Integration of Livestock systems in Natural farming

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Outline

- Introduction
  - Importance of livestock for Indian economy
- Livestock farming systems
  - Differences between natural and conventional
- Natural farming system
  - Why to integrate livestock with crop production
  - Advantages
- Features of different combinations of integration
- Case studies
- Summary

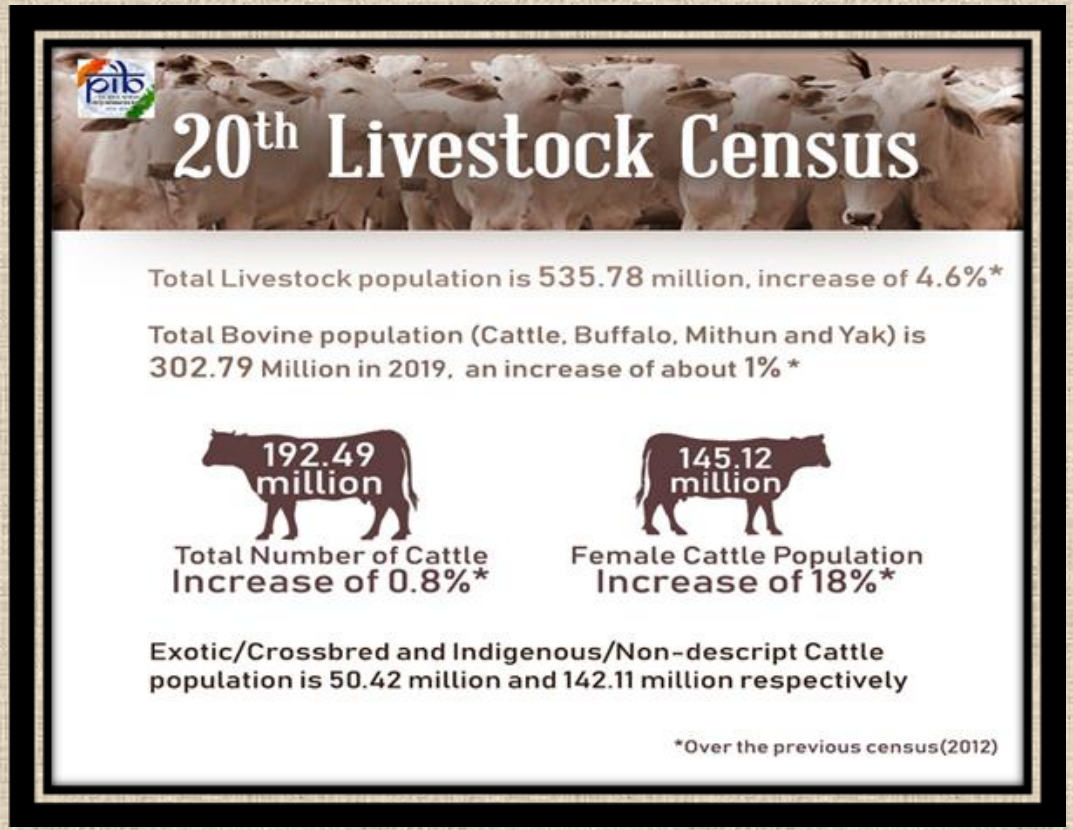
Contribution of livestock to our national economy

- Livestock sector contributed **Rs 11,14,249** Crores at current process to the Gross Domestic Product (GDP) in **FY 2020-21** which is equivalent to **30.87%** of the value of output from Agriculture and allied sectors.
- The contribution of livestock sector to Indian GVA is around **6.17 %.** Growth rate of **6.13 %** over the previous year.
- About **16.44 million** workers are employed in livestock farming activities including fisheries and aquaculture.

Livestock Products

- India is the largest producer of milk with **20.17 percent** share in the total milk production in the world. **221.06** million tonnes (in 2021-22) (annual growth rate of 5.68%)
- India accounts for **5.65%** of global egg production. **129.60 Billion** (in 2021-22) (growth of 6.19%)
- The total meat production in India is around **9.29 million tonnes** (in 2021-22) (growth of 5.62%)
- Draught power- one pair of bulloks-0.5HP.
- Animal power is also utilized for transport. 25,000 million tones km of freight per year this saves **6 million tons of diesel /petrol** worth Rs.4000 crores.

Livestock resources in India



www.dadf.gov.in

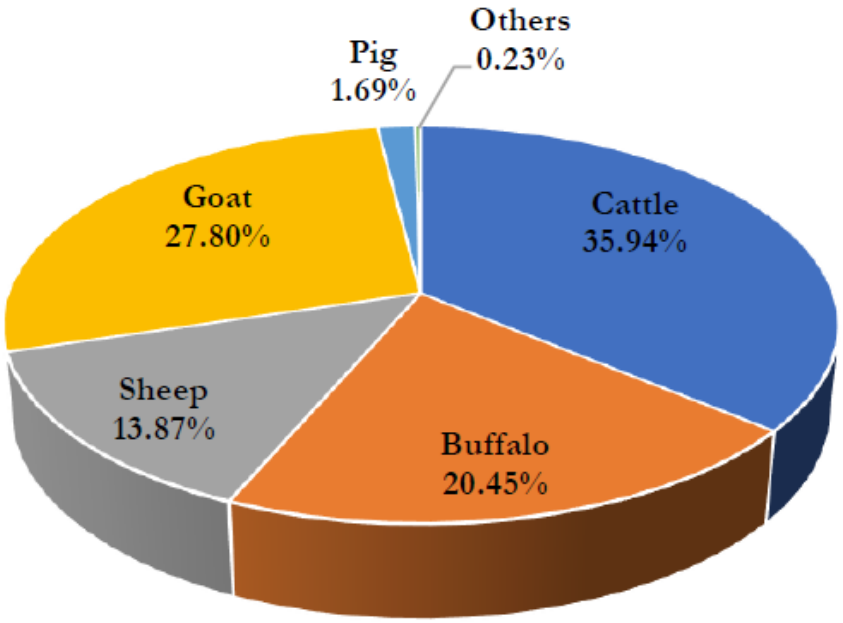
Some of the key outcomes of the 20th Livestock Census

Category	Population (In million) 2012	Population (In million) 2019	% growth
Cattle	190.90	192.49	**0.83**
Buffalo	108.70	109.85	**1.06**
Sheep	65.07	74.26	**14.13**
Goat	135.17	148.88	**10.14**
Pig	10.29	9.06	**-12.03**
Total Livestock	**512.06**	**535.78**	**4.63**

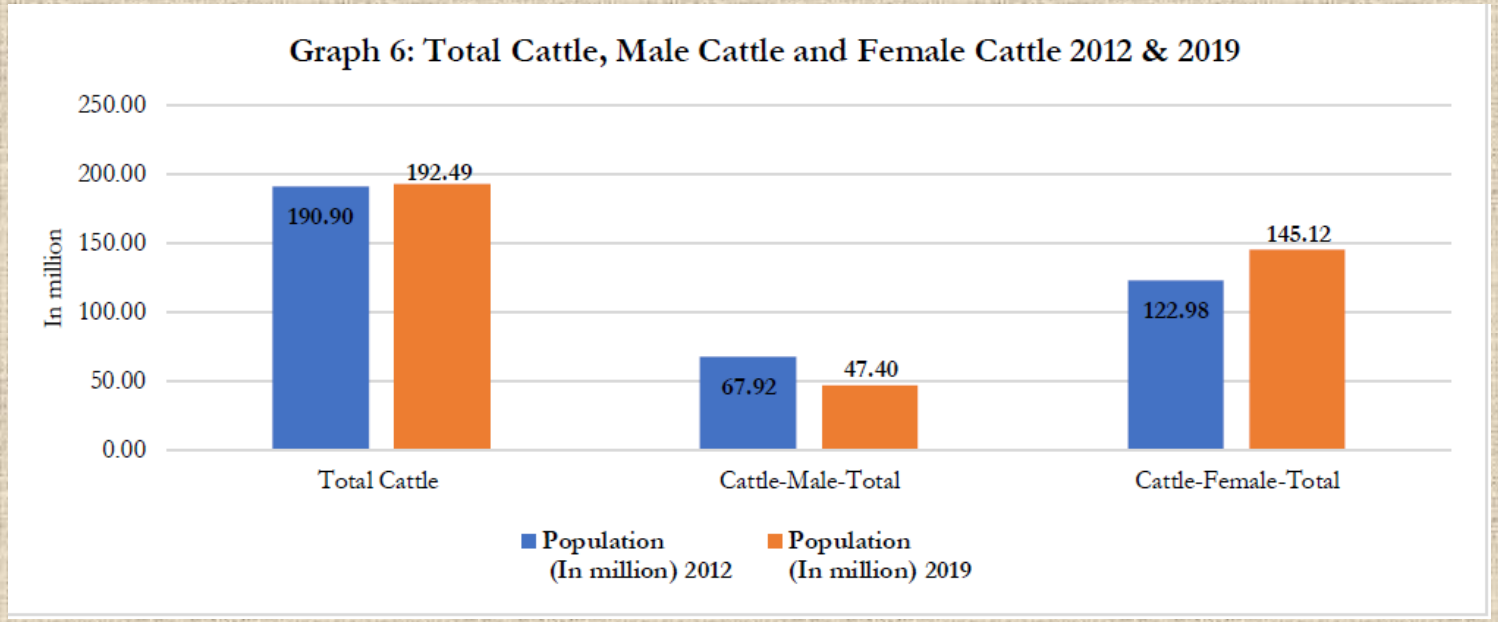
Poultry

	Population (In million) 2012	Population (In million) 2019	% growth
Total Poultry	**729.21**	**851.81**	**16.81**
Backyard poultry	217.49	317.07	45.78
Commercial Poultry	511.72	534.74	4.50

Graph 1: Livestock Population 2019 - Share of Major Species



Salient Features of Livestock census 2019



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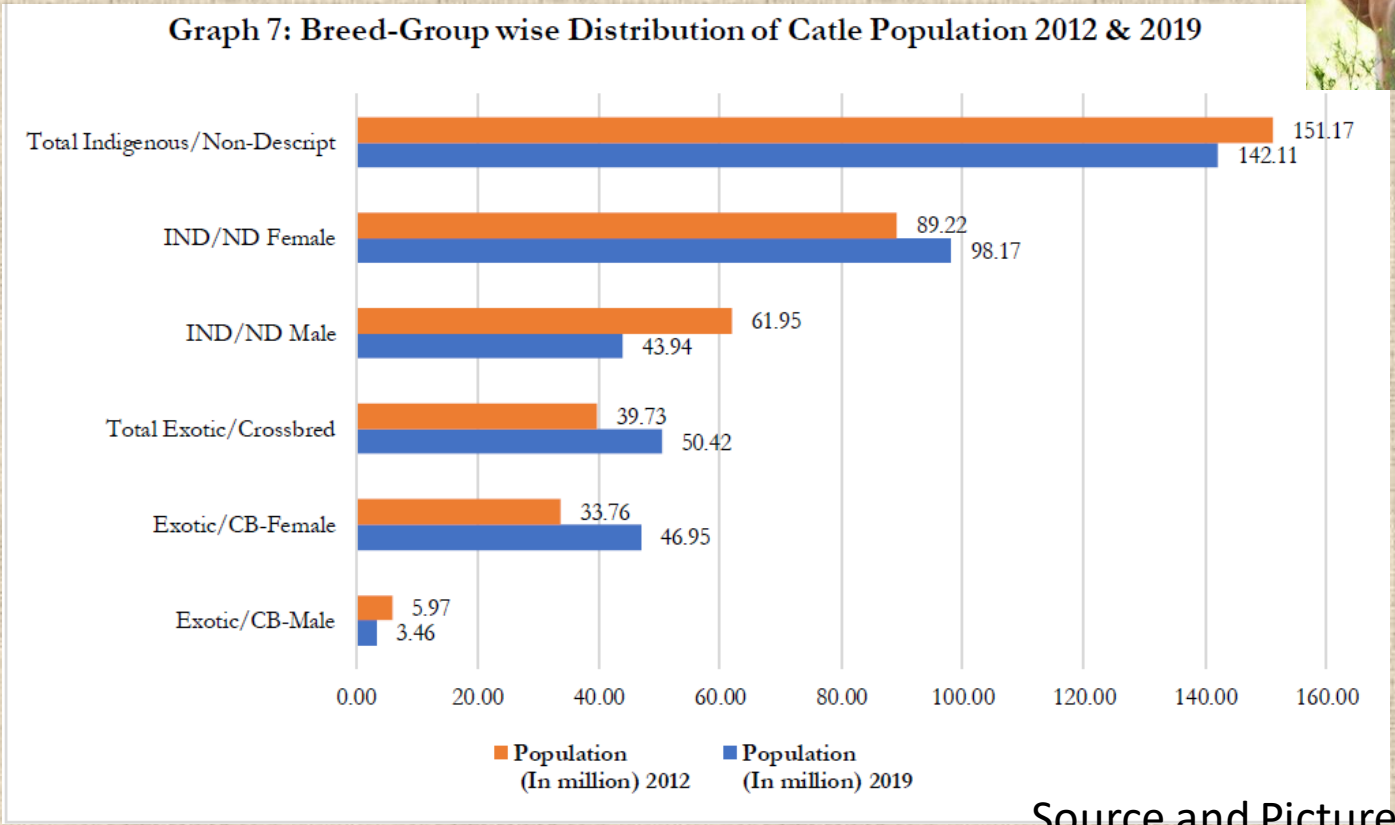
Salient Features of Livestock census 2019

Graph 7: Breed-Group wise Distribution of Catle Population 2012 & 2019



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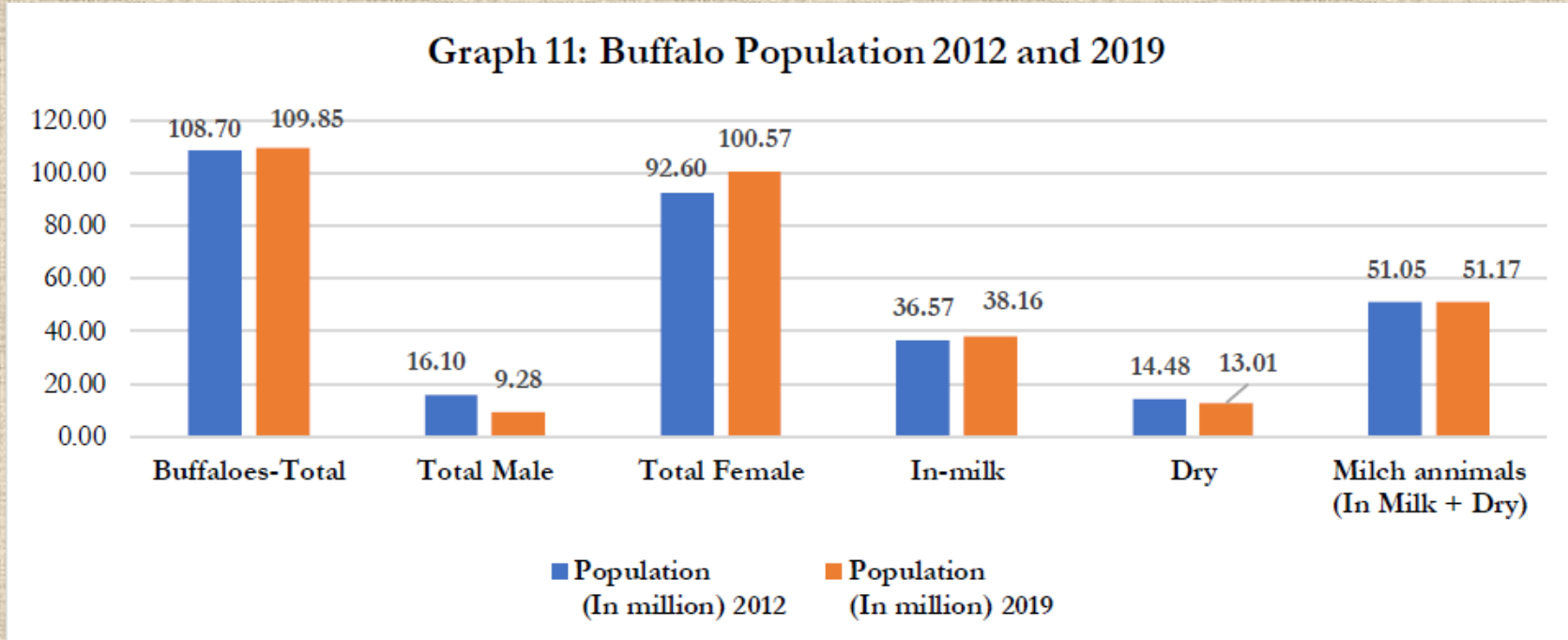
Salient Features of Livestock census 2019



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Sl No	Species	Recognised Number of breeds
1	**CATTLE**	**53**
2	**BUFFALOE**	**20**
3	**SHEEP**	**45**
4	**GOAT**	**39**
5	**POULTRY**	**20**
6	**PIG**	**14**
7	**Horses and Ponies**	**8**
8	**Camel**	**9**
9	**Donkey**	**3**
10	**Yak**	**1**
11	**Duck**	**3**
12	**Geese**	**1**

13- Dog 3

14-synthetic cattle 1

BIODIVERSITY

Total Number of Breeds in India: 220

Livestock Farming Systems

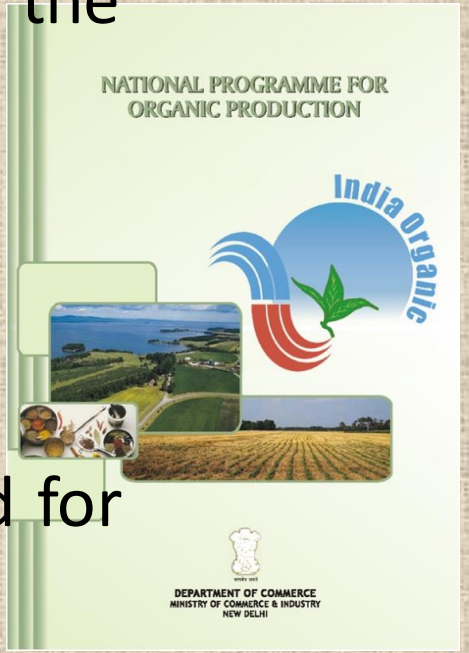
- **Natural Livestock Farming System**
- Organic Livestock Farming System
- Commercial Livestock Farming System
- Contract/Integration Livestock Farming System
- **Integrated Livestock Farming System**

Natural (Traditional) Livestock Farming System

- Traditionally followed livestock farming for ages
- Supplementary to agriculture
- Agricultural byproducts are used as input
- Animals usually are low producing
- Low input-Low output system
- Sustainable model for natural farming with no waste in the system

Organic Livestock Farming System

- Origin of the animals and the inputs for the system are of organic in origin
- Livestock maintained in their natural environment
- Animal welfare is the major priority
- At no point any chemicals or drugs used for treatment or supplement
- Low level of production
- Certified products sold at a premium



Seventh Edition: November 2014

Differences between Organic and Natural farming

NATURAL FARMING	ORGANIC FARMING
No external fertilisers	Organic fertilisers are allowed
No ploughing, tilling and weeding No pesticides, No herbicides, No pruning	Basic agro practices like ploughing, tilling, weeding are performed
Apart from natural manure, natural farming encourages decomposition of organic matter by microbes and earthworms	Manures like compost, vermicompost are used on farmlands
Less regulated	Guidelines & regulations to be followed for certification purpose
Lost cost farming method	Expensive due to requirement of bulk manure

Commercial Livestock Farming System

- Livestock rearing is the primary and agriculture secondary function
- Profit is the motto
- Under Indian Conditions can be further categorized into small, medium and large on the herd/flock size
- Large commercial farms are high input and high output ventures
- Scientific management with some mechanization could be seen
- Technology is generally in use

Differences in natural and commercial production systems

	Natural Livestock Production	Commercial Livestock Production
01	More emphasis on livestock welfare and environment	More emphasis on livestock products
02	Less number of animals in more space	More number of animals in less place (Focus on intensification)
03	Less impact on environment	Environmental consideration is not an issue
04	Natural behaviour of animals is preserved	No such consideration
05	Recycling of wastes	No such consideration
06	Subsistence? Profits -minimal	Higher profitability is the main aim

Contract (Integration) Livestock Farming

- "A contract farming arrangement involves a wage contract between an integrator who supplies the intermediate inputs and procures the output (as per pre decided terms) and a poultry farmer who provides inputs such as administration, rearing and care taking."

(Adopted from: Poultry Sector – A Discussion,(Dr. Raji Ajwani-Ramchandani, 2012)

Integrated Livestock Farming System

- Several species of animals are reared simultaneously for different purposes
- Revenue generated from multiple sources
- Sustainable model for Indian conditions

- “An **integrated farming system** consists of a range of **resource-saving practices** that aim to achieve acceptable **profits** and high and **sustained production** levels, while **minimizing the negative effects** of intensive farming and **preserving the environment**”

(Gupta et al., 2012)

Why to integrate livestock with crop?

- Land holdings- fragmented
- Seasonal income
- Risk of crop failure
- Mono cropping
- Resource deterioration

Benefits from integration of livestock

- Can make the system sustainable
- Ensure the revitalisation of the land resource
- Employment throughout the year for the family
- Recycling of waste with in the production system
- Balanced food for the family
- Effective utilization of the available resources eg., land
- Increased income leading to higher standard of living

Nutrient flow in integrated Crop-livestock farming system

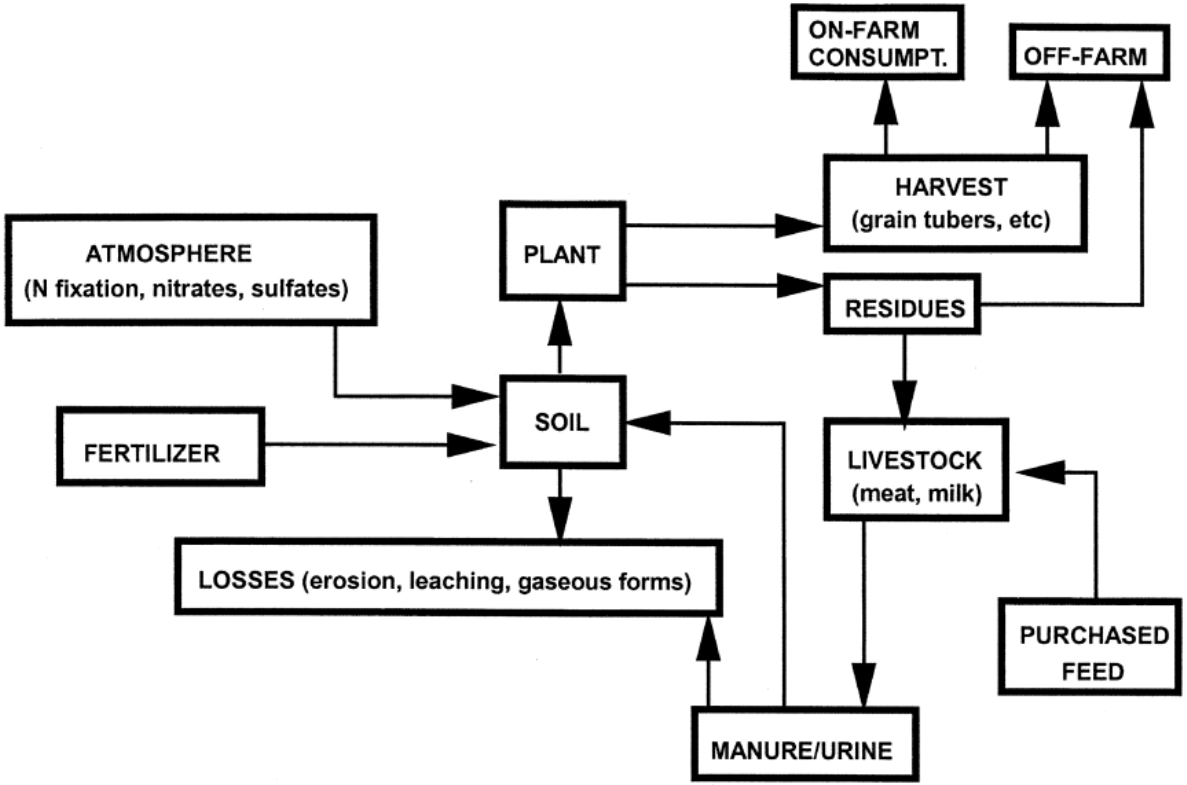


Fig. 3. Pathways of nutrient flow in mixed crop–livestock farming systems (Stangel, 1995).

Nutrient flow in integrated Crop-livestock farming system

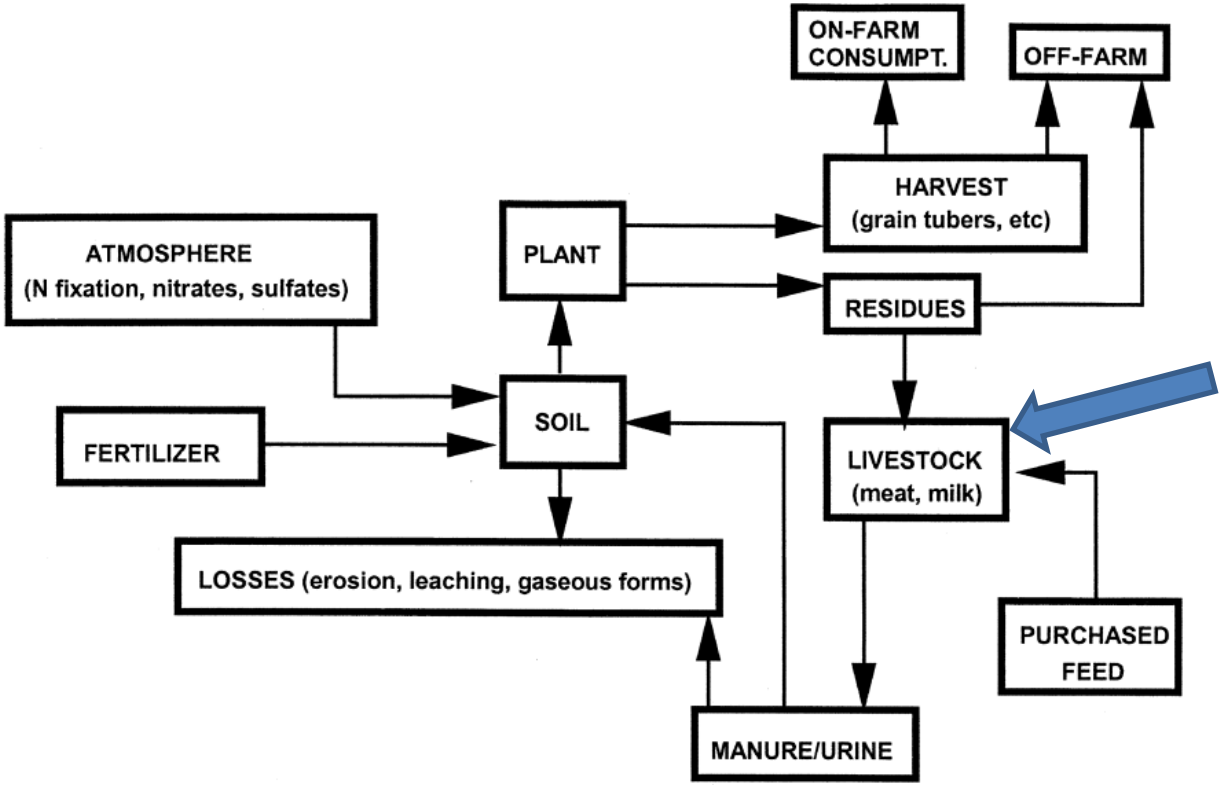


Fig. 3. Pathways of nutrient flow in mixed crop–livestock farming systems (Stangel, 1995).

Questions?
Which species
Which breed
How many animals/ Birds??

Factors to be considered for introduction of Livestock

- Resource availability-land, labour, capital
- Soil and climate
- Resource utilization at present
- Skills about the management of the livestock to be introduced
- Marketing capabilities
- Economics of the integrated farm

Example1. General farming-system characteristics*

Types of farming systems	Crop without livestock (CWL)	Crop with dairy (CD)	Landless with livestock (LWL)	Crop with small ruminants (CSR)	Crop with diverse livestock (CWDL)
	n = 1326	n = 1063	n = 188	n = 165	n = 23
Ownership of land	Y	Y	X	Y	Y
Ownership of livestock	X	Y	Y	Y	Y
Distribution per farm type					
Marginal (> 1 ha)	40%	15%		20%	21%
Small (1–2 ha)	37%	31%		32%	26%
Medium (2–4 ha)	21%	42%		32%	48%
Large (>4 ha)	2%	12%		30%	4%

(Kuchimanchi et al., 2022)*Info from Telangana state

General farming-system characteristics

Types of farming systems	Crop without livestock (CWL)	Crop with dairy (CD)	Landless with livestock (LWL)	Crop with small ruminants (CSR)	Crop with diverse livestock (CWDL)
Cropping characteristics	Rain-fed, Limited irrigation, Monocropping	Irrigated, Mixed cropping, Continuous irrigation		Rain-fed; Limited irrigation, Monocropping	Rain-fed, Mixed cropping
Crops	Predominantly cash crops	Cash & food crops with residues, Green fodder		Predominantly Cash crops	
Livestock characteristics (dominant species)	Native poultry	Large ruminants crossbred/ exotic cattle/buffalo	Native poultry and small ruminants	Small ruminants	Diverse livestock species

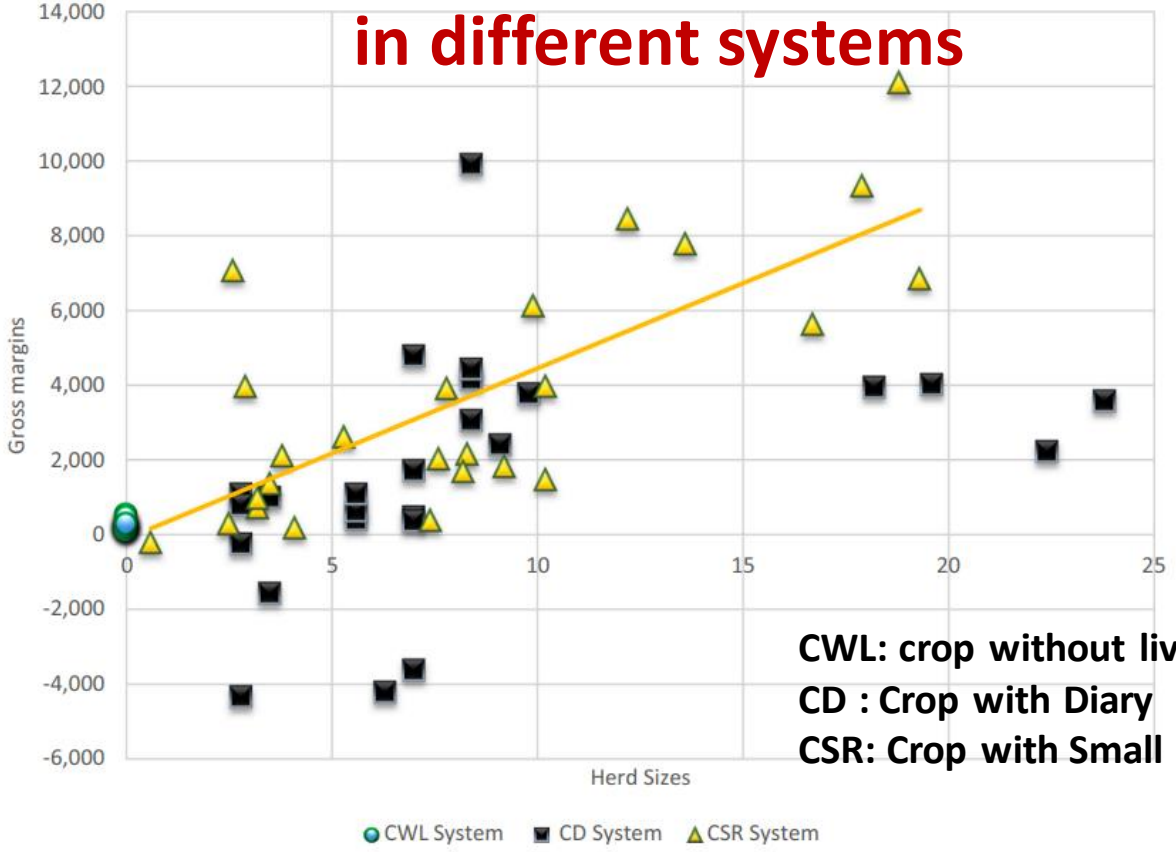
General farming-system characteristics

Types of farming systems	Crop without livestock (CWL)	Crop with dairy (CD)	Landless with livestock (LWL)	Crop with small ruminants (CSR)	Crop with diverse livestock (CWDL)
Crop - livestock practices	Intensive specialized technologies	Intensive specialized technologies	Traditional, Subsistence Depend on CPRs for Grazing	Intensive specialized technologies Depend on CPRs for grazing	Traditional, subsistence , Depend on CPRs for grazing
Farm infrastructure	Traditional/basic	Use Farm machinery	Traditional/basic	Use Farm machinery	Traditional/basic

CPR-common property resources

(Kuchimanchi et al., 2022)

The relationship between herd size and gross margins in different systems



CWL: crop without livestock;
CD : Crop with Diary
CSR: Crop with Small Ruminant

Fig. 2. The relationship between herd size (in TLUs) and gross margins (in USD) for the three farming systems under study. Only the regression line for the CSR system is plotted because it was the only farming system in which herd size resulted in a significant factor for gross margin.
Note: crop without livestock (CWL), crop with dairy (CD), and crop with small ruminant (CSR) farming systems.
Source: Economic performance study of three farming systems (2016–2017, $n = 75$).

(Kuchimanchi et al., 2022)

In terms of economic performance

- **Crop Without Livestock (CWL) system**
  - a medium-input/low-output system, consistently exhibited **low economic performance,**
  - with low revenues attributable primarily to **higher production costs** for cash crops and **market volatility**
- **Crop with Diary (CD) system**
  - A ***high-input/high output system*** , was **less profitable,** due to **high production costs.**
  - This system exhibited high variability in Gross Margins from moderate to substantially negative records across House holds,
  - the **consistent income** obtained from dairy farming came at the **expense of crop production** in the winter season, as scarce **water resources were diverted** for dairying. This strategy resulted in the loss of additional income

In terms of economic performance

- **Crop Small Ruminant (CSR) system**
  - is a **medium-input/medium-output** system
  - showed the **best performance**, as explained by **the low water** requirements and **low feed production costs** (e.g., leasing croplands and use of existing CPRs).
  - The profitability of this system was further enhanced by growing market demand and the current market price for small ruminant meat.
  - The system also **adapted to the dynamic context** by **adjusting herd sizes** to the decreasing availability of common property resources,
  - suited to the dryland context
  - which cultivated crops for two seasons each year, in addition to rearing small ruminants

(Kuchimanchi et al., 2022)

Example2. Dairy based Integrated farming system

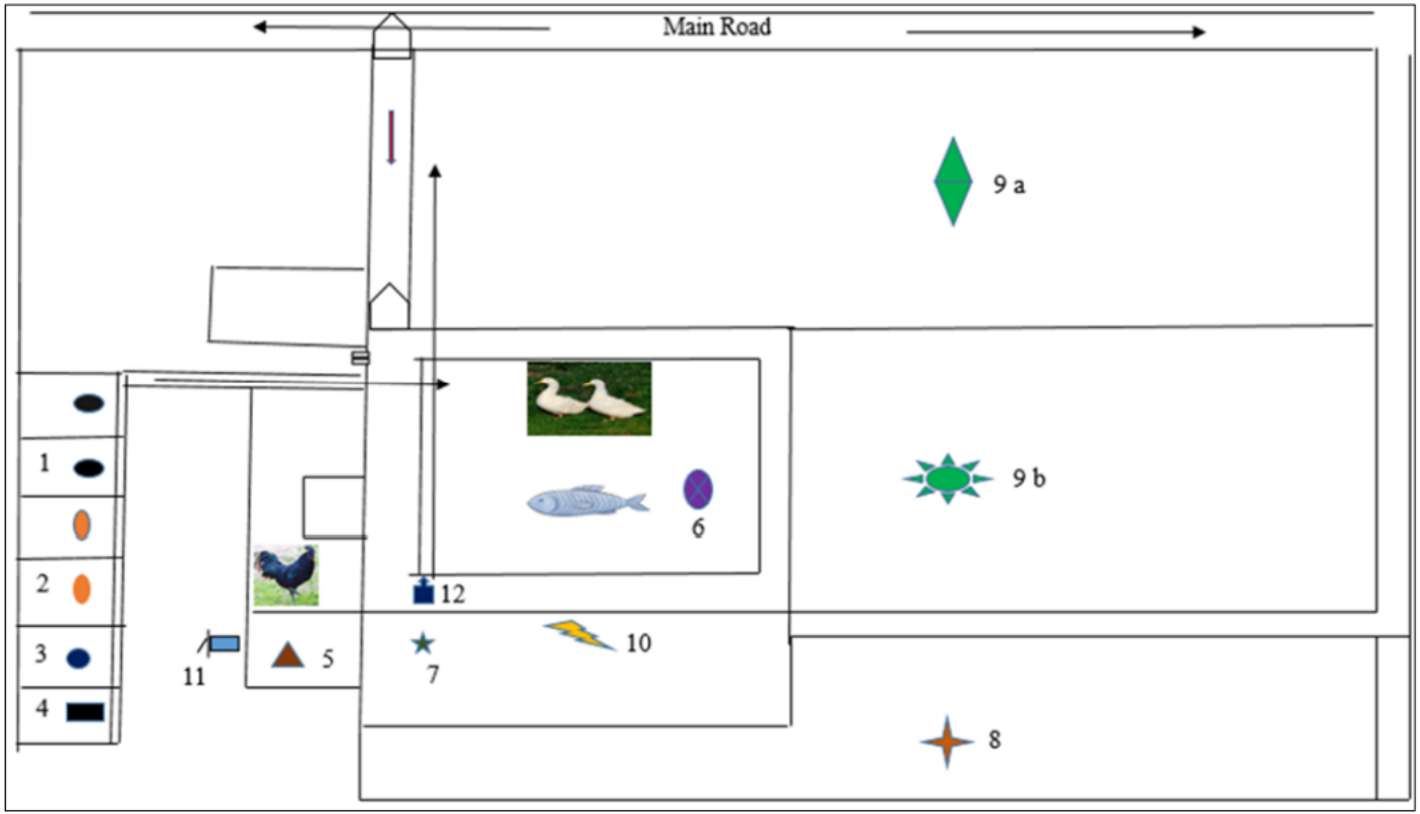


Fig 1: Design of dairy based IFS model under 1 ha. area. (1. Buffalo shed, 2. Cattle shed, 3. Goat shed, 4. Poultry and Duck shed, 5. Vermicompost unit, 6. Fish Pond, 7. Nursery, 8. Crop component, 9. Forage production (a-perennial forage with intercrops and b-annual forage), 10. Fruit plants, 11. Chaff cutter machine and 12. Electric motor for water)

(Regar et al., 2022)

Table 1: The area distribution of dairy based IFS of each enterprise at NDRI

Area	Components	Proposed interventions
Livestock 5ACU	Sahiwal cattle - 3 Buffaloes -3 Crossbred (AxB) goats - 10 Poultry -20	
	Annual and perennial forage crops	Berseem (BL-42) + Japanese Sarsoo HN+ Berseem + Japanese Sarsoo Moringa
0.4ha	Cereal crops	Wheat (HD 3086) Rice (Pusa Basmati 1121)
0.1 ha	Fruit tree on pond dyke	Papaya (Taiwan red lady-786)
0.1 ha	Misc.	Compost/Vermin-compost, Fishery (25 x 15 x 3)

(Regar et al., 2022)

Nutrient recycling in dairy based integrated farming system model

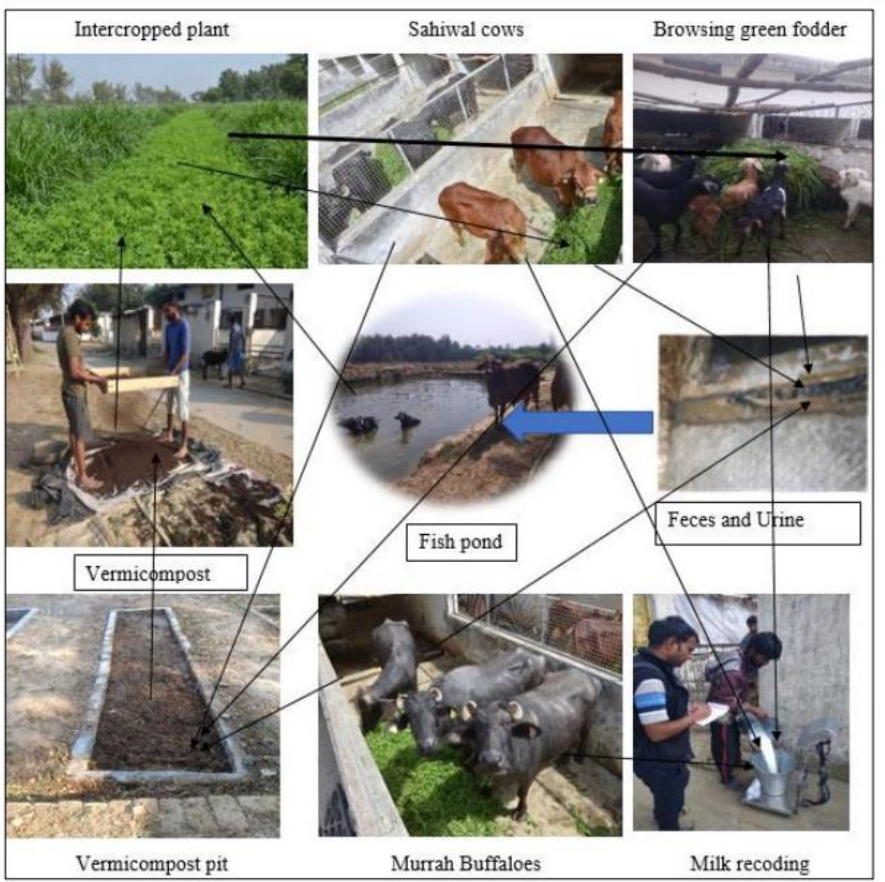


Fig 2: Nutrient recycling in dairy based integrated farming system model

(Regar et al., 2022)

Table 4: Cost and returns (Rs.) of different enterprise as a whole system of dairy based IFS

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

Return from - Dairy: 59.89%, Crops: 32.75%, Subsidiary enterprises: 7.36%

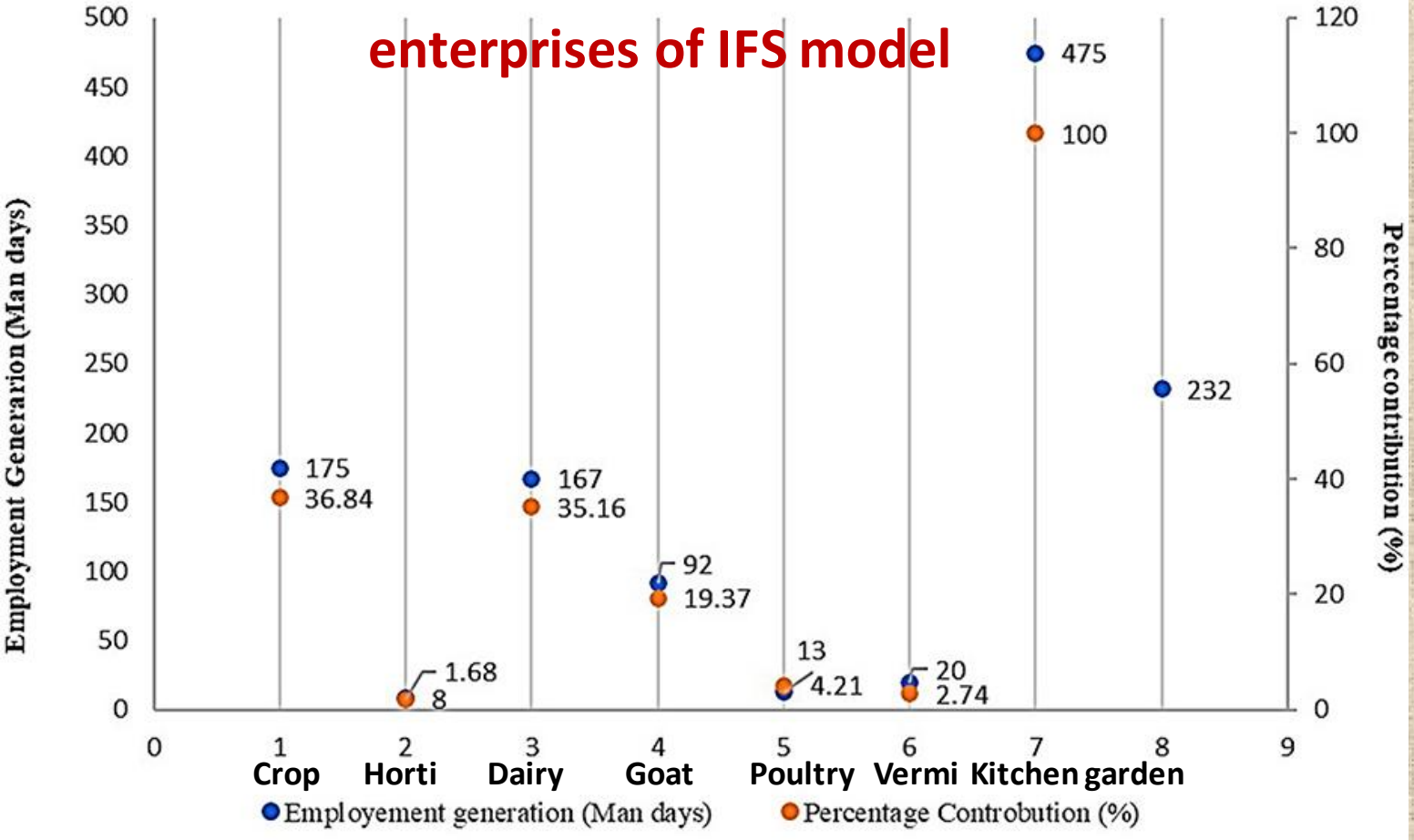
(Regar et al., 2022)

Example 3. Integrated farming system at TNAU

Components	Area (m^2)	Details				
Crop	8,500		*Kharif*	*Rabi*	*Summer*	*Area* (m^2)
		CS I	Cowpea (VBN 3)	Ragi (CO 15)	Dhaincha	1,500
		CS II	Maize (COH(M) 6)	Sunflower (SF hybrid CO 2)	Dhaincha	1,500
		CS III	Prosomillet CO (PV) 5	Chillies (Samba)	Dhaincha	1,500
		CS IV	Pearl millet CO (Cu) 10	Cotton (TCH1819)	Dhaincha	1,500
		Fodder unit	Bajra Napier grass (CO BN 5) and *Desmanthus* (CO 1)			1,500
			Grazing unit: *Cenchrusciliaris* (CO 2) and fodder trees			1,000
Horticulture	1,000	Fruit trees: Sapota PKM 2 and PKM 1 (3:1), Guava (Lucknow 49), Amla NA7 and BSR1 (4:1), Pomegranate (Bhaguva)				
Dairy (2 + 2)	50	Native breeds (Gir and Kankrej)				
Goat rearing (12 + 1)	50	Native breed (Salem black)				
Poultry (150 birds)	50	Desi poultry birds (Aseel) for meat purposes (50 per batch; 3 batches per year)				
Vermicompost	50					
Kitchen garden	200	Vegetables and greens				
Border planting		Annual moringa (PKM 1), curry leaf (Senkambu), agathi, *Gliricidia sepium*				
Areas for supporting activities	100	Manure pit, fodder chopping unit, bakery unit, *etc.*				
Total	10,000					

(Shanmugam et al 2024)

Employment generation and percentage contribution in different enterprises of IFS model



(Shanmugam et al 2024)

Economics of production in IFS model

Components	Total cost/	Gross return/	Net return/	B:C	Net return contribution (%)
Cropping	103,337	209,435	106,098	2.03	33.39
Horticulture	7,309	22,815	15,506	3.12	4.88
Dairy	125,261	155,501	30,240	1.24	9.52
Goat	49,208	122,687	73,479	2.49	23.12
Poultry	26,600	49,598	22,998	1.86	7.24
Vermicompost	49,964	89,880	39,916	1.80	12.56
Kitchen garden	5,196	14,801	9,605	2.85	3.02
Boundary planting	5,133	25,056	19,923	4.88	6.27
Total	372,008	689,773	317,765		100
Conventional (crop + horticulture + livestock)	164,231	266,236	102,005	1.62	
Fold change (times)	+2.27	+2.59	+3.12		

B:C, Benefit-cost ratio.

52.0%

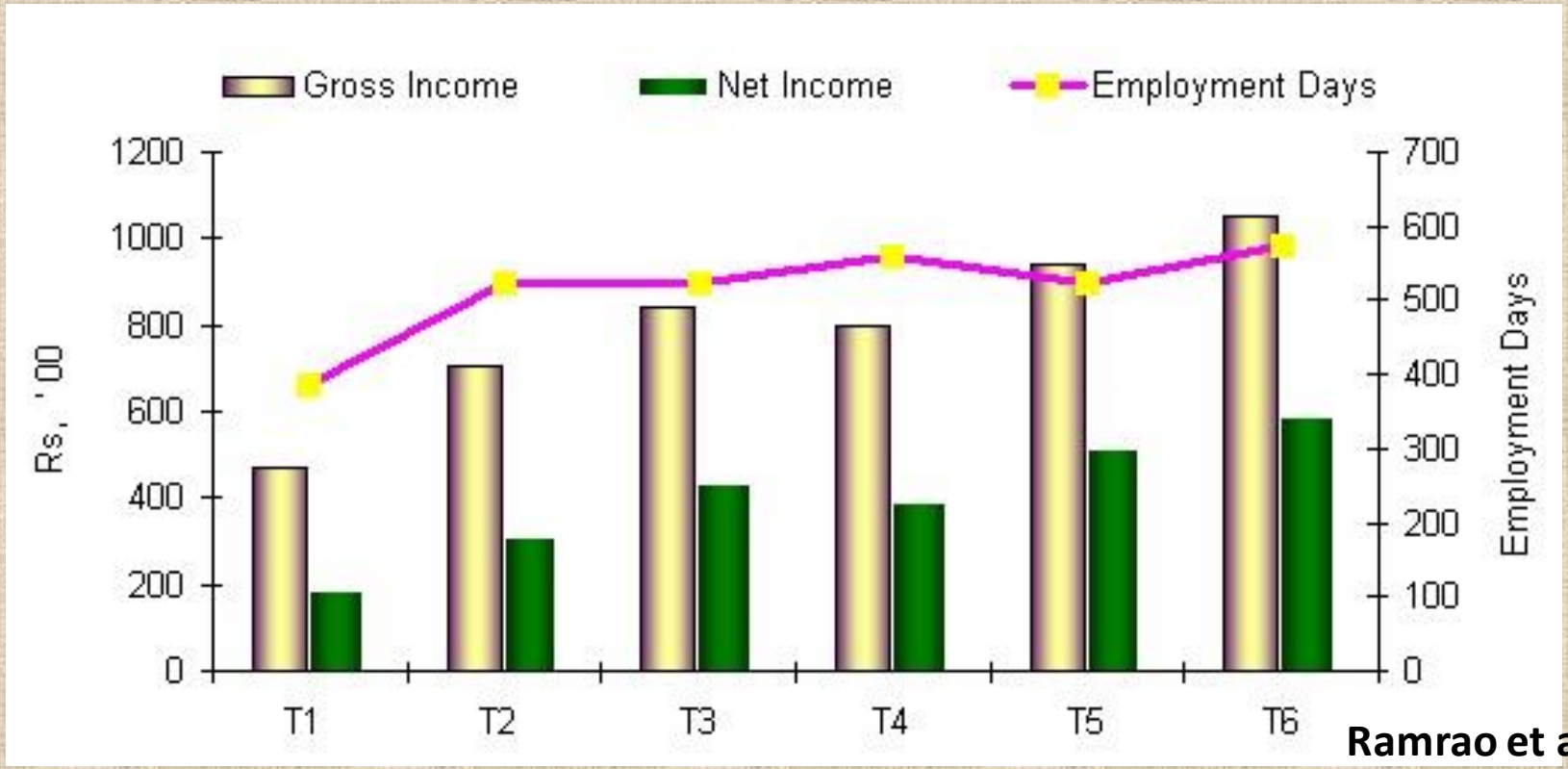
(Shanmugam et al 2024)

Example 4. The modules formed for marginal farmers having 3.5 acre land holding

T1	Crop (3.5 Acre)
T2	Crop + 2 Bullocks + 3 Cows
T3	Crop + 2 Bullocks + 3 Buffaloes
T4	Crop + 2 Bullocks + 1 Cow + 2 Buffaloes
T5	Crop+2 Bullocks + 1Cow + 2 Buffaloes + 15 Goats
T6	Crop + 2 Bullocks+ 1 Cow + 2 Buffaloes + 15 Goats + 20 Poultry + 20 Ducks

Ramrao et al 2005

Income and expenditure in different mixed farming models for Small Holders



Ramrao et al 2005

T_1 (Crop), T_2 (Crop + 2 Bullocks + 3 Cows), T_3 (Crop + 2 Bullocks + 3 Buffaloes), T_4 (Crop + 2 Bullocks + 1Cow + 2 Buffaloes), T_5 (Crop + 2 Bullocks+ 1Cow + 2 Buffaloes + 15 Goats), T_6 (Crop + 2 Bullocks+ 1Cow + 2 Buffaloes + 15 Goats + 20 Poultry + 20 Ducks).

Integration of poultry with fish production

•In poultry-fish farming **500 birds** is enough to fertilize **one hectare pond** area.

• The yield of about **3.9t/ha/yr** has been obtained in composite culture system stocked **@8000 fish/ha**.

Fish used in practice :

•Silver carp- big head – herbivores – higher level of water (surface).

•Grass carp –carnivore- stay in middle.

•Common carp-omnivore – stay in bottom.

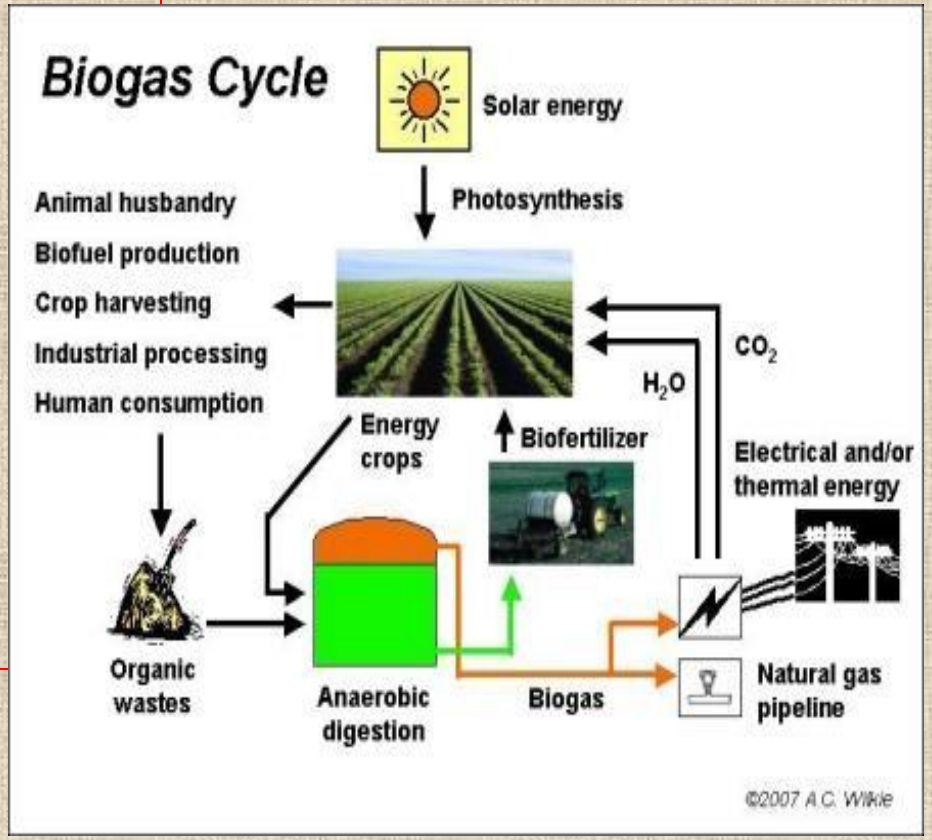
Cattle-Fish Culture

- The manuring of fish pond by using cow dung is one of the common practices all-over the world.
- A healthy cow excretes over 4,000-5,000 kg dung, 3,500-4,000 lt urine on an annual basis.
- Manuring with cow dung, which is rich in nutrients results in increase of natural food organism and bacteria in fishpond.
- A unit of **5-6 cows** can provide adequate manure for 1 ha of pond.
- In addition to 9,000 kg of milk, about 3,000-4,000 kg fish/ha/year can also be harvested with such integration.

Integration of goat farming with backyard poultry

Integrated Biogas Generation

- Renewable source of energy
- Biological decomposition
- Cheaper & better fuel
- Optimize the use of chemical fertilizer
- Solids are recovered – Tanks
- Effluent - protein rich feed for animals
- Used as a fuel and non - fuel



Biogas production

- Apart from manurial value biogas can be produced from livestock dung and poultry droppings.
- **32 kg of cow dung/20 kgs of pig faeces/12 kgs of poultry droppings** can produce **1 m^3 – 34 cft of bio gas**. the calorific value of bio gas –**500 to 700 BTU per cft** in comparison to Natural gas – **850 BTU/cft**.
- *BTU is British Thermal Unit. It's a traditional unit of heat. It is the amount of temperature required to raise 1 pound of water by 1 degree Fahrenheit.*

- **1 m^3 of slurry** fed to biogas plant produces on an average **0.15 to 0.20 m^3 of biogas** daily.
- Based on equivalent effective heat produced **2 m^3 biogas plant** replaces in a month fuel equivalent of **26 kgs of LPG** contained in standard gas cylinder or **37 litres of kerosene** or **88 kgs of charcoal** or **210 kgs of fuel wood** or **740 kgs of animal dung.**

Enriched organic manure for agriculture

Improving soil fertility and increase crop yield

Supplying additional NPK

Available macronutrient Present in the commonly available manures

Sl.no	Manure	N%	P%	K%
1	Fresh cattle dung	0.3-0.4	0.1-0.2	0.1-0.3
2	FYM	0.4-1.5	0.3-0.9	0.3-1.9
3	Compost	0.5-1.5	0.3-0.9	0.8-1.2
4	Poultry manure	1.0-1.8	1.4-1.8	0.8-0.9
5	Cattle urine	0.9-1.2	Trace	0.5-1.0
6	Paddy straw	0.3-0.4	0.8-1.0	0.7-0.9
7	Wheat straw	0.5-0.6	0.1-0.2	1.1-1.3

Pugalendhi (2001)

Nutrient content of animal and poultry manure (mg g dry weight^{-1})

	Cattle	Sheep	Pig	Horse	Poultry
Nitrogen	25-40	20-45	20-45	17-30	28-62
Phosphorus	4-10	4-11	6-12	3-7	9-29
Potassium	7-25	20-29	15-48	15-18	8-29
Calcium	5-8	8-19	3-20	7-29	17-69
Magnesium	5-8	3-6	2-3	3-5	3-8
Sulphur	3-4	2-3	3-5	1-3	4-7

Summary

- Integration of livestock to crop systems increases profitability, provides more labour, better resource utilization
- Choosing the right combination of different species or the birds depending on the farm resources is the key to successful integration

QUESTIONS?