was observed to be more than four and half months (139 days). Season of calving was observed to influence service period. The mean service period of animals calving from December till June were more than 40 days and was significantly higher than mean service period of animals calving in the months of July to November (<110 days). The difference in service period of buffaloes may be due to high temperatures during summer. Hot dry summers with limited access to water affect buffalo's heat expressions particularly from March to June. During extreme summers animals have relatively non-functional gonads with less number of sperms in semen of males and poor expression of heat in females. This is mainly due to higher thermal heat loads on animals that they are unable to dissipate. Non- availability of water or limited access for drinking and wallowing affects buffaloes during summer. Buffalo heifers have a greater sensitivity to high temperature than other livestock.

PHYSIOLOGICAL FUNCTIONS

Effect of temperature and humidity on cattle, buffaloes, sheep and goats has been investigated with emphasis on their thermal stability and adaptability. Metabolism of livestock species is affected by ambient temperature rise and humidity levels. The magnitude of response depends upon species, breed and physical environment factors. The Zebu cattle maintain a low temperature than the crossbreds indicating that their metabolism is set at lower level than crossbreds. In maintaining body temperature radiation, conduction, convection and evaporation plays significant role. The sweat gland distribution, the capacity of skin vascular blood dispersion and the effective adrenergic mechanism governing the sweating rate are responsible for the efficiency of heat loss from animal surface (Macfarlane, 1981; Dowling, 1955). As the environmental temperature increases heat loss by conduction, convection and radiation decreases and heat loss by evaporation increases. Zebu breeds have higher number of sweat glands and produce more sweat therefore maintain low body temperature (Aggarwal and Upadhyay, 1997). The Indian breeds of livestock have capacity to withstand thermal stress, feed and water scarcity, diseases and parasite load. The multipurpose zebu breeds perform across multi dimensions of use. The livestock of tropics are more resilient to environmental and climatic stress due to their genotype and capacity to interact with environment. The mechanisms that facilitate easy transfer of heat from body without much loss of moisture are unique in Zebu and other tropical livestock species in addition to mechanisms that conserve energy for body maintenance at high temperatures. Adaptive mechanisms to deal with heat gain and loss are coat colour, length of hair coat, skin pigmentation, number of sweat glands and their secretion. The small body size with low energy requirement for maintenance and capacity to use poor quality feeds and fodders make them superior to many breeds of livestock in efficiency of feed conversion. The water recycling and economy in these animals is much more that give them higher capacity to dehydrate and withstand higher thermal stress. Body appendages and higher body surface area per unit of weight help them in heat dissipation. The necessity of heat loss to maintain thermal balance particularly during hot humid conditions force thermal distressed animals (Taurine breeds' crossbreds and buffaloes) to employ open mouth panting with tongue protruded out to complement heat elimination process. Studies on Sahiwal and Sahiwal X Holstein cattle have revealed that during hot dry summers and under direct sun exposure Sahiwal cattle are able to withstand extra environmental heat loads due to their capacity to increase skin evaporative losses. However Sahiwal-Holstein crossbreds, in spite of their ability to increase pulmonary and skin evaporative losses, are not able to dissipate extra heat of environmental or work and raise their body temperature too much higher levels. The Crossbreds exhibit distress symptoms like open mouth panting, tongue protrusion, profuse salivation and restlessness. The ability of Sahiwal cattle to increase evaporative cooling at higher temperatures without increasing their respiratory frequency much is an important factor in establishing the heat tolerance superiority of the Sahiwal compared with the heat tolerance of Sahiwal-Holstein crossbreds (Aggarwal and Upadhyay, 1997). Temperature rise during summers and solar radiation exposure cause thermal stress on crossbreds more than Zebu (Banerjee and Ashutosh, 2011). Heat exposure studies on young and adult buffaloes also reveal that both adult and young animals are stressed during heat and require protection and /or mitigation measures for heat stress alleviation. Physiological functions of cattle and buffaloes and their change with temperature rise have been evaluated under ambient conditions and in climatic chamber. Physiological responses, surface temperature and sweating rate have been observed to increase due to temperature rise. Body heat storage of crossbreds and buffaloes increased beyond their capacity to tolerate heat particularly on days, when THI exceeded 80 during summer and hot-humid conditions. Zebu breeds of cattle under hot dry/ hot humid conditions have better heat tolerance than crossbreds or buffaloes. The speed of change in physiological functions with rise in temperature based on the Van't Hoff Arrhenius effect (Q10) indicate that the physiological responses (Respiratory frequency, heart rate and energy expenditure) doubles or trebled for an increase of 10°C in temperature. Zebu cattle exposed to heat stress experience less severe alterations in feed intake, growth rate, milk yield and reproduction than European breeds.

Thermal stresses trigger a complex program of gene expression and biochemical adaptive responses. Heat shock proteins (HSPs), a large protein family, allow cells to adapt to gradual environment changes and are considered to play crucial roles in environmental stress tolerance and thermal adaptation (Sorensen et al. 2003). These proteins are highly conserved across evolutionary lines (Lindquist 1986; Parsell et al. 1993) and represent between 2-15 per cent of total cellular proteins expressed by all living organisms (Morimoto et al. 1994).

FEED INTAKE

Impact of temperature change on feed intake of cattle and buffaloes has been assessed. The analysis of feed intake in relation to changes in T max and T min indicated that crossbred and buffaloes are sensitive to temperature rise observed during summer and rainy season. Dry matter intake declines with increase in Tmax/ Tav/ THI during summer (hot)/ rainy (hot-humid) season and dry matter intake increase with Tmin decline during winter. Temperature rise due to global warming during summer and rainy season is likely to impact feed intake of animals that will result in reduction of milk yield and production of lactating animals.

ANIMAL DISEASES

Temperature rise due to global warming is likely to cause an increase in animal diseases that are spread by insects and vectors. Elevated temperature and humidity will favor spread and growth of insects/ vectors. Incidences of both protozoan and viral diseases affecting livestock will spread in susceptible population. Incidence of protozoan diseases like Trypanosomiasis and Babesiasis are likely to increase in high producing crossbred cattle and may be higher than now. Some of the viral diseases (PPR or RP like diseases) may also reappear and affect both small and large ruminants population. Frequency and incidence of mastitis and foot diseases affecting crossbred cows and other high producing animals may increase due to increase in number of stressful days. Climatic conditions favorable for the growth of causative organisms during most part of the year due to temperature rise will facilitate spread of diseases in other seasons and also increase area for their spread.

IMPACT OF CLIMATE CHANGE ON POULTRY IN INDIA

As the ambient temperature reached ≥34°C the mortality due to heat stress was significantly high in heavy meat type chickens (8.4%) as compared to light layer type (0.84%) and native type (0.32%) chickens. Feed consumption decreased from 108.3 g/bird/day at 31.6°C to 68.9 g/bird/day at 37.9°C. Egg production also decreased both in broiler (by 7.5%) and layer (by 6.4%) breeders as compared to their standard egg production. The body temperature increased from 41 to 45°C as the shed temperature rose from 28 to 42°C and the critical body temperature at which the birds succumbed to death was 45°C, which was observed at the shed temperature of 42°C. Naked neck birds performed significantly better than the normal birds with respect to thermo-tolerance, growth, feed efficiency and immunity at high temperatures.

EFFICIENCY OF PRODUCTION SYSTEM

At the end of twentieth century the world witnessed a shift in the “center of gravity” of livestock production, from the North to the South, from temperate regions to tropical and sub-tropical environments. In 1998, India emerged as the world’s largest milk producing country surpassing the United States. Earlier China overtook the United States and the entire European Union in terms of meat production. These changes are only indicative of the fact that livestock production system efficiency in tropical and subtropical regions is comparable. The Indian livestock production system contributes not only in terms of milk but also for animal power and majority of farms in India are dependent on animal power. The resource poor farmers under stressful climatic conditions and difficult terrains use animals for farm power. Though ecosystems of different agro-ecological regions have tremendous adaptive capacity to changing conditions, but current climate changes are occurring at pace not seen historically, therefore, the adaptation will be less than the pace of changes occurring. In general, the faster the climate changes, the greater the impact on people, ecosystems and efficiency. People, animals and the natural environment have become particularly vulnerable to the impacts of climate change.

ADAPTATION AND MITIGATION

Adaptation and mitigation of the detrimental effects of extreme climatic events plays important role to counter the impact of climate change on livestock production. Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Sustainable development and equity provides a basis for assessing climate policies.

ADAPTATION

Climate change adaptation is the adjustment in ecological, social, or economic systems to reduce the negative or enhance the positive impacts of climate change. The adaptation can occur through ecological change or through human action. In livestock, natural adaptation results from several mechanisms through which animals adapt to climatic conditions. Human adaptation involves different actions and practices which could help animals adapt to climate change and enhance their performance. In livestock, adaptation actions can be divided into three broad classifications: animal responses, management actions, and resource (Gaughan et al. 2019). Adaptation can reduce the current risks of climate change impacts and can be used for addressing emerging risks. The first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate and extremes. It is crucial to build adaptive capacity for effective selection and implementation of adaptation options.

ADAPTATION STRATEGIES

Through the reduction of vulnerability and exposure reduction through development, planning and practices:

a) Feeding management: Modifications in nutritional management are used to reduce the internal heat load on animal. The animals use more energy for digestion of poor quality feed, like crop residues and proportionately higher amount of heat per unit feed intake is produced. This extra heat also is to be lost from body to maintain thermal balance.

b) Improved animal housing: In the intensive system of production the animals are mostly fully housed for attainment of maximum productivity. In tropical and sub-tropical climate animal shelters are designed to curtail the heat load on animals from external macro-environment and providing congenial micro-environment in animal houses.

c) Heat ameliorative measures: During the period of high temperatures the use of water can be used to bring down the micro-environmental temperature within the animal shelters and increase the evaporative heat loss from animal body. Use of air cooling systems is very efficient but more expensive.

d) Community animal shelters: The animals in arid zone are out in the fields for grazing during day and are exposed to peak heat. These animals are reared under extensive system of farming and there is scarcity of feed resources in grazing fields. If the community shelters are available in these areas the animals can take rest during peak hot hours. Similarly suitable shelters in flood and cyclone prone areas can save morbidity and mortality losses.

e) Weather forecasting and early warning system: Weather forecasting and early warning are very important to enable the farmers to take preventive measures to protect the animals from extreme weather events like heat wave, cold wave, heavy precipitation events including thunderstorm, cyclone, flood and disease outbreaks. In India presently this component is almost lacking. To make the adaptation measures effective to overcome the effect of climate change this should be brought to international level.

f) Coastal protection: The coastal low lying areas are vulnerable to rise in sea level and cyclonic disturbances. Since the climate change is resulting in rise of sea level and the frequency of extreme weather events is likely to increase, it is very important to construct well planned structures to safe guard these low lying areas.

MITIGATION

Fifth Assessment Report (IPCC, 2014) provides a comprehensive assessment of all relevant options for mitigating climate change through limiting or preventing greenhouse gas emissions, as well as activities that remove them from the atmosphere. There are multiple pathways that are likely to limit warming to below 20C relative to preindustrial levels. These pathways would require substantial reductions in GHG emissions over the next few decades and near zero emissions of CO_2, and other greenhouse gases by the end of the century. Implementing such reductions poses substantial technological, economic, social and institutional challenges in countries like India where one quarter of the population still lives below poverty line, almost 70% of population is dependent on agriculture and food and nutrition security is low. Estimated GHG emissions from livestock during 2010 were 2771x109 kg CO2 eq. for world and 392x109 kg CO2 eq. for India (Patra, 2014). Thus the contribution of India in GHG emissions from livestock was only 14.1% of global value in year 2010 although it hosts more than 17% of the human population. Important greenhouse gases attributed to livestock are methane and nitrous oxide. The contribution of enteric methane emission from Indian livestock to total enteric emission from livestock in world was estimated to be 15.1% in year 2010. The contribution of manure methane and nitrous oxide from Indian livestock in year 2010 to total manure methane and nitrous oxide from livestock in world derived from values given by Patra (2014) was only 9.6% and 3.9% respectively. In view of the fact that India hosts more than 17% of the human population of world the per capita GHG emissions from livestock are also of lower level than the world average. Strategies and actions are required for climate resilient pathways for sustainable development. Sustainable development and equity provide a basis for assessing climate policies. Limiting the effects of climate change is necessary to achieve sustainable development and equity including poverty eradication.

MITIGATION PATHWAYS

Enteric Methane Emissions: Improvement in animal feeding: Balanced feeding and good feeding management increase conversion of feed nutrients to animal products and decrease in emission of nitrogen and methane.

Use of feed additives: Many compounds like chemicals, oils, plants and their extracts, condensed tannins, probiotics, acetogens, bacteriocins, organic acids and ionophore antibiotics have been used as feed additives to decrease the methanogenesis in rumen.

New approaches: New approaches for methane reduction such as vaccination of ruminants against methanogens and use of plant derived materials to divert the primary hydrogen sink channel without adversely affecting digestibility and production are still at a fundamental stage of development. Two potential materials, plant derived liquid (PDL) and yeast derived surfactant (YDS), have been found to reduce rumen methane production recently. Genetic selection of cows and buffaloes that have higher feed efficiency and low methane emission rates can be long term sustainable solution.

Heat ameliorative measures: Enteric methane emission/kg dry matter intake has been observed to increase under severe heat. This might be attributed to lower organic matter digestibility and shift in methanogens and other microbial fermentation, due to alterations in rumen environment. An increase in rumen temperature also causes increase in enteric methane emission. Protection of animals from severe heat stress through proper housing and heat ameliorative measures will be effective in reducing methane emission.

Supplementation of protected fat in feed to lactating cows and buffalo:Feeding of protected fat to by-pass rumen microbial degradation can improve production and decrease in emission of enteric methane. Intensification of livestock and crops:

Emission of Methane and Nitrous Oxide in Manure Management: Improvement In disposal of farm yard manure and its use for biogas production and use of biogas slurryas fish feed and use of water from fish farms irrigation can reduce methane emission from manure.

RESILIENT ANIMALS

Resilient capacity of an animal refers to the ability of an animal to recover its normal biological functions after the exposure to the adverse stressful condition. This coping ability helps the animal to bounce back to the original state and perform better than expected. Resilience is rather a process, and not a trait of an individual. The animals restore their normal functions using their inherent genetic potential as well as the previous exposure experiences

The traits of inherent resilient and adaptive capacity are: long legs, short hair coat, higher sweating rate, large surface area, body conformation, higher capacity for maintenance of heat balance, lower metabolic rate and higher feed efficiency, higher tolerance to dehydration and adipose tissue depots and capacity to alter the hormone and biochemical profiles to adapt to a particular environment.

CONCLUSIONS

Rise in temperature due to climate change is likely to impact livestock production and livestock health. Increase in physiological reactions and energy expenditure at high temperatures will elevate heat loads of animals resulting into decline in their productivity (milk, meat, wool, and draught power). Higher temperatures and prolonged period of stress will affect diseases and pest challenges. Incidence of diseases (parasitic and protozoan) is likely to increase. Inadequate resources and infrastructure will put stress on livestock and livestock production system with further substantial increase (160%) in stressful days due to climate change. India is likely to face a major water crisis that will severely impact livestock and livestock production system. In conclusion, it could be said that climate change will influence many physiological and behavioural manifestations of livestock species. The factors like changes in temperature with intensity increase or decrease with or without change in photoperiod length or intensity has ecological relevance in that it is a principal determinant of seasonal changes that can be considered as a cue to initiate or delay reproduction in animals. Natural environments being much more complex with far more environmental factors varying both spatially and temporally, it is likely that global warming and climate variability will amplify the complexity of genotype environment interaction and its genetic underpinnings.

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ADVANCES IN POULTRY FARMING FOR POND BASED INTEGRATED FARMING SYSTEM (IFS) ON EMPOWERMENT OF STAKEHOLDERS

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Integrated fish farming is a system of producing fish in combination with other agricultural/livestock farming operations centred around the fish pond. The farming sub-systems e.g. fish, crop and livestock are linked to each other in such a way that the by-products /wastes from one sub-system become the valuable inputs to another sub-system and thus ensures total utilization of land and water resources of the farm resulting in maximum and diversified farm output with minimum financial and labour costs. In a proper fish, crop and livestock integrated farming system, the possible inter sub-system interactions are - excreta and waste feed from livestock sub-system act as manure and feed for fish as well as can be used as manure for crop land. By-product/wastes of crop can be used as feed, manure for the fish pond and as feed for livestock. Nutrient rich bottom silt and water of pond can be a good source of fertilizers for the crop land. It thus appears that the different sub-systems in an integrated system are beneficially inter-linked to each other in a limited area, minimizing the production costs but resulting in a diversified outputs viz. fish, meat, eggs, vegetables, fruits, fuel wood and fodder which are the basic need of a farm family.

INTRODUCTION:

Integrated fish farming offers opportunity for taking up diversified farming activities with optimum utilization of available land space for food production, thus increasing household income of small farmers. Currently, the farmers mainly practice mixed farming system, where crop/fishery/ livestock sub-systems are independent of each other. Fish-livestock production in combination with planted crops on pond dykes could be a workable pattern of an integrated system. The inter-linking is easy: the farm animal produces organic manure for fertilization of agricultural land and fish pond - the crops and plants provide food for animals, fish and man - the nutrient rich pond humus can provide fertilizer to the crop land. Most of the excreta of these cattle, buffaloes, sheep, goats and chickens and ducks in the country. is not properly utilized and become wastes which may cause environmental pollution to some extent. If these livestock wastes could be applied in fish ponds through integrated fish farming system, fish production could be increased substantially (in optimal case 4–5t/ha/yr) without using any other fertilizer or supplementary feed for fish.

FISH FARMING INTEGRATED WITH LIVESTOCK:

Animal wastes in integrated fish farming: Animal wastes and waste feed particles which enter the food web of a pond ecosystem are utilized in several ways like as a source of nutrients required for primary production; as nutrients and organic substrates for heterotrophic micro-organisms which in turn may be consumed directly by fish or by invertebrate fish food organisms; and directly consumed by the fish.

Values of animal wastes: Animal manures contain major inorganic nutrients (N,P,K) as well other trace elements viz. Ca, Cu, Zn, Fe, and Mg. Out of the available nutrients in fresh animal manure about 72–79% of nitrogen, 61–87% of the phosphorus and 82–92% of potassium are recovered from the feeds fed to animals which could be utilized for fish production and hence their role in fish culture is highly appreciated. Waste output in the form of urine and faeces varies considerably in quantity and quality (Urine comprising about 40% by weight of the total waste excretion per day). The distribution of nutrients in faeces and urine also vary. Urine contains higher levels of nitrogen (N) and potassium (K) than in faeces. A higher level of phosphorous (P) is found in the faeces of animals except pigs which have high phosphorous in urine. In integrated fish farming the poultry can provide the most valuable manure because of high concentration of nitrogen, phosphorus and potassium. Under local conditions the quality of manure is determined by the factors viz. the time and method of storage, soil or bedding material content of the manure and whether the manure contains urine or not.

Storage of animal waste: Nutrient value of animal manure usually deteriorates during storage. The changes occur in all aspects of the quality (physical, chemical and biological). The loss of nitrogen is substantial. Under the prevailing climatic conditions expected loss might be more than 90%. The ammonia (NH_3), nitrate (NO_3) and nitrite (NO_2) do simply volatilize into the air. The deterioration is faster under aerobic conditions with high temperature. It is always better to use animal wastes when they are fresh. If the animal wastes are stored before using in the fish pond, following two points are to be considered. :i) make storage time as short as possible ii) store in a container or a pit, covered with polyethylene or mud. Try to store animal wastes in a cool place to avoid high temperature

PREJUDICES TO FISH/LIVESTOCK INTEGRATION:

a. Multipurpose use of wastes: Cattle and buffalo manure is widely used as fuel in the rural area. Chicken manure is also being used as fertilizer in crop land. In such cases, it has to be calculated carefully whether the use of manure in integrated fish culture would be able to produce more benefit for the farmer over its other uses.

b. Dislike using animal wastes in fish ponds: A large number of farmers in rural area are reluctant to handle and apply animal excreta in fish ponds. Some of them also hesitate to eat fishes raised out of integrated fish-poultry farming where fish consume fresh poultry manure directly.

c. Multipurpose use of pond: Most of the ponds in our country are built for serving various social functions such as raising foundations for houses, bathing, washing, cooking and even for drinking. Adoption of integrated fish-livestock farming is not possible in many ponds, particularly in homestead ponds, because of the use of water for domestic purposes.

d. Public health risks: The dangers of fish acting as vectors for human pathogens are still not clear. Public health aspects of fish produced in human wastes might be expected to be more serious than those of animal/fish integration. Researchers have made comparative studies of natural fish populations and those grown using cattle manure or effluent. Large numbers of bacteria, including potential pathogens were found in skin, gill and intestine of the fish cultured using manure or efficient; but tissues and blood appeared sterile on both groups. This suggests that the consumption of fish cultured in waters containing animal manure would not cause a health risk greater than that of fish caught from natural waters.

FISH CUM POULTRY FARMING SYSTEM:

GENERAL CONSIDERATION: In most of the agricultural farms, extensive fish culture and extensive poultry raising is practiced, but the two systems are not interlinked. To develop an integrated system of poultry production and fish culture, the first thing a farmer has to reorganize is the poultry raising and the stocking structure of fish. Although fish production is the more profitable component, in a integrated system the profitability of poultry sub-system (even if it is minimal) must also require to be a self-sustaining activity be ensured, or, at least, the poultry sub-system must pay for itself. The modern methods of poultry raising require sophisticated management which seems to be beyond the capacity of most of the rural fish farmers. It may be easier for a proven poultry farmer to integrated fish culture with his poultry rearing rather than a fish farmer integrating poultry raising in his fish farming system. The Management of fish sub-system - as second consumer level - seem to be easier, as it is mainly “served” by the poultry sub-system. Considering consumer's preference and local price structure, only three types of poultry farming is economically viable.

a. Chicken egg production
b. Duck egg production
c. Chicken meat (broiler) production in selected places

FISH SUB-SYSTEM IN INTEGRATED FARMING: While designing the fish sub-system, both fish production conditions as well as the type of wastes/by-products expected from other sub-systems that are to be recycled in fish pond are to be evaluated. Except for modifications in the design to accommodate the poultry/crop sub-system, the rest remains more or less similar to normal poly-culture system.

a. Size of pond: Considering rural conditions, mainly the smaller ponds can be used for integrated fish culture. Majority of the homestead ponds are suitable for this purpose. Generally 0.5–1.5 bigha size is easily manageable by small farmers.

b. Depth of pond: Any pond that retains 2–3 m water can be considered as suitable. However, the determining factor is the water depth in dry season. Minimum of 1.5m of water depths is essential even during the summer season. In low water depth the danger of organic over-loading is high from the poultry sub-system and that may cause fish kills in the summer months.

Fish pond management: The basic management practices in integrated fish pond are more or less similar to that of simple poly-culture system. Pond preparation, daily routines, sampling, harvesting, and health care are same as for poly-culture system .However, fish species combination has to be adjusted according to the type of the livestock sub-system to be integrated. There should be very little or no supplementary feeding and fertilization of the pond water

SELECTION & STOCKING RATE OF FISH SPECIES: Considerations for selection:

- The selected species should be compatible with each other
- The species and their combination ratio should be adjusted according to the amount of feed stuff and manure that are expected to be made available by the other sub-system
- As far as possible the species should fast growing
- Selected fish should be hardy and resistant to common diseases and parasites

- The species should be able to tolerate low oxygen levels and high organic content in the water.

The species combination and stocking ratio may vary according to the local requirements and possibilities. A general guideline on the fish stocking density and species ratio in an integrated fish-cum-poultry farming system is given in Table 1.

Recommended size of stocking material: Size of the stocking material also depends upon the level of management. In a well prepared pond, fingerling of the size of 5–10 cm may be stocked. However, if the pond is not poisoned or dewatered, larger size fingerlings 10–15 cm should be stocked. These guidelines are suitable for a semi-intensive production level, based on a poultry sub-system. If the organic waste requirement falls short of supply from the integrated livestock sub-system, stocking density of fish should be decreased; otherwise supplementary feeding and manuring would be necessary. If the fish sub-system is supported by other by-products, or supplementary feeding, the stocking number can be increased with the species which can utilize best the added by-products/feed.

Table 1: Recommended fish species combinations and stocking in a typical integrated fish-cum-poultry farming system

Trophic niche	Fish species	Stocking ratio (%)	Number of birds/bigha			
			20	50	100	140
			Number of fish/bigha			
	Silver carp	35	94	210	280	385
Surface feeder	Catla	10	27	60	80	110
Mid-water feeders	Rui	10	27	60	80	110
	Grass carp	5	14	30	40	55
	Thai sarputi	20	54	120	160	220
Bottom feeders	Mirror/common carp/ Mrigal	20	54	120	160	220
Total stocking		100	270	600	*800	*1100
Fish yield to be expected (kg/bigha/year)			200	330	500	700

Managing proper growth rate in integrated pond: In most cases of integrated culture system the waste output from livestock component remain constant during the production cycle. While during the initial phase of fish rearing the biomass of fish is not big enough for full utilization of available nutrients. As a result, initially the growth rate of fish is high. The larger the fish, the more absolute amounts of food is required in order to sustain its potential growth and maintain its body weight. As soon as the biomass reaches the critical standing crop (the point when the food requirements of fish and the natural supply of feed are in balance) the growth rate starts decreasing and even may reach zero mark. In small scale integrated system supplementary feeding is not usually required. As soon as the sampling results show the pattern of decreasing growth, the biomass should be decreased by periodical partial harvesting.

POULTRY SUB-SYSTEM:

Background: Intensive production of broiler meat and egg is now common in many parts of the world. In integrated fish-cum-poultry farming system the birds are typically fed complete diets in pelleted or mash form and the manure is used fresh or as dried poultry waste. The waste recycling is the key feature of the system, and integration of fish culture with poultry raising is one of the best ways of poultry waste management. The digestive tract of a chicken is very short, only 6 time its body length. Therefore, some of the eaten feedstuffs are excreted by the chicken before being fully digested. Research has shown that about 80 per cent (dry matter) of feed stuff is utilized and digested by the poultry, leaving 20 per cent for use by the fish in the integrated fish culture system. Chickens while peaking scatter about 10% of their food over the ground. This wasted feed is utilized directly by fish. The total protein content of dry chicken excrement can be as high as 30 per cent. Usually, good chicken feed stuffs have a protein content over 18 per cent (Table 2).

Table 2: Composition (%) of chicken manure from different chicken-raising methods.

Constituent	Raising above the pond/in cage	Ground raising	
		Sawdust bedding	Dry grass bedding
Moisture	11.4	12.3	15.5
Crude protein	26.7	21.9	22.3
Crude fat	1.7	1.7	2.3
Nitrogen Free Extracts	30.6	30.0	27.1

Crude cellulose	13.0	17.2	18.7
Minerals (Ca, P, etc.)	16.5	16.9	14.1

BENEFITS OF FISH CUM CHICKEN INTEGRATION: Following are some of the additional advantages when fish culture is integrated with chicken raising on/or near the pond dykes:

i. The direct discharge of fresh chicken manure to the fish ponds produces enough natural fish feed organisms without the use of any additional manure/fertilizer.
ii. The transportation cost of the manure is not involved.
iii. The nutritive value of applied fresh manure is much higher than dry and mixed with bedding materials e.g. saw dust or rice husk.
iv. Some parts of the manure is consumed directly by the fish.
v. No supplementary feed is needed for the fish.
vi. No extra space is required for chicken farming. Chicken sheds can be constructed over the pond water or on the dyke.
vii. More production of animal protein will be ensured from the same area of minimum land.
viii. The overall farm production and income will increase.

Selection of species: First of all the farmer should decide whether he wants to take up egg or meat production. Where the market chain is good for broiler it is preferred over layers because the shorter broiler production period can easily be programmed with pond culture period. On the other hand, egg production of layer chickens can start only after five months of rearing. Area of good markets, both for broiler and layer chicken are recommended for the sub-system

Housing of birds: Poultry sheds can be constructed out of locally available materials such as bamboo, wood, tin, etc. The size depends on the number of chicken and type of chicken. Floor space, nests, ventilation, temperature regulating device, dryness, light and sanitation are the main features to be considered during shed construction. Size of the house depends on the number of birds to be kept - normally 2–3 sq. ft. area is required for a layer chicken and 1–1.5 sq. ft for a broiler. One of the main point is to make the pen as cheap as possible and simple in design. However, it should be strong enough to last at least for 5 years. Otherwise, frequent repair and maintenance will cost more. To extend the life of bamboo structure water proof painting is recommended.

USEFUL CONSIDERATIONS WHILE CONSTRUCTING A CHICKEN PEN:

i. Rectangular house has been found to be suitable from overall management point of view.

ii. Location: The house should be built at the most wind protected side of the pond. Storms can cause serious damages to the structure. If the house is constructed above the pond, it has to be carefully considered that the gap between the house floor and the pond water surface should be at least 1 foot at highest water level in monsoon period.

Structure: Roof-Tin is the long lasting and perfect roof material. At roof design first have to calculate with the available length of tin sheets on the market. The tin roof should rest over a bamboo mat rice or rice straw mat to cut down heat inside the chicken house during the summer months.

Wall: Wall material can be bamboo mat, bamboo sticks or wire mesh. Optimal height of the wall should be 120–160 cm. If bamboo mat is used, the upper 1/4 of the walls. should be left free and fitted with wire mesh for light and ventilation If the walls are built with wire mesh and supporting bamboo stick, the lower one third of the walls should be covered with bamboo mat to give protection for the chicken and nests against bad weather.

Floor: The floor of a chicken house over the pond should be constructed with bamboo splits. The gap between the bamboo splits should be wide enough (1.5 – 3 cm) to let the chicken faeces drop into the pond water below, but should not be too wide so as to cause injury to the legs of the birds.

Bridge: Should be movable in order to avoid pouching and predation. Three or four linked bamboo sticks serve well as a movable bridge for the caretaker and the chickens.

FACILITIES IN A POULTRY HOUSE:

i. Feeders: can be prepared out of tin or wood. The numbers should be sufficient to allow all the chicken to eat at the same time. If the height is too low (2 – 3 cm) the chicken will peck out too much feed. Simple self-drinkers are suggested for use. It is more hygienic and practical than open jar. Readymade drinkers from tin are available in bigger towns and cities, but homemade self-drinkers can be prepared easily from ordinary tin plate and empty milk powder cans. While preparing, care should be taken so that the hole in the can should be lower than the top of the plate. Simple bamboo cane should be kept on top to avoid being overturned by the birds. One drinker should be provided for every 25 chicken.

ii. **Laying boxes**: If layer chicken are integrated with fish farming, the use of laying nests is necessary from the time the layers are 150 – 160 days old. One laying box can be used for every 6–7 chickens. Use of some rice straw on the nest is useful. Size of laying box should be 30 × 30 × 30 cm.

iii. **Sitting bars**: Fixing some sitting bars for night sleeping is recommended. Mainly in winter when cold air streams though the gaps in between the bamboo splits on the floor. The chicken sitting on the bars can protect itself from the cold by closing around its feathers. The birds are also separated from their night excreta.

iv. **Lighting**: Artificial lighting is recommended for both layers and broilers. If electricity is available, one 60 watt bulb can be used for 100 chicken

v. **Calculating the number of chicken for fish culture:** A stocking density of 80–100 chicken per bigha of water surface has been found satisfactory enough to ensure good fish yield.

Chicken feed and feeding: To achieve good production of eggs or meat the chicken should be fed with balanced diet. The ingredients are available locally and can be mixed by the farmer. Some of the ingredients can be replaced with other (e.g Til cake with Mustard oil cake) but the vitamin complex should not be changed or omitted. For small-scale egg production operations (50–200 birds), it is recommended that additional feedstuff which are easily found around the farm such as grass, crushed snail, kitchen waste etc. should be fed to the birds. Appropriate feeding guidelines are suggested for both layer and broiler chicken .Simple homemade feeders and self-drinkers are suggested for use. 10–12 cm feeder length can be allowed for one chicken. The daily required feed should be given in two instalments, one in the morning 5–6 am and another in the afternoon at 4–5 pm. clean drinking water must always be made available to the birds. Lack of water, besides quickly affecting egg production, can cause dehydration, kidney damage and death. Polluted water will cause various disease problems. Water from the tube-well is better than the water from the fish pond.

Important points of management: In integrated fish farming system usually smaller numbers of birds are used, and it is not very difficult to manage the chicken sub-system. However, the following important points should always be considered.

FEED AND FEEDING:

- Prepared feed can be stored for 2 weeks in the dry season but not more than 1 week in rainy season. Correct storage of food stuff is very important. Decomposed or fungus infected feed must be avoided.
- The chicken should be allowed to graze for one hour a day in the afternoon.

- Food and fresh water should be kept in front of the layer, always in clean feeders and drinkers.
- Feeders and drinkers must be kept clean.

Intensity and continuity of laying: Laying of eggs should start when the chicken reach 140–150 days. Egg production period is about one year. After that the flock should be changed. Commercial layer can increase the production up to 90–95 % laying rate at the beginning. Later the intensity will decrease. With proper management an average of72–75 % laying rate could be achieved with the recommended species. In the laying period, addition of some artificial light after sunset can increase the egg laying capacity by 15–20%. The use of artificial light should be started from the time the birds are 150 days old. Starting with 30 minutes a day it should be increased by 30 minutes per week, until reaching 16 hours of continuous illumination. This optimal duration should be maintained till the end of the laying period. For broiler raising, 24 hours lighting is suggested.

Ventilation: Climate in the rainy season remains too hot and humid causing discomfort to the birds. As a result, laying often goes down to 60–65 %. Practically on farm level nothing can be done except maximizing the natural ventilation. Therefore, in the summer/rainy season, provision for additional ventilation in the chicken house should be made.

Brood stage: After laying certain number of eggs, a hen may start to brood and stop laying eggs. This can be reversed by keeping the hen under light and by not allowing it to settle on the nest. In such cases, the hens start laying eggs within a few days if they are kept locked in a small wire case.

Health Control : Every effort should be made to ensure good health of the birds. For this quality of feed and the feeding programme must be maintained. The birds should be protected from stresses caused by changes in temperature, over-crowding, excessive noise etc. As a preventive measure strict programme of vaccination against common disease must be followed. In addition to vaccination programme periodic deworming of chicken should be done

CONCLUSION:

The overall discussions revealed that the integrated pond fish farming with poultry was an excellent package for sustainable production, skill development, income generating, reducing poverty, increase use of untapped resource and creates awareness for farmer towards semi-intensive integration. The results of the study showed that there were different factors affecting farmers' to implement integrated pond fish farming with poultry and vegetable. This includes: lack of knowledge and skill to use locally available untapped resources through semi-intensive integrated farming, lack of training and researches conducted on integration, land scarcity and traditional farming most of farmers' land occupied by perennial crops and fruit trees.

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ADVANCES IN EMERGING, ZOONOTIC LIVESTOCK DISEASES IN SUSTAINABLE ENTREPRENEURSHIP

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The diseases and infections which are naturally transmitted and/or shared between vertebrate animals and man are known as zoonotic diseases. It is documented that nearly 13% of the human pathogens are emerging and re-emerging and 75% of the emerging and re-emerging pathogens are classified as zoonotic pathogens. Globally over 60% of human infectious diseases are caused by pathogens that are shared with wild or domestic animals. Extensive studies on human–animal interface are quite expedient to understand the ways of emergence of zoonotic diseases and to explore the possible prevention mechanisms. Livestock animals have interfaces with both wildlife and people and hence have a role to play in the emergence of zoonotic diseases. There are strong evidences that modern farming practices and intensified systems can be linked to disease emergence and amplification. Intensification of livestock farming, besides high animal numbers and density facilitates disease transmission where effective disease management strategies and biodiversity measures are absent. Awareness and updated knowledge are quite expedient to venture successful entrepreneurship at the local level. Preparedness to address emergence of zoonotic pathogens is considered as a key to successful animal husbandry practice as well as sustainable entrepreneurship.

INTRODUCTION

As hunter-gatherers started settling down, domestication of animals was a necessity for various reasons, viz. food, transportation, agriculture, security, recreational activities etc. This incidence gave rise to increased contact and sharing of habits between man and animals. With the passage of time disease transmission between them was imminent. Enhancement of human population and industrialization encouraged breeding of high yielding varieties of animals to make large number of improved animals for more quantity of food production. Movement of human, animals and animal products has increased tremendously in the last couple of decades of globalized world each carrying plausible infections.

As per the World health Organization (WHO), the diseases and infections which are naturally transmitted and/or shared between vertebrate animals and man are known as zoonotic diseases. The different zoonotic diseases encompass viral (e.g. rabies, Japanese encephalitis, yellow fever, influenza, Kyasanur forest disease, Congo crimean haemorrhagic fever etc.), bacterial (e.g. anthrax, brucellosis, plague, leptospirosis, salmonellosis, scrub typhus etc.), fungal (e.g. cryptococcosis, histoplasmosis, dermatophytosis, aspergillosis etc.), parasitic (e.g. trypanosomiasis, toxoplasmosis, leishmaniasis, hydatidosis, taeniasis, schistosomiasis, scabies etc.).

The increasing trend of zoonoses is a global phenomenon including India. Important to note that out of 1407 human pathogens (538 bacteria and rickettsia, 317 fungi, 208 viruses, 287 helminths and 57 protozoa) more than 800 are zoonotic in nature indicating they are capable of being transmitted naturally between animals and humans. Moreover, nearly 13% of the human pathogens may be considered as emerging and re-emerging. It is to be noted that 75% of the emerging and re-emerging pathogens are classified as zoonotic.

In India, the predominant zoonotic diseases affecting public health are rabies, brucellosis, toxoplasmosis, cysticercosis, echinococcosis, Japanese Encephalitis, trypanosomiasis, plague, leptospirosis, Scrub typhus, kyasanur forest disease, nipah and congo-crimean haemorrhagic fever. As per a study conducted by International Livestock Research Institute, 2.4 billion human cases and 2.2 million deaths occur in India per year. Incidentally, burden of the highest zoonotic diseases with wide spread human diseases exist in Ethiopia, Nigeria, Tanzania and India. New zoonotic diseases such as cutaneous leishmaniasis, Japanese Encephalitis, leptospirosis and scrub typhus are spreading to a much wider area at an alarming rate. It is anticipated that the re-emergence of neglected zoonotic disease such as kyasanur forest disease may pose problems in future as the strategies and policies to address this disease issues is wanting.

DRIVERS OF ZOONOTIC DISEASE RISK

It is now known that, globally over 60% of human infectious diseases are caused by pathogens that are shared with wild or domestic animals. In this context, extensive studies on human–animal interface are quite expedient to understand the ways of emergence of zoonotic diseases and to explore the possible prevention mechanisms. It is an established fact that, the transformation of the natural landscape promotes encroachment into wildlife habitats, thereby creating opportunities for closer and more frequent interactions between humans, livestock, wildlife and vectors, while the intensification of livestock farming, associated with increased animal numbers and density facilitates disease transmission when effective management and bio-security measures are not in place. Concurrent anthropogenic factors, such as changes in land-use provide new wildlife-domestic species interfaces by creating shared ecologies, with opportunity for spill over and amplification of new emerging zoonotic diseases.

Activities manipulating wildlife species provides an animal-human interface facilitating a potential pathogen spill over. Hunters and persons handling dead animals during trade and cooking are often exposed to potential pathogens present in animal carcasses and their body fluids. Bushmeat consumption has led to the emergence of Ebola virus disease outbreaks in Central Africa and West Africa. Moreover, fruit bats were identified as reservoir species and spill over to human may happen via an intermediate wildlife species. In contrast to this, in some Ebola outbreaks in Central Africa, Chimpanzee or gorilla carcasses were identified as source of human infection indicating the role of animal species in zoonotic spill over.

Several species of mammals like deer, rodents, civets and mink are bred under a wide range of production systems worldwide. Health monitoring programmes in wildlife farms are seldom implemented, despite intensive farming conditions and low genetic diversity. For these reasons farmed wildlife species being in stress and in immunosuppressive condition are predisposed to disease emergence. This was observed in ostrich farms of South Africa where avian influenza strains are in circulation; in ranched kudu of Namibia were repeated outbreaks of rabies occur and in mink farms in the Netherlands where SARS-CoV-2 was detected.

Livestock and companion animals have interfaces with both wildlife and people and hence have a role to play in the emergence of zoonotic diseases. Anthropogenic factors such as changes in land use provide new wildlife domestic species interfaces by creating shared ecologies with opportunity for spill over and amplification of new emerging zoonosis. This happened in Nipah virus emergence in Malaysia in 1998. Dual-agriculture of intensive pig farming with mango plantations created a bat-pig interface that allowed spill over of Nipah virus from bats feeding on the fruit trees to pigs housed below. Repeated spill over events from bats resulted in prolonged circulation of the virus in pigs increasing the opportunity for spill over to people. This shows that large, dynamic population of a single livestock species can increase the risk of emerging zoonosis in people by enabling persistence of a potential pathogen at the livestock-human interface. Mixing of domestic species may also give rise to emerging zoonosis as observed in influenza virus circulation and re-combination in domestic poultry in live-bird markets. Further, companion animals may provide interface for emerging zoonosis between wildlife and people as seen in Hendra virus and *Chlamydia psittaci* infections.

Sometimes farming practice compelled to do deforestation that encourages livestock-wildlife interface and consequently give rise to potential risk of pathogen spill over from wildlife to livestock. It is felt that human, animal and environment cannot be separated and therefore, sustainable use of natural resources has to be considered.

ROLE OF MODERN FARMING PRACTICES IN EMERGING ZOONOTIC DISEASES

There are strong evidences that modern farming practices and intensified systems can be linked to disease emergence and amplification. However, the evidence is not sufficient to judge whether the net effect of intensified agricultural production is more or less propitious to disease emergence and amplification than if it was not used. Expansion of agriculture promotes encroachment into wildlife habitats, leading to ecosystem changes and bringing humans and livestock into closer proximity to wildlife and vectors, and the sylvatic cycles of potential zoonotic pathogens. This greater intensity of interaction creates opportunities for spill over of previously unknown pathogens into livestock or humans and establishment of new transmission cycles. Anthropogenic environmental changes arising from settlement and agriculture include habitat fragmentation, deforestation, and replacement of natural vegetation by crops. These modify wildlife population structure and migration and reduce biodiversity by creating environments that favor particular hosts, vectors, and/or pathogens.

ROLE OF LIVESTOCK IN EMERGING ZOONOTIC DISEASES

Transformation of the natural landscape promotes encroachment into wildlife habitats, thereby, creating opportunities for closer and more frequent interactions between humans, livestock, wildlife and vectors. Moreover, intensification of livestock farming, besides high animal numbers and density facilitates disease transmission where effective disease management strategies and biodiversity measures are absent. It is now recognized that a considerable share of human diseases of evolutionary and historical significance originated in livestock. The pathogen pool of food animals is itself not static but also constantly undergoing evolutionary changes. For example, in swine between the study period of 1985 and 2010, 173 new pathogens variants from 91 species could be detected. It is surprising to note that, out of these 91 species, 73 had not been reported previously. Furthermore, one third of these new species was zoonotic. Rapid expansion and intensification of livestock industries without incorporation of stringent biosecurity measures and animal health/veterinary oversight enhances the likelihood of zoonotic disease emergence from food animals. Pathogen characteristics and relative importance of surmised drivers of emergence differ significantly between food and non-food animal associated emerging zoonosis. The main drivers of food animal associated emerging zoonosis are changes in agricultural practices at farm level and transformations of the food industries along the livestock value chain, from transporting through processing to retailing.

Intensification of livestock production, especially pigs and poultry, facilitates disease transmission by increasing population size and density, although effective management and biosecurity measures will mitigate the between-herd spread of zoonotic diseases, such as brucellosis and tuberculosis. As an alternative to investing in improved husbandry or in situations of poor animal health service provision, antimicrobials are often used for growth promotion, disease prevention, or therapeutically, which in turn promotes the evolution of antimicrobial resistance in zoonotic pathogens. Intensification also requires greater frequency of movement of people and vehicles on and off farms, which further increases the risk of pathogen transmission. Intensive livestock farming can promote disease transmission through environmental pathways. Ventilation systems expel material, including pathogens such as Campylobacter and avian influenza virus, into the environment, increasing risk of transmission to wild and domestic animals. Large quantities of waste are produced that contain a variety of pathogens capable of survival for several months if left untreated. Much of the waste is spread on land, where it can come into contact with wild animals and contaminate water. Intensive farms use fewer workers per animal, thereby reducing the number of people exposed to zoonosis compared with extensive systems. However, several cross-sectional studies report higher sero-prevalence in farm workers of pandemic H1N1/09 influenza, hepatitis E, and highly pathogenic avian influenza H5 and H7 compared with the general community. Intensive livestock systems generally have high density populations of low genetic diversity, which may favour increased transmission and adaptation.

The first known outbreak of Nipah virus occurred in Malaysia during 1998–1999, causing respiratory disease in pigs and high case fatality in humans. Epidemiological outbreak investigation showed that pig and human cases had occurred in 1997 on a large intensive pig farm in northern Malaysia, where Nipah virus-infected fruit bats were attracted to fruit trees planted around the farm. Respiratory spread of infection between pigs was facilitated by high pig and farm density and transport of pigs between farms to the main outbreak area in south Malaysia. Pigs then acted as amplifier hosts for human infection. Almost all human cases had contact with pigs; there was no evidence of direct spill over from bats to humans or of human-to-human transmission.

Both extensive and intensive farming practices can influence the likelihood of influenza virus spill over from wild birds to domestic birds and pigs and the subsequent evolution and amplification in domestic animals and transmission to humans. Rice paddies combined with free-grazing duck farming in wetland areas bring wild water birds into close proximity with domestic water birds. The latter are susceptible to infection but less likely to develop disease than chickens and are infectious to other domestic poultry by direct contact or environmental contamination. Other low biosecurity rearing systems, such as scavenging poultry, household poultry, and small-scale commercial poultry, also allow direct or indirect contact between wild and domestic birds.

H_5N_1 virus has emerged as early as 1996 in farmed geese in Guangdong Province of southern China but was not notable until the H_5N_1 virus made a dead-end jump from poultry to humans in Hong Kong in 1997, where the outbreaks of H_5N_1 infection in poultry coincided with severe respiratory infection and fatalities in human. Avian influenza was formally reported in South East Asia in Vietnam at the end of 2003. The infection rapidly spread in the country's poultry population where severe respiratory infection and lethality occurred among poultry and humans. Within a few ensuing months the disease had spread to Thailand, Cambodia, Indonesia, Laos, and Malaysia. Most outbreaks occurred among backyard poultry with instances of virus transmission to local commercial poultry farms usually via fomites (such as trucks, crates, and cages) and personnel. Even though the poultry industry is the major livestock industry undergoing rapid intensification in this region, 50–70% of poultry are raised in backyard farms where little biosecurity exists. Since its emergence in 2003 to January 2014, the World Health Organization has tallied 650 human confirmed cases of avian influenza and 386 deaths worldwide. South East Asia contributed to more than 50% of the cases and fatalities related to human H5N1 infection.

DETERMINANTS CONTRIBUTING TO THE EMERGENCE OF ZOONOTIC EVENTS

A ‘‘Convergence Model’’ was developed to emphasize the complexity of interacting determinants favouring the emergence of pathogens. Of all the following interacting determinants, those that contribute to the emergence of host range extensions, that is ‘‘species jumping’’ events leading to new zoonosis, may be the most important.

- Microbial/viral determinants (mutation, natural selection, and evolution)
- Determinants pertaining to the host (natural resistance, innate and acquired immunity)
- Natural determinants (ecologic, environmental, and zoonotic influences)
- Determinants pertaining to human activity (personal behaviour, societal, commercial, and iatrogenic factors)
- Accidental or malicious release

It is highly likely that there will not be any way to predict when or where the next important, new zoonotic pathogen will emerge; nor will there likely be any way to predict a new pathogen's ultimate importance from its early behaviour. However, preparedness in this regard is considered as a key to successful animal husbandry practice as well as sustainable entrepreneurship.

CONCLUSION

Many infectious diseases in humans originated from animals and agricultural expansion and intensification/diversification promotes disease emergence through ecosystem–livestock–human interface. In addition, encroachments of livestock into wild animal habitat enhance disease transmission at livestock– wildlife interface. The spread of these infections would threaten regional food security and safety. Emerging zoonosis causes major losses through reduced economic activity directly from trade restriction. The ripple effect from reduction in economic activity can spread to other livestock-related sectors at the national and international levels. Emerging and re-emerging infection causes additional cost to the country through general precautionary and preventive measures such as establishment of quarantine station and procedures, restriction of animal importation, pre-movement testing, vaccination, surveillance, and monitoring. Tremendous deterioration in livestock-affiliated economic activity in addition to a major shock to livelihoods of those affected by the disease warrant collaborative efforts at national and international level to minimize emerging diseases in livestock and humans. Awareness and updated knowledge in these regards are quite pertinent and expedient to cater sustainable entrepreneurship at the local level.

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SCIENTIFIC DUCK FARMING WITH FISH CULTURE FOR PROFITABLE IFS PRACTICES

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Now-a-days integrated farming is practiced for several beneficial points such as reducing use of chemical fertilizer and harmful agrochemicals, healthy production of crops and animal products, much profit out of land crisis and recycling nutrients. Numerous Animal Farming with other animals and Crop production are practiced

1. **Paddy farming with Fish and Duck production**-Japan, Korea, Vietnam, China and Pacific Ocean Rim Countries**.** The Advantage of this method are control Pest, save feed cost, soil fertility

2. **Integrated Fish Duck Farming-It helps to p**roduce planktons for fish, Check weed population, weeds, insects, larvae, earthworms, Dibbling bottom for soil fertilizer, Good water aerator

3. **Agriculture Field fallen grain Grazing:** Duck are fed fallen grains (paddy, maize, snails, earthworms, insects, and small fishes from marshi field)during harvesting- this type of duck rearing in Kerala and Tamilnadu **Adv**: Feed cost, Fertilizer for land, Insect and pest management

Duck supplies about 10% of poultry eggs and meat. It is resistance to many infections and diseases but some diseases are there in duck that hamper production, morbidity and mortality. The following duck diseases are discussed below.

A. VIRAL INFECTION IN DUCKS

DUCK PLAGUE /DUCK VIRAL ENTERITIS

Definition: It is an acute contagious DNA herpes virus infection of duck geese, swan characterized by vascular damage, tissue haemorrhage in digestive mucosal eruption, lymphoid organs and parenchymatous organs like liver and lungs.

Morphology of virus: The nucleo-capsid is 91-93nm diameter. The virus is about 126-129nm dia. It is DNA virus. The viral particles have both neocleocapsids (91-93nm) with nucleoid (61nm)

Distribution: The disease mostly prevalent in Neither land other country where it is prevalent are India, China, France Belgium, Thailand England, Canada, Hungary, Austria , USA and Vietnam. The natural hosts are antidae family include duck, geese, swans. First outbreak in 1967 in NY Pekin duck industry; now widespread, but sporadic Latent carriers most likely. Most outbreaks in April-June during breeding season

Transmission: By direct contact with animal to animal, fomite, feed, water. Incubation period 3-7 days. It infects young duckling to mature ducks. It can infect naturally to other avian species and even mammals as well. It affects almost all breeds of duck (Anas platyrhynchos) like white pekkiin, khaki Campbell, Indian runner. Experimental infection can be made by oral, nasal, intravenous and other routes.

Clinical signs: On of a sudden, high mortality in ducks and ducklings. In adult the death is fresh but prolapse of penis is evident and egg drops sudden. Photophobia, half closed eye lids, in appetence, thirst, drooping, ataxia, ruffled feather, nasal discharges, soiled vent watery diarrhoea. **Duckling:** of 2-7 weeks dehydration, loss of wt., blue beak, conjunctivitis, lacrimation, opisthotonus, photo phobia, and convulsion, nasal exudates of blood stained. Mortality 5-100% adult ducks are more susceptible. Complication with *Pasturella, Reimerella, and E.coli.* Young ducklings of 2—7 weeks of age shows dehydration, loss of body wt. Blue beak, conjunctivitis, lacrimation, oculo-nasal discharges. Incubation period 3-7 days; death in 1-5 days

Immunity: Active Immunity develops once infected naturally and experimentally. Both inactivated and live vaccine produces immunity. Maternal immunity also been reported in ducklings but the strength of immunity is very weak short lived.

Diagnosis of Duck plague: Clinical signs are the main key for diagnosis of disease in field condition**.** By isolation and identification of duck plague virus. Viral samples may be collected from infected liver, kidney, bursa and even cloaca. Day old duckling and 9-14 days embryonated duck eggs, embryo fibroblast, liver and kidney cells are ideal for isolation.

Treatment and Control: There no specific treatments for the duck plague. Symptomatic treatment can be done with broad spectrum antibiotic and rehydration with water and mineral mixture. Vaccination with inactivated vaccine can protect infection. Attenuated vaccine can be done at 2 weeks of age. Collect the carcass and incinerate. Euthanasia of sick birds to prevent spread.

DUCK VIRAL HEPATITIS /DUCK VIRAL ENTERITIS

Definition: It is highly fatal and rapidly spreading viral disease caused by duck hepatitis picorna virus. The disease characterized by ataxia, closed eye, spasmodic kicking with legs, death occurs within few hours of clinical signs.

Morphology of virus: Most commonly occurred virus DHV is 20-40nm sized. There are three serotypes of virus namely duck hepatitis type 1, duck hepatitis type 2 and duck hepatitis type 3 strains.

Epizootiology: This acute disease is occurs during early life of age. The mortalities vary farm to farm but reaches up to 95% and successive illness reduces mortality. It very endemic in Korea, china and other duck rearing countries..

Transmission: By direct contact, carriers and vectors have some role in transmitting the disease. Aerosol infection is the main way of transmission. Recovered animals act as carriers. Brown rat may acts as reservoir host. Vertical and horizontal transmission possible.

Clinical signs: Onset and spread of DH type 1 is very rapid and mortality within 3-4 days. Cardinal clinical signs are stop moving from the brooding place, fall at sides, kick spasmodically with both legs, die in per acute case with very high mortality. Ailing ducklings continue to drink and may pass green watery diarrhea. Adult duck may be infected without clinical signs.

Patho-morphological lesions: Enlarged liver, hemorrhage of both petechial and ecchymosis and abnormal sized of liver. Spleen is many fold enlarged and kidney also enlarged. Liver surface is mottled and hemorrhagic.

Immunity: Recovery from DH type 1 results solid immunity viral neutralizing antibodies in serum. Passive immunity from mother is transferred from yolk to hatchling to protect them. Vaccine at adults' ducks shows immunity in the ducklings.

Diagnosis: Isolation and identification of DHV type 1 virus can be done in many ways like inoculation of DHV 1 virus to 1-7 day old duckling with characteristic pathological lesions and clinical signs. Inoculation in 9-12 days embryonated eggs and inoculation in embryonic liver cells of duck.

Serologically virus neutralizing test is best for disease diagnosis. Agar gel immune diffusion test is also helpful for the diagnosis of DHV. Plaque reduction test for diagnosis considered to be more sensitive than Virus neutralizing test.

Differential diagnosis: Sudden onset, severe mortality, rapid spread, per-acute course of this disease simulates several other infectious diseases like, other strains of DHV type 2, type 3. Bird influenza, Salmonellosis, Aflatoxicosis characterized by liver involvement and diarrhea.

Treatment: Intramuscularly administration of antiserum from the immune duck which has already been vaccinated or immunized but practically it very difficult to treat with large number of duckling on the face of outbreak. Administration of immune duck egg yolk may be helpful. Although antibiotic has little effect on virus but broad spectrum antibiotic can be used to check secondary infection.

Prevention and control: The deadly disease duck viral hepatitis can be prevented by various measures. Taking strict management measures like isolation of infected stock during the first week of duckling from adult to avoid carriers. Immunization with antisera and egg yolk from immunized duck. Attenuated DHV type 1 strain is suitable for vaccine. Vaccination with attenuated strains can be done to day old duckling by foot web puncture. Passive immunity can be grown in breeders duck giving attenuated two vaccines at six week interval that pass the immunity to the duckling through the yolk.

DIFFERENCE BETWEEN DUCK PLAGUE AND DUCK HEPATITIS

Duck Viral Hepatitis	Duck Plague
Young ducklings are most susceptible (1-3 weeks) DVH ,2,3serotypes(1945), picorna virus, Brown rat is resevoir	Mature duck mostly susceptible. Herpes virus (1923) Neitherland by Herpes virus, 3-7 days IP.
No relation of canine&Human hepatitis	Little public health importance
Clinical signs: Fail to keep up body and fall,stop moving, eye closed/ partially closed, death within hours, kidney fatty changes, pancreatitis, liver & spleen enlarged with mottle,	Sudden symptomless death, penile protuberance, drastic drop in egg production, photophobia,half closed eye, extremethrust,droopiness,ataxia,ruffled feather,nasal discharge, diarrheaic bloody vent, loss of wt, conjunctivitis,

DUCK INFLUENZA

Influenza actually referred to epidemics of acute rapidly spreading catarrhal fever in humans caused by viruses of Ortho-myxoviridae. There are several strains of viruses under the influenza viruses that cause respiratory diseases in human (H1N1, and H3N2 viruses of subtype A), cattle, horse, pigs, birds (Subtype A of H5N1,H7N7,H5N2,H7N3, H5N2 etc.) and others animals. Avian influenza sometime called 'bird flu' recognized as highly lethal systemic disease caused by various strains of influenza viruses. Synonym of bird influenza is fowl plague and fowl pest etc. The influenza virus A, B, C types have several strains. In human and birds since 2003, highly pathogenic avian H5N1 strains circulating in parts of Asia, especially India, Indonesia, Europe, Middle East, Africa. A number 387 human case, with 63% mortality rate and 200 million poultry & waterfowl died or euthanized.

Definition: it is a highly lethal viral disease characterized by severe respiratory signs like sneezing, coughing, rales, lacrimation, occasional diarrhea, rough fled feather, emaciation in recovered birds. Highly pathogenic form with torticollis, opisthotonus, respiratory disorders and damaged of multi-systemic organs. The disease is caused by the influenza virus in poultry and other animals.

TABLE-1: SUBTYPES OF INFLUENZA VIRUS AND HOST RANGE

Birds species affected	Subtypes of influenza virus
Chicken	H5N1,H7N7, H5N2, H7N3,H7N4,
Turkey	H5N1,H7N3,H5N9, H7N7,H5N8,
Human	H1N1, H1N2, H3N2,H5N1 and H3N2
Swine	H1N1,H3N2, H1N2,
Duck	H5N1 ?

Duck flue with clinical infection and symptoms is rare. Several influenza lethal viruses like H7N2, H4N1, H1N1 experimentally inoculated in ducks revealed lacking of clinical signs although high titer of virus excreted through feces and other secretion. No antibody response was detected in the blood. Duck acts as reservoir of the influenza virus.

ADENOVIRUS INFECTION

A sub group 1 of avian adenovirus under genus Avi-adenovirus within adenovirus family can cause duck pathological conditions. Duck adenovirus 2 causes hemorrhagic enteritis and related diseases.

Morphology of virus: The adenovirus virion is a non-enveloped icosahedral structure (70-90 nm). It is double stranded DNA virus. Neutralizing antibodies produced against the type specific epitopes should provide protection but short lived.

Transmission and carrier: Both vertical and horizontal transmission is possible in adenovirus infection. Vertical transmission is important as transmitted through eggs while horizontal transmission also important, virus spread through feces, tracheal and nasal discharges and other body discharges. Aerial spread between farms doesn't appear to be important. Spread by fomites, personnel, and transport also possible. The incubation period is 24- 48 hours.

Patho-epidemiology: The chicken adenovirus is ubiquitous in fowl population demonstrated by antibody sero-surveillance. The virus has been recovered from turkey, geese, pigeon, guinea fowl and duck. It can affect both older and duckling even day old birds.

Clinical signs: A diphtheroid steno sing tracheitis with occasional bronchitis and pneumonia are seen in 10% ducklings of low age. The mortality may reach as high as 12% in 4-11 days ducklings and gosling. Catarrhal tracheitis with excess mucus is noted.

Immunity: Following infection or challenge birds develops neutralizing antibodies that detectable after weeks. Young birds excrete virus for more time as to produce antibodies it needs longer time.

Diagnosis: Isolation and identification of virus can be done from feces, pharynax, kidney, and other affected organs. Virus can be grown in chick's embryos, cell culture, and immune-cytochemistry fluorescent dye technique. Serological the disease can be diagnosed by double immune-diffusion (DID) test but the test is sensitive for natural occurring cases.

Intervention and Vaccination strategies: The disease is potent pathogen for disease production and mortality. All the premises can be made with heavy concrete stuff. Close vigilance and restrict movement of staff, birds to be maintained. Inactivated vaccine to be used for immunization.

DUCK POX

Definition: Pox in duck characterized by diphtheritic lesion on mucous membrane in mouth and upper respiratory tract. Chicken, turkey and pigeon are highly susceptible but duck, goose, quail, pheasant are less susceptible. Duck can experimentally be infected with typical clinical signs.

Transmission: Direct contact, mechanical transmission with bill and legs, aerosol and vector bite (mosquito) transmission is not uncommon. The virus can invade the bloodstream through natural openings such as eyes, ears and skin wounds, or nasal route. Incubation period varies from 4-10 days.

Forms of Duck pox: Ducks of all ages and breed are susceptible to duck pox. There are two forms of duck pox occurs dry and wet form. The former characterized by raised, wart-like pimples on the skin feather uncovered areas. The smaller macule takes several days to heal. The wet form characterized by blight-like lesions near the bill and adjacent areas can be observed.

Clinical Signs: The underneath surface of affected areas has haemorrhagic appurtenance, retuned growth, temporary reduction of production. The duck may suffer with both the forms. Blindness in duck and turkey also found due to ophthalmic involvement.

Diagnosis: Typical clinical signs of cutaneous lesions on foot web, bill and respiratory passage, ocular lesion with mucous. Isolation of virus can be done in chicken embrocated eggs at 9-12 days. Cell culture and observing characteristic cyto-pathic effect. Serologically the pox infection can be diagnosed by ELISA, immune-diffusion test, passive haem-agglutination test, Viral neutralization test in cell culture or chicken embryo. Fluorescent antibody techniques, immune-peroxidase. Molecular methods of Polymerase chain reaction (PCR), restriction endonuclease analysis of Avian poxvirus DNA, genome fragments diagnostic probe.

Treatment and prevention: There is no known treatment for fowl pox. However, it is quite slow-infecting. Hence, it is possible to administer live vaccination to stop a wide contamination. Normally vaccine is administered at the wing web at the age of two months. Once the natural infection is there is strong immunity in the infected birds.

REO-VIRUSES IN DUCK AND GEESE

Different breeds of duck are affected with the reo-virus infection, the most susceptible breeds are mallard, Muscovy and Pekin, The virus causes the viral arthritis in chicken. Respiratory stress and enteric diseases in chicks causing morbidity and mortality.

The reo-virus is under the genus of Ortho-reo virus in the Reo-viridae family. It is non-enveloped, icosahedral symmetry have about 75nm diameter.

Transmission: Spread by lateral infection as the virus excretes in faeces and respiratory discharges. The virus may stay in the cloacal fold for long time. There are reports that the reo virus transmitted vertically from eggs of infected dam.

Epizootiology: The virus affects ducks, geese and pigeon. The virus affects the gastrointestinal tract characterized by diarrhoea, malaise, stunted growth and incoordination of movement. The morbidity and mortality varies from 30 and 20% respectively.

Pathogenicity: It has been found that the reo virus causes arthritis but it can cause other conditions like retarded growth, enteritis, pericarditis, myocarditis, hydro-pericardium, hepatitis, bursal infection, osteoporosis and chronic respiratory problems. It can complicate with the infection of coccidiosis, colibacillosis, Apoptosis causes the main pathogenicity by the virus after infection of cells.

Clinical signs: Gradual loss of body conditions, diarrhoea, tenosynovitis, Sudden drops of production of eggs. Respiratory distress including sneezing, nasal discharges and dyspnoea.

Diagnosis: Virus isolation in different cell line, embryonated chicken's eggs. Serologically evidence reo virus of antibodies can be detected by neutralizing antibodies, indirect fluorescent antibody assay and even with ELISA. A reverse transcription-polymerase chain reaction (RT-PCR) procedure for the detection of avian, duck, and goose reo virus (ARV, DRV, and GRV) RNA from cell culture supernatant and clinical samples was established

Treatment and control: Elimination of virus exposure is almost impossible, the can be transmitted both vertically and horizontally and resistance to inactivation. Management measures with clinginess of farm and hatchery is essential.

GOOSE PARVOVIRUS / GOOSE INFLUENZA/ GOOSE HEPATITIS

Definition: Goose parvovirus infection is a highly contagious disease affecting young geese and duck characterized by acute sub-acute and chronic anorexia, prostration, and death. It is non-capsid, hexagonal single stranded DNA virus with 20-22 nm diameters.

Epidemiology: The disease is distributed worldwide in Europe, Asian duck rearing countries like Taiwan, china, Vietnam, Japan and North American countries. Geese, Pekin and other ducks are susceptible; however some duck and poultry infection is refractory. Morbidity and mortality may be as high as 100% in day old gosling. Older one shows scanty clinical signs.

Transmission: By direct and indirect contact, vertical and horizontal transmission is possible. Older birds acts as carriers and transmit the virus through their eggs.

Clinical findings: Naturally incubation period varies from 3 5 days but in older birds it may take up to 10 days. Anorexia, polydipsia, prostration followed by death is very rapid in younger goslings within 2-3 days. Redness of eye and ocular discharge and headshaking is frequent. Profuse white diarrhoea and pseudo membrane covering the tongue and oral cavity. Prolong course terminating retarded growth. The mortality varies depending upon the age. One week goslings it is 1005 but 2-3 the mortality may be 10%. Once infected hard immunity develops.

Pathological Lesions: The lesion mainly found in heart rounded, spleen and pancreas swollen and congested, sero-fibrinous per hepatitis with dystrophy and pericarditis and large amount of straw coloured fluids in abdominal Cavity, pulmonary oedema, catarrhal enteritis may be present. Diphtheritic ulcerative lesion in the oral cavity.

Diagnosis: Isolation and identification of parvovirus from affected organs of liver, heart can be made in the Muscovy duck embryonated eggs through allantois cavity. Culture can be stained with Haematoxylin Eosin for Cow dry type–A intranuclear inclusion and syncytium formation. Electron Microscopy of virus taking from faeces and other samples. Molecular identification by PCR and serologically by viral neutralization test, Ager gel precipitation, ELISA etc.

Differential Diagnosis: Adenovirus infection be similar to that of Avian parvovirus infection. The herpes virus infection in duck causes enteritis with high mortality may similar to that of Parvovirus infection but isolation and identification clarify the two entities. Duck viral hepatitis is also a fatal disease with high mortality but not pathogenic in goose. Haemorrhagic nephritis enteritis in geese affects geese of 4-20weeks with high mortality.

Treatment and Control: Management of duck and geese to avid vertical transmission infection, only eggs to be hatched from known parvovirus free eggs. Serologically testing and reactor bird be isolated and destocked by slaughter. If vaccine develops, vaccination could immunize the birds from infection.

B. BACTERIAL INFECTIONS IN DUCKS

DUCK SEPTICEMIA

Duck septicaemia is a bacterial disease caused by *Riemerella (pasturella) anati-pestifer*. The most important duckling disease with high mortality at the age of 4-9 weeks characterized by septicaemia, sleepiness, aimless circling, torticollis and serositis. The disease is very prevalent in ducks, geese, turkey and other domestic and wild birds.

Epidemiology: The disease is prevalent where the duck population is there, there several serotypes of the bacteria. Duckling of 1- 8 weeks are very susceptible but breeder duck is resistant. Transmission by respiratory tract, wound and vector borne.

Clinical Findings: After the incubation period of 2-5 days the clinical sign appears. Most of the cases listlessness observed, occulo-nasal discharges, sneezing, greenish diarrhoea, ataxia, tremor of head, neck, and coma. Affecting duckling lie on back paddling their legs, inability to move. Mortality may 5-75%. Survived birds show stunted growth. Duckling once recovered from the disease never prone to this disease.

Post mortem findings: Fibrinous exudates in general in pericardial cavity, liver surface, air sacculitis, enlarged spleen, sero-fibrinous deposits in oviducts, chronic localized lesions may be found in skin and fatty layers.

Diagnosis: Isolation and identification of bacteria in blood agar, trypticase soy agar anaerobically. Agglutination test can be done, ELISA can be done.

Treatment and Control: Antibacterial agents like Sulphmethazine 0.2-0.3% in drinking water or in feed. Injection of lincomycine and spectinomycin may be attempted. Inactivated bacterin may prevent mortality. Live Vaccine can be given against different serotypes (polyvalent vaccine).

DUCK CHOLERA/ PASTEURELLOSIS

Duck cholera is a highly fatal infectious bacterial disease caused by *Pasteurella multocida.* The disease is in duckling above 4 weeks of age but any age group may be affected with this infection. The causative bacteria are Gram negative bacteria with bipolar characteristics.

Epidemiology: Pasteurella enter into the host system through mucous membranes respiratory tract and conjunctiva or coetaneous abrasion. Amongst the birds turkey is most susceptible. The predisposing factors like climate change, nutrition, excitement may acts important determinants for the disease.

Transmission: Contaminated feed, crates, equipment's are the direct contact for infection of duck cholera. Through the open carcasses that died of duck cholera. Vector transmission through insect may be possible.

Clinical findings: In acute cases sudden death may happen, associated clinical signs are loss of appetite, increased thirst, fever, ruffled feather, serosanguinus stool, respiratory stress and modulatory and joint pain may be there. Endotoxins produced by the Pasteurella are both virulent and non-virulent. The lipopolysaccharides in nature which is histamine releasing and liver damaging substance cause pathogenicity.

Diagnosis: Clinical finding and patho-morphlogical lesions are suggestive of the duck cholera. Isolation of bacteria from the clinical samples in different media.

Treatment and Control: Antibiotic therapy after suitable anti-biogram is necessary. Different sulpha drugs may be tried with feed and water. Sulphadimidine and Sulphamethazine at 0.2% in drinking water or feed supplement may be given both preventive and therapeutic treatment. Other antibacterial like Streptomycin, Chlortetracycline and chlorampenicol can be used. Management of duckery with elimination of reservoir, isolation and sacrifice of the reactor animals, cleaning and hygiene of the shed to be maintained.

SALMONELLOSIS / PULLORUM DISEASE

Salmonellosis in duck may be due to two species of bacteria out about several species of Salmonella genus. The *Salmonella typhimurium, Salmonella enteritidis* and *Salmonella anatum*. In duck the disease Salmonellosis is called "Keel disease" or paratyphoid.

Transmission & Epidemiology: Most infection spread by vertical transmission from parent to their following generation but direct contamination is not uncommon**.** The mortality and morbidity due to salmonellosis depend on the host specificity cross infection causes minimum clinical signs. Mortality in young animals is high but adult animal's acts a carrier and few cases with localized infection. However mortality may vary from 0- 100%.

Clinical signs: in duckling sudden death may happen without much clinical signs. General clinical signs are loss of appetence, watery diarrhoea, vent paste with loose faeces; eye may be watery shining, nostrils and nasal passage constricted, respiratory involvement leading to labour breathing. Blindness at the later stage and local swelling at tibial and humeroradial and ulnar articulations.

Post-mortem Lesions: In acute cases there will be enlarged and congestion of liver, spleen, and kidney. The yolk sacs and its content may not be revealed much change but there may be less yolk absorption prolongs cases. Whitish nodular growth may appear in the lungs and heart as a result passive congestion may be there. Intestine may have caseous materials. Splenomegaly and necrotic foci may there.

Diagnosis: Isolation and identification of salmonella bacteria in different selective media and biochemical as well as molecular process. Different serological, molecular methods may useful to diagnose the disease.

Treatment & control: Different selective antibiotic and antibacterial have been developed for treatment of Salmonellosis. Salphonamides, Chloramphenicol, furazolidone can be used for treatment. Vaccination with killed, live modified are available for vaccination in different countries.

BOTULISM

Botulism is intoxication by the toxin produced by *Clostridium botulism* type C. It is also known as western duck sickness, limber neck.

Transmission & Epidemiology: The disease is reported worldwide in poultry and waterfowl. The disease thought to be affect through contaminated feed to all birds including scavenging birds during summer and winter months but the organism also grow in gastrointestinal tract as facultative parasites. The potential exotoxins of botulism produced under anaerobic condition at 10-47ºC which acts at the peripheral cholinergic nerve terminus. There are three components of toxins C1, C2 and C3. The clinical signs can be developed within 1-2 days starting with paralysis.

Clinical Signs: Flaccid paralysis of legs, wings, neck, and eye lids are predominant. The paralytic signs start cranial from legs, wings, neck, eye lids. Birds remain seated and reluctant to move, if tried to move they appeared to be lame. Wing drop may be seen lastly and shows panting if they are handled. Death occurs due to respiratory and cardiac failure. Morbidity and mortality in botulism varies, low level toxin can cause little morbidity but the mortality can be as high as 40%.No immunity develops in duck on exposure of toxins.

Post-mortem Lesions: Botulism in animals and birds leaves little lesions. The carcass may be shown paralytic extended wings, legs and lower eye lids, roughled feather. Occasionally maggots, feathers and some autolytic materials can be found in crops.

Diagnosis: History of clinical signs, detection of toxins in serum, crop or gastrointestinal washings from morbid birds. Mice inoculation test with suspected sample sera with control mouse receive suspected sample with type specific antisera. Death of mouse within 48 hours where the control group are protected with antisera.

Treatment: Avoid problems by keeping ducks out of muddy, dirty stagnant pools, especially in hot months. Supply affected ducks fresh drinking water, If necessary, introduce water into the oral cavity, throat with a syringe even a crop tube could be used to lead water in GIT. Magnesium sulphate at 1 tea spoon full in 100ml can be added into water to reduce propagation bacteria and purgative. Use of sodium selenite in very low concentration with vitamin A, D and E can reduce mortality. Antibiotics especially bacitracin, 100g/ton feed or 1 gram / litter of drinking water.

AFLATOXICOSIS:

Aflatoxicosis is intoxication in animal and man with high sensitivity and carcinogenic properties those are produced by different cereals and food particle produced, stored and preserved under humid, wet and unlearned environment. Under favourable condition the toxic fungi like *Aspergillus flavus, Aspergillus parasiticus and Aspergilluspenicillium* are grown on feed and grains and produce aflatoxins. Two fused dihydrofuran rings with different moieties the aflatoxins are termed as B1, B2, G1, G2 as per the blue and green light emits on fluorescent exposure. Of the four component aflatoxin B1 is most potent cause’s hepatotoxicity, gall bladder, oacreas, urinary tract and bone carcinogenesis. Ducklings are most susceptible.

Source of Aflatoxins: The main sources of Aflatoxins are produced by fungus *Aspergillus flavus*, *Aspergillus parasiticus* etc,widespread available in nature (soil, decaying vegetable, hay, straw, cereal and nuts). The molds can propagate before harvest crops or during humidity storage. Human contamination through food of Cassava, chilies, cotton seed, millet, peanuts, food, rice, sorghum, sunflower seeds, tree nuts, wheat, and a variety of spices intended for human or animal consumption. Organic crops which are not treated with fungicides may be more susceptible to contamination with several aflatoxins.

Clinical Signs: Initially in duckling ingested with aflatoxins shows inappetance, reduced growth, feathers pricking, abnormal vocalizations, purples discoloration of legs, lameness, ataxia, recumbence, anaemia, convulsion and death preceded to opisthotonus. Immunosuppression is eventual in aflatoxicosis that may invites coccidiosis, Marek's disease and salmonellosis.

Immuno suppression: The avian immune system depends on the bursa Fabricius, thymus and spleen to produce mature or active leukocytes. Even at low dietary concentrations, AFB1 damage this immune system in ducks. Exposure to afltoxins show decreased phagocytic activity in chicken leukocytes, heterophils, monocytes and, macrophages. Aflatoxin causes lymphocytopenia and depletion of lymphoid cells in bursa, spleen and thymus. Induces splenocytes, thymocytes and bursal B-cells as seen in young chickens during aflatoxicosis

Post mortem Lesions: Enlargement and necrosis of liver, kidney and palor in colour. Hyper pericarditis associated with acites, shunken nodular liver, distended and haemorrhagic gall bladder, bile ductile, fatty degenerative liver, extended hepatic fibrosis. Degenerative changes in kidney and pancreas are common. Immunosuppressive action can cause atrophy of bursa Fabricius, thymus and spleen.

Clinical Pathology: Aflatoxins causes anaemia in general featuring reduction in PCV, RBC, Hb%, mean corpuscular volume, leucocytosis and lymphopenia are common. Decrees in total proteins, lipoproteins, cholesterol, uric acid, primary serum minerals like calcium, phosphorus, copper, iron, zinc and lactate dehydrogenese enzymes. Blood coagulation properties are hampered interfering prothombin activities.

Diagnosis of Aflatoxicosis: A Clinico pathological finding at necropsy is primary aid to diagnose the pathological changes in liver, lung, kidney and gastrointestinal system. Cultural identification of fungus in specific media. Thin-Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), Gas chromatography (GC) and Liquid Chromatography-Mass Spectrometry (LC–MS). Combination of antibody with nanogold particles was also characterized by UV-visible (UV-vis) light absorption spectra,by transmission electron microscopy (TEM), fluorescence spectroscopy, titers, cross reactivity and stability measurements

THERAPEUTIC INTERVENTION

Chemical Detoxification:

Candidate chemicals like ammonium hydroxide, calcium hydroxide, hydrogen peroxide, sodium hydroxide, and sodium hypochlorite. All these hydrolyse and degraded products are less toxic.

Use of feed additives:

Immuno stimulant like Selenium to boost for detoxification. Antioxidants like butylated hydroxyl tolouene and turmeric can be used. Natural absorbents super-activated charcoal, zeolites (hydrated sodium calcium aluminosilicate) can be used to precipitate aflatoxin in feed.

Probiotics:

Bacteria, including *Streptococcus*, *Enterococcus*, *Lactococcus*, and *Berevibacillus*, can bind aflatoxins. Effective probiotics of *Lactobacillus*, *Bifidobacterium*, and *Propionibacteriumare* useful.

Toxin Binder:

There are several toxin binders like Bentonite (1%), Spirulina platensis (0.1%) and Glucomannan (0.2%) mycotoxin adsorbent may be used.

Biodegradation of Toxin:

Removal of aflatoxin B1 from soils and feeds to evaluate their ability in animals and ducklings. Fungi *Cellulosimicrobium funkei* showed the AFB1 biodegradation up to 97%. Supplementation of *C. funkei* alleviated the adverse effects of AFB1 on growth performance, and provided protective. Levels of protein and vitamins A, D, E, K and B should be increased through feed.

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EMPOWERMENTOF WOMEN THROUGHSUSTAINABLE INTEGRATED FARMING PRACTICES

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INTRODUCTION:

India is predominantly an agriculture-based country. Around 70% of the people are depending on agriculture and allied activities in rural areas in India. Women occupy an important place in Indian societies. They are endowed with versatile qualities. With the change in time, the role of women in society also started changing. Their initiative to accept challenges to meet her personal needs of her family to become economically independent. Economic independence motivated women to occupy and render their services in various fields. Women in rural India work hand in hand with men almost in all the fields, especially in agriculture. Initiating innovations in agriculture – women contributed a remarkable portion not only in the development of her family but also for their society.

Women made a significant contribution by starting agricultural advancement. The development of agriculture depends heavily on women. Specific agricultural tasks like transplanting, weeding, winnowing etc are performed exclusively by women. However, because of gender based discrimination in society, the contributions of women are not sufficiently recognised. Women's decision-making in marketing, value addition and diverse agricultural operations improves the lives of rural women. There are several connections between agriculture and nutrition. The most obvious link between the two has long been nutrition.The most obvious link between the two has long been understood; among proper nut rition's three pillars, together with appropriate care and good health is food security. From the moment we start working in agriculture, caring for animals, processing (cleaning), preparing food, and other labour intensive tasks, collecting fuel and water, selling farm products, looking after family members and maintaining residences are not always simple, yet we are seldom acknowledged as farmers at home or in society. To meet the demands of an expanding population without upsetting natural balance, a methodical approach is required.

The literal definition of integration is to integrate two or more business so that each is completely absorbed by the other. As a result, a variety of technical solutions are required to provide sustainable agriculture on a worldwide scale, each of which is tailored for a particular agro climatic zone. As the majority of farmers are small-scale and the majority of farmland is cultivated under rain-fed circumstances, there is a great need to increase productivity per unit area per unit of time per unit of capital input due to the exponential increase in population. Numerous production techniques exist, including integrated farming systems, organic farming, urban conservation agriculture, Agro forestry, and better animal production. The Latin word "*Integrare*", which meaning to make whole, to complete by addition of pieces, or to unite components into a whole, is the source of the English word integrated.

INTEGRATED FARMING SYSTEM:

The term "Integrated Farming System" (IFS) refers to a set of interdependent, related, and frequently interlocking production systems that are based on a small number of crops, ani mals, and related subsidiary businesses and are designed to maximise resource utilisation in e ach system while minimising them adverse environmental effects. The development of low-cost farming methods appropriate for Indian conditions was pursued in India. These systems were founded on the ideas of productive farm waste use and greater utilisation of available resources and personnel. A result of the on-going research efforts is integrated farming systems that combine agriculture, livestock farming, and fish culture. The development and rigorous verification of the packages of practises for fish-cum-pig, fish-cum-duck, and fish-cum-poultry farming have been done at the farmer level. The introduction of animal manure to ponds encourages the growth of phytoplankton and zooplankton, which serve as a source of nutrients for fish. Animal manure includes significant amounts of nutrients and biomass. Fish ingest indigestible feed components found in dung directly.

CLASSIFICATION OF INTEGRATED FARMING SYSTEM:

It can be divided into some categories, like-

- Integrated Fish cum Pig farming
- Integrated Fish cum Duck Farming
- Integrated Fish farming-cum-poultry farming
- Integrated Fish farming-cum-Cattle farming
- Integrated Fish farming-cum-Rabbit farming
- Integrated Fish farming-cum-Agriculture

ROLE OF WOMEN IN IFS PRACTICES:

It is now widely accepted that environmental deterioration has had distinct effects on women's lives than it has on men. Many environmentalists have highlighted women as the main victims of overall global ecological degradation. This is mostly attributable to the fact that tasks, both on farms and in households, clearly fall into one of the genders. Women are generally in charge of growing, processing, and gathering food, getting water, and bringing wood for the fire. They traditionally view the farm and the household as one cohesive unit rather than as two separate ones. In India, the use of microcredit has given rise to a significant feminist movement. It has been adopted by numerous NGOs and the government, and it has been a significant tool for women's empowerment. By being a part of a close-knit group that serves as a platform where they can be themselves and enhance their managerial abilities, women gain their greatest strength, or social capital.By strategically utilising family labour, adopting creative strategies, and assuring multiple applications of diverse household and farm resources, there is a significant opportunity to increase household profitability. This is made possible by empowering women through targeted trainings and crucial need-based support.

The new permutation combination in IFS needs to be taught to women. The fact that women are the primary keepers of traditional knowledge provides another justification for improving their IFS skills. Women have played a crucial role in managing and safeguarding traditional knowledge, and this cannot be understated. Due to their social and economic responsibilities, which have compelled them to obtain food, fuel, and fodder from the environment for generations, women and natural resources have a strong relationship. IFS are necessary for the survival of small and marginal farm households, which constitute the foundation of agriculture worldwide.

EMPOWERING WOMEN TO ADVANCE THE ECONOMY

Women confront inequalities and difficulties that prevent them from accessing appropriate employment opportunities and raising their productivity, despite the critical responsibilities they play in the rural economy. In addition to fisheries, forestry, handicrafts, and livestock husbandry, agriculture employs about 68% of working women who live in extreme poverty. Women frequently engage in multiple economic activities at once, and when more secure employment options are not available, they often accept informal, unsafe jobs. Women in rural areas devote more time to domestic and reproductive tasks than their counterparts in cities and men, including time spent gathering water and fuel, husking grain, processing meals, and tending to young children and the sick. The ability of both men and women to engage in, contribute to, and benefit from growth processes in ways that respect their dignity, acknowledge the value of their efforts, and enable negotiations for a more equitable sharing of the benefits of growth is known as women's economic empowerment. Women's access to economic resources and opportunities, such as employment, financial services, real estate and other productive assets, skill development, and market intelligence, grows with their economic empowerment. Women's economic empowerment and involvement are essential to advancing their rights since it gives them control over their life and the ability to make a difference in society.

Women face a variety of forms of discrimination in the rural economy. They may experience prejudice due to their religion, ethnicity, or social background in addition to gender discrimination. Socially disadvantaged groups, such indigenous or tribal peoples, frequently struggle to find adequate labour since they live and work in geographically inaccessible rural locations. Harassment and violence, which involve actions and procedures that violate human dignity and damage people physically, psychologically, or sexually, are frequently linked to inequality and discrimination that rural women encounter. Inequality in power between men and women is the root cause of gender-based violence, which can also be committed against those who do not fit into predetermined gender roles. Focusing on smallholder farmers, who make up the majority of the agricultural industry in developing nations, is also implied by the idea of empowering rural women through good work. More than 500 million small farms with less than 2 hectares of land exist worldwide. An emphasis on smallholders, especially women, helps to reduce poverty and provide food security while promoting community resilience and empowerment in areas that are vulnerable to a variety of threats, including those brought on by climate change and armed conflict. However, women's work as smallholder farmers is far too frequently overlooked and given insufficient assistance. In order to support women smallholders, it is important to provide their access to land and financial services as well as to help them start their own businesses, including cooperatives.

Indigenous women play important roles in their communities as custodians and transmitters of traditional knowledge, which is essential for the survival and integrity of their peoples and indispensable to their livelihoods and resilience. These women are engaged in traditional occupations and subsistence activities in agriculture, livestock, hunting, and forestry. Indigenous women are looking for work in the informal sector at a higher rate due to the instability of their livelihoods, which may be brought on by the effects of climate change or a lack of access to land and natural resources. Due to the disproportionate impact of climate change on indigenous and tribal groups, indigenous women are at increased risk of socioeconomic exclusion. Therefore, it is not unexpected that India's contribution of women to GDP, at 17 per cent, is lower than the global average of 37 per cent.

Sustainable Development Goals that can be achieved by economically empowering women:

SDG 1: No poverty

SDG 4: Quality Education

SDG 5: Gender Equality

SDG 8: Decent work and economic growth

SDG 10: Reduced inequality

SEVERAL FARM BUSINESSES THAT WELCOME WOMEN ARE AS FOLLOWS:

These are as: Apiculture, fishery, Goatery, Piggery, Biogas, Backyard Poultry farming etc.

1) **Apiculture:**

   Refers to beekeeping and honey production, can indeed contribute to the economic development of women in various ways. Here are some key points on how women can benefit from apiculture:

2) **Income Generation:**

   Through the selling of honey, beeswax, pollen, and other bee-related goods, beekeeping can give women a source of income. Women are able to start their own small beekeeping businesses and sell their wares locally, regionally, or even internationally.

3) **Empowerment and Entrepreneurship:**

   Women who work in apiculture have the chance to start their own businesses. Women who run their own beekeeping businesses can hone their commercial abilities, become financially independent, and take charge of their economic activities.

4) **Low Investment and Space Requiremen**t:

   Beekeeping can be started with relatively little capital outlay and infrastructure needs, making it accessible to women with restricted financial resources. Due of bees' adaptability to many surroundings, it can be carried out on a modest scale even in metropolitan and peri-urban locations.

5) **Skill Development:**

   Certain abilities and expertise are needed for beekeeping, including hive management, beekeeping methods, honey extraction, and product processing. Women can get these skills by participating in apiculture, which increases their expertise and presents prospects for further growth and specialisation.

6) **Environmental Stewardship:**

   By promoting pollination and the maintenance of bee populations, beekeeping supports environmental conservation and biodiversity. Apiculturist women can actively contribute to sustainable farming methods and spread knowledge about the value of bees and their place in ecosystems.

7) **Social Integration and Networking:**

   Collaboration and networking with other beekeepers, organisations, and markets are frequent components of beekeeping activity. Women can join cooperatives or associations for beekeeping, where they can exchange information, have access to training opportunities, and take use of group marketing and purchasing development.

- **FISHERY:**

1. **Equal Access to Resources:**

   Women in many societies confront obstacles while trying to acquire resources like money, technology, and education. Women can actively engage and contribute to the fisheries sector’s economic success by being given equal access to these resources.

2. **Skill Development and Training:**

   Women in the fishing industry can have their capabilities and productivity increased by investing in training and skill development programmes that are specifically created for them. A variety of positions and responsibilities within the industry are made possible for women through these programmes, which can cover topics like fishing skills, processing, marketing, and entrepreneurship.

3. **Ownership and Leadership Opportunities:**

   Women can be given more ability to make decisions and have more control over their financial results by encouraging their ownership of fishing vessels, processing plants, and other associated companies. A further way to guarantee women's active participation in decision-making processes is to support their leadership positions in fishery cooperatives, associations, and management bodies.

4. **Access to Markets and Finance:**

The key to empowering women economically is to make it easier for them to access markets and credit. Creating market connections, assisting the growth of female-led fisheries enterprises, and offering financial services catered to their requirements, such as microcredit and savings programmes, are a few ways to do this.

5. **Value Addition and Diversification:**

Women's involvement in value-adding tasks including fish processing, packaging, and product development can open up markets for higher-value goods and boost their income.

We can advance gender equality, boost women's economic independence, and encourage inclusive and sustainable growth in coastal communities by empowering women through the economic development of the fisheries industry.

- **GOATARY-**

1. **Income generation:**

For women, goat farming can be a reliable source of income. They can make money for their families by selling goat milk, meat, and other goods like cheese and yoghurt. Women become financially independent and may contribute to the financial health of their households when they have a source of income of their own.

2. **Poverty alleviation:**

Women and their families may be able to escape poverty by engaging in goat husbandry. Selling goats to alleviate their poor. Women who sell goats or their products can make money to cover their basic expenses, pay for healthcare and education, and invest in other income-generating ventures.

3. **Food security and nutrition:**

Milk and meat from goats are great sources of nutrient-dense food. Women and their families can increase their dietary intake and general wellbeing by consuming goat products. Additionally, extra goat products might be distributed or sold within the neighbourhood to alleviate difficulties with food security.

4. **Empowerment and decision-making:**

   By offering them a sense of ownership, responsibility, and purpose, goat farming may empower women. They take on decision-making roles in a number of goat farming-related areas, including as breed selection, herd management, and marketing tactics. This kind of participation fosters leadership, **assertiveness, and confidence in women.**

5. **Community development:**

   When raising goats, women frequently organise into cooperatives or self-help organisations to handle problems, pool resources, and gain access to markets. These organisations give women a forum where they may work together, share knowledge, and fight for their rights and interests, fostering the growth of the entire community.

6. **Environmental sustainability:**

   The farming of goats is typically regarded as being more environmentally friendly than the raising of huge numbers of cattle. In order to preserve natural resources and lessen their

   impact on the environment, women can adopt eco-friendly practises including pasture rotation, sustainable feeding, and waste management.

- **PIGGERY:**

1. **Economic Independence**:

   Women can create income and achieve financial independence by starting a pig farm. Women can profit from the selling of piglets, pork, and other pig-related goods by owning and operating piggeries. They have more control over their lives and more decision-making ability as a result of their financial independence.

2. **Employment Opportunities**:

   Operations involving pigs involve a variety of duties, including feeding, cleaning, breeding, and marketing. Individual or group work for women is possible in various fields, which will increase job prospects and the local economy.

3. **Skill Development**:

   Women who work in pig farms gain valuable knowledge about marketing, financial management, breeding methods, and livestock management. Their knowledge and competence are increased by these talents, which increases their capacity for successful business management.

4. **Social Empowerment:**

   By disrupting prevailing gender roles and expectations, piggery can enable women to take on more powerful societal positions. When women step into roles that have historically been held by men, stereotypes are contested and cultural perspectives are altered, promoting gender equality and empowering women in their communities.

5. **Access to Resources and Services**:

   Giving women access to resources and services like training programmes, finance facilities, veterinary services, and market connections is a common strategy for encouraging their participation in pig farming. Women can start and grow their piggery companies with the help of these resources and services.

6. **Community Development:**

   The general growth of a community can benefit from women's participation in pig farming. Women are better able to contribute to social welfare efforts such as healthcare, education, and other social welfare programmes by working and taking part in decision-making processes.

7. **Environmental Sustainability**:

   Designing piggy operations with environmental sustainability in mind is also possible. The implementation of sustainable practises, such as adequate waste management, effective feeding strategies, and using organic farming practises, can greatly benefit from the involvement of women. This strategy increases the long-term survival of the piggery enterprises while also benefiting the environment.

- **BIOGAS:**

1. **Improved cooking facilities:**

   Women are typically in charge of gathering firewood and preparing meals for their families in many poor nations. The time spent gathering fuel for this work, which frequently requires hours each day, puts women at risk of physical damage, exposes them to dangerous smoke from conventional cook stoves, and reduces their time for other tasks. Traditional cook stoves can be replaced with biogas, which offers a healthy and effective alternative. Women can cook in a smoke-free environment and spend less time searching for firewood thanks to biogas. This improves their health.

2. **Income generation:**

   The ability to generate revenue through the use of biogas systems has the potential to significantly increase the status of women. Women can work in biogas plant maintenance and operation, as well as the collecting and processing of organic waste. The by-products of biogas generation, including organic fertiliser, can also be sold or utilised for agricultural purposes, giving women new sources of income.

3. **Enhanced sanitation:**

   Utilising organic waste products like crop leftovers or animal manure is frequently necessary for biogas systems. Biogas technology supports proper treatment of organic waste, which enhances hygienic procedures. In order to maintain sanitation and cleanliness in their homes, women are essential because they run the household and are the primary carers. Access to biogas can aid women in addressing sanitary issues, lowering their risk of contracting waterborne illnesses, and enhancing their general health.

4. **Reduced drudgery**:

   By requiring less human labour for domestic tasks, biogas systems can lessen the physical stress on women. Biogas, for instance, can be applied to home tasks. For instance, using biogas for lighting can lessen the need for candles or paraffin lamps. This saves women the time and effort needed to obtain and maintain conventional lighting sources while also providing a safer and more dependable source of light.

5. **Community development and decision-making:**

   Projects involving biogas frequently include community involvement and deliberative decision-making. Women can develop their leadership abilities, confidence, and voice in local affairs by getting involved in biogas efforts. They are able to actively participate in the planning.

Raising a few chickens, ducks, or other poultry in one's backyard or on a small piece of land is known as backyard poultry farming. Women can manage it with less resources and infrastructure because it is a method of cattle production that is relatively affordable and accessible. *The following are some ways backyard poultry can promote women's empowerment:*

Economic empowerment:

Women who raise chickens in their backyards can make extra money for themselves and their family. They have access to a source of money that can help them pay for home bills, healthcare costs, educational costs, and other necessities by selling eggs, meat, or live birds in their local markets.

Skill development: It takes a variety of abilities, including knowledge of animal husbandry, feeding, healthcare, and marketing, to run a backyard chicken farm. Women can learn these skills and have a solid understanding of cattle management via practical experience. These abilities can be utilised to improve their future entrepreneurial endeavours or to pursue other sources of income.

Food security and nutrition: For women and their families, backyard poultry can increase food security and nutrition. Fresh eggs and meat are available to them, which can add protein-rich foods to their diet. In order to increase food availability and dietary diversity, surplus produce can also be used or sold.

Social Empowerment: Backyard poultry farming gives women the chance to get involved in social networks and women's self-help organisations. They may communicate with one another, share experiences, and work together to promote their rights and interests thanks to these platforms. Women can create social possibilities for women to join in community networks and women's self-help organisations by becoming a member of these networks. They may communicate with one another, share experiences, and work together to promote their rights and interests thanks to these platforms. Women can develop social ties, receive assistance, and gain access to resources for their empowerment by joining these networks.

Environmental sustainability:

Organic feed production, composting, and waste management are just a few examples of how backyard chicken farming may advance ecologically friendly practises. Women can be instrumental in putting these practises into practise, helping to preserve natural resources and lessen the environmental impact of raising poultry.

It is crucial to give women access to education, resources, technical assistance, and market connections in order to assure their success. Furthermore, encouraging legislation and initiatives that promote women's rights and deal with gender-based barriers might help women's empowerment in the agriculture industry.

If smallholder farmers have enough farm resources, they can add horticulture crops, such as fruits, vegetables, and flowers, as a second line of business to their current ones. Marginal farmers who live close to fruit orchards can combine their mushroom and apiary operations. If they have access to enough irrigation water or live near a low-lying riverbank, farmers may choose fishing as a side business. Only farmers that take a cautious stance throughout the entire agricultural process may make small-scale farming systems viable.

The economic opportunities, skill development, resource access, and elevated social standing that come with an integrated farming system empower women. It encourages gender equality in agriculture and aids in the sustainable growth of rural areas. Societies may leverage the power of women in agriculture to influence good change and build more resilient and inclusive agricultural systems by recognising and promoting their involvement in farming.

Table.1. Income Cost Calculation of Integrated Fisheries (Per Hectare)

PARAMETERS	CATTLE	PIG	CHICKEN	DUCK
Dung per hectare (per anum tons)	15-25	15-25	10-15	10-15
Dung per animal per year (kg)	5000-7000	500-600	20-25	40-45
No. of animals/hectare for dung	3-4	30-40	500-600	250-300
Fish per hectare seeding production	5000-6000	5000-6000	5000-6000	5000-6000
Fish (ha per year per tonnes)	3-5	3-5	3-5	3-5
Animalproduction (per year) Meat (kg)	-	1500-2000	1000-2500	500-600
Animalproduction (per year) egg (number)	---	----	10,000-15,000	3000-6000
Capital (approx money)	80,000	70,000	80,000	50,000
Average income (per anum) in ha, in Rs)From fish	1,30,000	1,30,000	1,30,000	1,30,000
Average income (per anum) in ha, in Rs) from animals	25,000	60,000	75,000	30,000
Gross income (approximate)	1,55,000	1,90, 000	2,05,000	1,60,000
Recurring Cost (per ha per year)	90,000	95,000	1,05,000	80,000
Gross profit (per ha per year)	65,000	95,000	1,00,000	80,000

N.B. Profitability in projects based on local resources and market rates. But it varies depending on time and place.

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REGION SPECIFIC LIVESTOCK BASED INTEGRATED FARMING PRACTICES FOR SUSTAINABLE LIVELIHOOD OF STAKEHOLDER'S

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INTRODUCTION:

Indian economy is mainly agriculture oriented where small and marginal farmers are the core of the Indian rural economy constituting 85% of the total farming community but possessing only 44% of the total operational land (GOI, 2014). The average size of operational land holdings has reduced by half from 2.28 ha in 1970-71 to 1.16 ha in 2010-11. The operational farm holding in India is still declining. Due to ever increasing population and shrinking land resources in the country, practically there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure reasonable periodic income to farm families (Gill et al., 2005).Rapid population growth, urbanization and income growth in developing countries like India, the demand for food of animal origin is increasing, . Integrated farming system seems to be the possible solution to the continuous increase of demand for food production, stability of income and nutritional security particularly for the small and marginal farmers with limited resources. Integrated farming system in our country lacks scientific and systemic approach. The most dominant cropping system of the area is rice- wheat, followed by rice -maize. Suppose for eg ; For every one kg of rice and wheat we will get 3-4 kg of dry fodder and this dry fodder is the by-product of main crop and it will be utilized as source of feed to the livestock and the waste of livestock can be used as manure to fields even manure to ponds for fish farming so everything is integrated .

CONCEPT OF IFS:

Integrated farming system (IFS) is a broadly used term to explain the suitability of a more integrated approach towards farming over monoculture approaches. In this system an interrelated set of enterprises are maintained and by-products or wastes from one production system becomes an input for another production system, which reduces cost and improves production and or income. FAO (2017) stated that ‘there is no waste’, and ‘waste is only a misplaced resource which can become a valuable material for another product’ in IFS. For example, paddy straw, by-product from rice crop can be used as a valuable input for mushroom cultivation or dry fodder for dairy animals. Similarly spent of mushroom cultivation (used straw) can be used as a raw material in compost or vermin-compost pits and by-products from dairy unit like dung can be used as fish feed or raw material for vermin-compost unit. The farming system is essentially cyclic, organic resources – livestock – land – crops.

Why Integrated Farming System is So Important and different from Mixed Farming?

Integrated Farming Systems (IFS) and mixed farming are related concepts that involve combining different agricultural activities on a single farm. While there may be some overlap between the two, IFS is often considered a more comprehensive and holistic approach. Here are some reasons why Integrated Farming Systems are particularly important:

Resource Optimization: IFS aims to optimize the use of available resources such as land, water, energy, and nutrients. By integrating different components like crops, livestock, aquaculture farmers can make more efficient use of resources. For example, crop residues and livestock manure can be used as organic fertilizer, reducing the need for external inputs. This approach helps maximize productivity while minimizing waste and environmental impact.

Ecological Balance: IFS emphasizes the promotion of ecological balance and biodiversity. By integrating different species and farming practices, farmers can create a more resilient and diverse ecosystem. For instance, planting trees in agroforestry systems provides shade, improves soil health, and supports wildlife habitats. This ecological balance helps control pests and diseases naturally, reduces the reliance on synthetic inputs, and supports the long-term sustainability of the farming system.

Nutrient Cycling: Integrated Farming Systems focus on nutrient cycling within the farm. Livestock can provide manure that is used as fertilizer for crops, and crop residues can be fed to animals. This closed-loop system reduces the dependence on external inputs and minimizes nutrient losses, leading to improved soil fertility and reduced environmental pollution.

Risk Mitigation: IFS can help mitigate risks associated with mono-cropping or specialized farming systems. By diversifying production through the integration of multiple crops, livestock, and other activities, farmers can spread their risks. If one component of the system faces challenges, others can compensate for the losses. This diversification provides a buffer against market fluctuations, climate variability, and pest or disease outbreaks, contributing to the resilience of the farm.

Economic Viability: Integrated Farming Systems can enhance the economic viability of farming operations. By diversifying income sources and value addition through integrated activities, farmers can increase their overall revenue and reduce income volatility. For example, income from livestock products, such as milk or meat, can complement crop sales, providing a more stable and sustainable income stream.

Environmental Stewardship: IFS aligns with the principles of sustainable agriculture and environmental stewardship. By minimizing the use of synthetic inputs, reducing chemical pollution, and promoting biodiversity, IFS contributes to the conservation of natural resources and ecosystems. This approach fosters a more sustainable relationship between agriculture farm system helps achieve sustainability, resilience, and economic viability while minimizing environmental impact.

So here we will take crop(most efficient cropping system of that particular area) + *Livestock(introduction of location specific low cost livestock*)+ pond(0.5-1hct of land) location specific farming system models which could extend

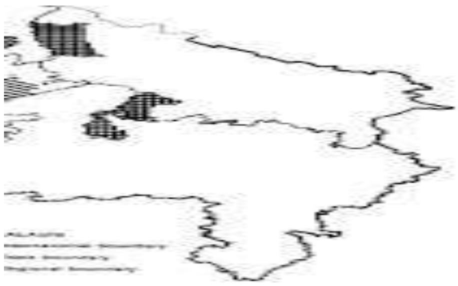
(i) sustainable production system,
(ii) ensure food and nutritional security at household and even at individual level,
(iii) mitigate climate change impact on crop productivity,
(iv) improve resource use efficiency and water productivity,
(v) Provide gainful employment through farming practices.

Since, India is having very vast and diversified geographical features, so for the convenience different IFS models have been created on different zones of India based on demographic and climatic conditions which model is best suitable for sustainable growth of farmers. The models are made by keeping in mind about the most suitable , location specific , low cost livestock breed available , so that sustainable farming can be done however changes can be done by the farmers according to preference of what kind of breeds of livestock farmers wants to rear .

Fig 1: Different zones of INDIA for IFS model

1. **CENTRAL ZONE :-**

This zone includes area of Uttarpradesh, Madhya Pradesh,Chhattisgarh. Central India is a plateau region, and the home of some of the famous mountain ranges, including Satpura and Vindhya. The region is drained by several rivers, including the Ganga , the Chambal, the Son and the Narmada, the Mahanadi .Crop production along with rearing of milch animals (crops + dairy) is the prevailing farming system in the western plain zone of utter Pradesh as about 96 per cent farmers of the area adopt this system. The geographical conditions is very much suitable of diary majority IFS models



- Crops + Dairy (Dominate Farming System of the Region)
- Poultry + Fishery (Most Promising Enterprises for Integration/ Diversification)
- Piggery + Vermicompost + goatry (Supplementary Enterprises)

Breeds of Livestock Animal Suitable According To Geographical Location

Cattle – Malvi, Kosali, Gangatiri

Buffalo – Bhadawari, Chattisgarhi

Sheep – Muzzafarnagri, Jalauni

Goat – Barbari, Jamunapari, Rohilkhandi

Fish – Rohu, Catla, Silver Carp, Mrigal

Swine – Gurrah

EASTERN ZONE:

This Zone include area of West Bengal, Orissa , Bihar , Jharkhand its common geographical features are region lies in the humid-subtropical zone, and experiences hot summers from

March to June, the monsoon from July to October and mild winters from November to February. The interior states have a drier climate and slightly more extreme climate, especially during the winters and summers, but the whole region receives heavy, sustained rainfall during the monsoon months.

(Mohanty et al., 2010) found that the IFS model includes field crops (rice, groundnut, maize, pigeon, pea, and ragi), horticulture crops (yam, banana, tapioca, and vegetables), chicken (Vanaraja breed), and vermicomposting.

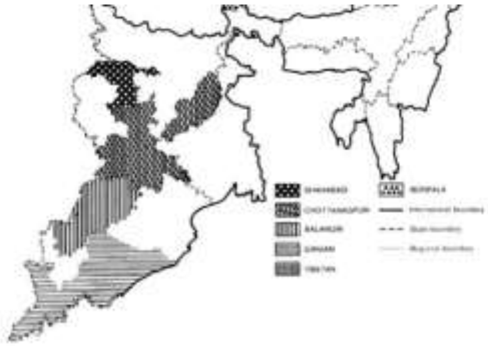
Crop + Dairy, Crop + Dairy + Goats + Horticulture

Crop + Horticulture +Goats, Crop +Dairy + Vegetables

Dairy + Vegetables + Horticulture, Dairy + Vegetables

Dairy + Crop + Companion Animals Are Among the Primary Components in IFS,

+ Pond (Catla, Talepia) + Fodder Cultivation Aquaponics Been Very Much Suitable



Breeds of Livestock Animal Suitable according to Geographical location

Cattle – Bachaur, Binjharpuri, Ghumusari, Purnea

Buffalo – Chilka, Kalhandi, Manda, Nagpuri

Sheep – Garole, Ganjam, Balangir, Shahabadi, Kendrapada, Chotanagpuri

Goat – Black Bengal, Ganjam

Swine – Ghoongroo, Purnea, Banda

Fish – Rohu, Catla , Silver Carp, Mrigal

SOUTHERN ZONE:

This zone include Andhra Pradesh, Telangana, Kerala, Tamil Nadu, Karnataka as it The Malabar Coast moist forests are found on the coastal plains. The South Western Ghats moist deciduous forests are found at intermediate elevations. The southern Western Ghats have high altitude rain forests called the South Western Ghats mountain rain forests. The Western Ghats are a biodiversity hotspot.

Goat +Crop,

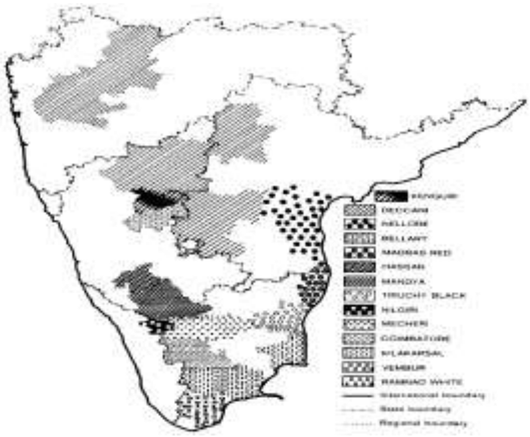
Goat +Dairy + Crop, Goat + Dairy,

Goat +Dairy +Crop Systems as the Key Components in IFS,

Pond + Poultry

Piggery + Pond + Aquaculture

Duck + Pond+ Crop



According to (Manivannan et al., 2011) Agriculture — Horticulture, Forestry, Dairy, Fish farming, Duck rearing are all components of IFS. Mushroom farming - sericulture, azolla farming, kitchen gardening, fodder production, and nursery Vermiculture, Pigeon Rearing, Apiary, Goat Rearing, and Poultry Production are all examples of seed production. Piggery, Rabbitry, and Sheep Rearing Addition of value (Lal et al., 2018).

The increasingly popular practise of aquaponics is an integrated method peculiar to small-scale farms. Aquaponics is a combination of fish culture (aquaculture) with soilless plant production that is commonly connected with greenhouse or other controlled environment production methods.

Breeds of Livestock Animal Suitable According to Geographical Location

Cattle – Ongole,

Buffalo – Toda

Goat – Bidary, Salem Black, Malabari

Sheep – Bellary, Hassan, Mandya, Ramanandwhite, Deccani

Swine – Ankamali

Fish – Rohu, Catla, Mural Cat, Telapia

WESTERN ZONE:

This area comprises of states Gujrat, Maharashtra**.** The area falls in the sub-tropical climate zone and experiences sub-humid climate in (South of River Narmada), moderately humid climate in central Gujarat (between Narmada and Sabarmati rivers), humid and sultry climate in the coastal region (south facing coastal region of Saurashtra), dry climate

The farmers here follow the

Crops + Dairy Kind of integrated Farming

Crops+ Goatry + Pond+ Poultry

Breeds of Livestock Suitable According to Geographical Location

Cattle – Gir, Galao

Buffalo – Pandharpuri Buffalo and Nagpuri Buffalo, Jaffrabadi

Goat Breeds – Sangamneri, Berari, Osmanabadi, Kokkan Kal, Surti, Kachchii

Sheep – Madgyal

Fish – Rohu, Catla, Mural Cat, Telapia

NORTHERN ZONE:

North India is a loosely defined region consisting of the northern part of India. The dominant geographical features of North India are the Indo-Gangetic Plain and the Himalayas, which demarcate the region from the Tibetan Plateau and Central Asia.

North India lies mainly in the north temperate zone of the Earth. Though cool or cold winters, hot summers and moderate monsoons are the general pattern. North India is one of the most climatically diverse regions on Earth. During summer, the temperature often rises above 35 °C across much of the Indo-Gangetic plain

This area consist of states like Haryana, Punjab, J&K, Uttrakhand, and northern parts of UP.

Crops+ Diary

Goat +Crop

Goat +Dairy + Crop

Goat + Dairy

Goat +Dairy +Crop Systems

Breeds of Livestock Suitable according to Geographical Location

Cattle – Sahiwal, Haryana, Kankrej, Mewari, Rathi

Buffalo – Murrah, Niliravi, Gojri,

Sheep – Bhakarwal, Chokla, Gaddi, Jaisalmeri, Malpura, Magra, Punchi

Goat – Beetle, Chegu, Gaddi, Chunthangi, Marwari, Jhakarna, Sirohi, Pantja, Sojat

NORTHEAST ZONE:

This zone consists of Sikkim, Assam, Arunachal Pradesh, Tripura, Meghalaya, Mizoram, and Nagaland. The common geographical features of this area are plateau and hilly based, humid sub-tropical climate with hot, humid summers, severe monsoons, and mild winters.

The following Integrated Farming Systems suitable particularly for hilly regions of the North Eastern Region are explained below in a concise manner.

- Integrated Fish cum Pig farming
- Integrated Fish cum Duck Farming
- Integrated Fish Farming-Chicken
- Integrated Fish farming-cum-Cattle farming
- Integrated Fish farming-cum-Rabbit farming
- Integrated Fish farming-cum-Agriculture

Breeds of Livestock Suitable According to Geographical Location

Cattle – Siri, Lakhimi, Thu Tho, Masilam

Sheep – Bonpala

Goat – Sumi- Ne, Assamhill,

Swine – Niangmegha, Tenyi Vo, Doom, Maali, Manipuri Black

Fish – Rohu, Catla, Silver Carp, Mrigal

Farming systems under small farm holders can only be made profitable if farmers adopt a conservative approach at all stages of farming. For this he has to utilize each and every inches of land for raising suitable field and plantation crops, select low cost viable enterprises for diversification, recycle all farm wastes and crop residues within the system itself and make productive use of farm boundaries and waste lands if any.

SCIENTIFIC ANIMAL WASTE MANAGEMENT: PREREQUISITE FOR SUSTAINABLE INTEGRATED FARMING SYSTEM

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INTRODUCTION:

Animal waste can be defined as the urine, faeces, or other unwanted excretions that are removed from the body of an animal. Poultry wastes include feather, spoilt eggs, litter materials etc. According to the 19th Animals Census, India has 512.05 million livestock, producing 1095 million MT of manure annually (Prasad *et al*., 2014). It has been found that roughly 2.5 billion pigs and cattle on the earth annually excrete more than 80 million metric tonnes (MMT) of waste nitrogen. Comparatively, the output of the total human population is barely over 30 MMT. Gaseous excreta include methane gas that are produced by the ruminants. Methane gas is created during the organic matter's breakdown. Unmanaged livestock wastes can release pollutants that harm the environment, and manure's methane emissions may have an impact on climate change. Steeg and Tibbo (2012) estimate that agriculture is responsible for between 59% and 63% of the world's non-carbon dioxide (non-CO_2) GHG emissions, including 84% of nitrous oxide (N_2O) emissions and 54% of methane (CH_4) emissions. A large portion of the estimated 35% of global greenhouse gas emissions attributable to agriculture and land use, according to McMichael *et al*. (2007), comes from the raising of livestock. Waste management may be defined as the collection, transport, processing, recycling or disposal and monitoring of waste materials. Integrated Farming system includes the management of animal waste in a proper manner so that the one species can use the waste of another species.

CLASSIFICATION OF ANIMAL WASTES

Animal wastes can be dealt in separate sections that are prevalent for a particular type of species. The different types of wastes classified based on species are explained below.

DAIRY WASTE:

In a dairy farm, dairy animals like cows and buffaloes are kept in the barn specified for them in a conventional manner. The waste generated from them will include dung, dust, bedding materials, feed wastes, etc.

The milk processing units also generate a large quantity of wastes. They include milk, milk products and all dairy processing wastes that do not meet applicable quality standards, have become contaminated, or have become unsuitable for human consumption, animal feed or any such beneficial use.

The safe disposal of the sizeable amount of wastewater is a real challenge in the dairy industry because water is its primary component. Lactose, nutrients, fats, sulphates, chlorides, suspended and dissolved solids, as well as trace and soluble organic components are all present in dairy wastewater. It also typically exhibits high COD and BOD levels. Dairy wastewater is typically treated using physical, chemical, and biological techniques. Due to the high cost of reagents and the limited removal of COD by physico-chemical methods, biological methods are preferred. Studies on the treatment and utilisation of dairy effluents and by products are becoming more and more prevalent (Ganju & Gogate, 2017). These wastes can be effectively used as a source of energy or as a raw material for the manufacture of other industrial products (Chandra et al., 2018).

GOAT MANURE PRODUCTION AND WASTE MANAGEMENT:

The secret to breeding healthy, thriving goats is maintaining a clean farm. Because their waste attracts flies and other insects, we must regularly remove it from the shelter. When goat waste is mixed with hay, flies can lay their eggs in an ideal environment. As a result, daily cleaning of the goat shelter and yard keeps the goats tidy and parasite-free. It is advantageous to install a livestock fan inside the shelter to encourage proper ventilation during the sweltering summer months.

The farmers will investigate the uses for the waste produced by their goats. They can either sell it to a nearby retailer, give it to a local farmers union, or use it as manure in their crops. Herbs, vegetables, trees, and other crops benefit greatly from the use of goat manure as a fertiliser. Among its many uses, goat manure is renowned for improving the soil's ability to retain water.

One must never undervalue the amount of waste that a single goat can generate. The combined waste of food and hay from a single goat is thought to weigh more than 2200 lbs (1000 kg) annually. Therefore, having a sound and legal waste management plan in place beforehand will keep you protected against environmental, health, and legal issues (such as water pollution).

PIGGERY WASTES MANAGEMENT:

Piggery waste is the most problematic animal waste. Because pig production industries have expanded along with the demand for pork meat, there will be a worsening problem with piggery waste management in the future.

In many nations, the land that receives piggery wastes has already become overly fertilised with nitrogen and phosphorus, making the problem even more difficult to solve as the amount of land that can be used for disposal decreases.

Composting, anaerobic digestion, nitrate nitrification and denitrification, Anammox, advanced oxidation, adsorption, and membrane technologies are just a few of the conventional and cutting-edge methods that can be used to treat piggery waste.

The farmers will investigate the benefits of using their pigs' waste. They can either sell it to a nearby retailer, give it to a local farmers union, or use it as manure in their crops. Never undervalue the amount of waste that a single pig can generate. A medium-sized pig weighing 110 lbs (50 kg) is predicted to produce manure weighing 1600 lbs (720 kg) per year. The annual total wastes from just one medium-sized pet pig can exceed 2200 lbs (1000 kg) if you include the food wastes. Therefore, you must create a compliant, sustainable, and environmentally friendly waste management policy in advance. Pig manure is a great fertiliser for seeds, herbs, and vegetables, but it needs to compost for at least 5 to 6 months before being added to the soil. It is a good idea to buy 2 large compost bins for every 1 pig. One can add grass clippings, leaves, newspapers, and vegetable kitchen waste in addition to pig manure to the compost bin. Fall-produced pig manure can be added to the soil the following spring.

POULTRY WASTES:

A chicken typically produces 1 kg of fresh manure with variable water content for every kg of feed it consumes, whereas a commercial layer produces about 20 kg of waste annually. Litters from broiler and layer birds, hatchery waste, dead birds, and a variety of other waste are included in a poultry farm's waste. Manure, bedding material, leftover feed, feathers and occasionally soil are all components of grill litter. On the other hand, all of the aforementioned items—aside from bedding and casing material—are present in litter from the cased layer. These wastes can be successfully used for crop production, but doing so requires soil testing, knowledge of the nutrients crops need, the nutrient value of manures, and proper application and storage techniques. Additionally, chicken litter can be used as a component of cattle feed and as fuel for engines. However, a nation's environmental safety regulations, public concerns, and financial viability are what primarily drive waste management.

Large-scale production of poultry waste is caused by the growing concentration of egg production facilities. With the public becoming more aware of and concerned about environmental pollution, this also presents handling and disposal issues for many poultry producers. Depending on the type of farm rearing system used, the two main types of waste produced by poultry enterprises are litter from cages and waste from poultry. Poultry litter is the leftovers from deep litter systems, and because it primarily contains used litter material, it has little nutritional value. Excreta gathered beneath the cages, spilled feed, and feathers make up the majority of the waste produced by cage layers. The most popular method for layer rearing is cage rearing.

PROCESS FOR TREATMENT OF ANIMAL WASTES:

The processes employed for the treatment of animal wastes can be basically classified as physical and biological processes.

Physical processes

The different physical processes include sedimentation, mechanical separation, incineration, solar drying, pit disposal, rendering, membrane processes etc. They are explained below:

- Sedimentation: The most straightforward method for removing suspended solids from liquid manure is to use natural settling or sedimentation. The relatively straightforward technique and affordable equipment make the sedimentation option seem like a promising way to remove fine particulates from slurry.
- Mechanical separation: Mechanical screening, a simple method that can be used on farms to separate the course materials from the slurry, can result in a quicker separation. In many full treatment methods, mechanical screening is also a preliminary step in the process.
- Incineration: For better management, animal excrement might be burned. However, it is impossible to burn the enormous volume of waste produced by the animals. The wealthy nations have a set of emission criteria that must be adhered to in this procedure, and the underdeveloped nations cannot afford the incinerators used for waste treatment.
- Solar drying: The manure is dried by the sun to extremely low moisture levels. At such low moisture levels, most bacteria and protozoa become inactive, and the disease-causing capacity of the manure declines. Because there are fewer worms in the manure, the environmental contamination is also appropriately decreased.
- Pit disposal: Dogged pits have long been the preferred way for disposing of animal faeces because of their low cost and simplicity. For the disposal of dead birds, a deep

pit with internal frame and a tight-fitting lid or an open trench created by a backhoe have been utilised.

- Rendering: By removing carcasses from the farm and converting trash into a useful feed ingredient, the rendering option helps prevent environmental contamination. Processing plant wastes are heated, hydrolyzed, and pressed into by-product meal during rendering.
- Membrane processes: Reverse osmosis, a type of membrane technology, can be used to dewater sow slurry, but before the liquid enters any membrane treatment stage, the organic fraction must be broken down and the solids removed by efficient sedimentation, separation, or filtering procedures.

BIOLOGICAL PROCESSES:

It is feasible to use these species for the specific goal of biological treatment to produce beneficial end products by enhancing the environment of naturally occurring microorganisms. The biological procedures used to treat animal faeces are as follows:

- Aerobic treatments: Activated sludge, continuous aerobic treatment systems, aerobic trickling biofilter use, built wetlands, and overland flow are a few of them.
- Anaerobic treatments: One of the most crucial treatments for animal dung and other organic wastes is anaerobic digestion, which results in the creation of CH_4, a universal energy carrier. Pumpable slurries are the most convenient and frequent way to do anaerobic digestion, however high solids content (20–40% DM) plug flow reactors have recently been developed. Biogas, a combination of 60–70% CH_4 and 30–40% CO_2, is one of the by-products of the process (Nanda *et al.*, 2022).

VERMICULTURE:

Animal waste can be converted into vermin-cast and vermin-meal (protein meal) using a low-cost vermiculture system. 80 kg of dungworms can grow in one tonne of cattle manure, claims Boda (1990). Omoyakhi and Nwokoro (2004) estimated that layer manure has a total maggot production capacity of 12.59 percent. These crustaceans were fed to livestock without causing any illnesses or fatalities, according to reports from several other authors (Atteh and Oyedeji, 1994).

ALTERNATIVE ANIMAL FEED:

Through the utilisation of the properly handled and dried animal waste as animal feed, the price of chicken meat and eggs will drop, increasing the profit margin. Reduce human hunger and poultry-human conflict over food. Dried animal waste, such as poultry dung, is comparable to cereals like barley in terms of protein and essential amino acids.

CONCLUSION:

Developed as well as developing nations should adopt and uphold the rules and regulations required to properly handle and dispose of animal waste in order to protect the environment. The risk of global warming and climate change can be reduced once these regulations are considered and different techniques for getting rid of animal waste are used. In IFS model, we can successfully and effectively use the waste of all the species of animal and birds for enhancing productivity. More research is being done to create new technologies that will safeguard the environment in addition to those that already exist. Farmers and the general public should be given incentives to adopt these technologies, protecting the environment and raising the standard of living on Earth. The national governments should take the lead in this effort in coordination with civil society organisations.

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