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ANALYSIS OF LAND USE PATTERN IN INDIA

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Land is a crucial natural resource and an important determinant of a country's socio-economic and ecological health. Given the finite supply of land resource, sustainable use and management of land resources is a necessity for the well-being of people of a country. Like any other resource land has two dimensions, viz., quality and quantity, and both of these crucial aspects are under serious threat due to the intensive and extensive use of land both for agricultural and non-agricultural purposes(Ramasamy *et al.*, 2005). The layout or arrangement of the uses of the land is known as "land use pattern". With the rapid increase in population and development of urbanisation, the growing demand for resources, especially for cultivated land resources, has led to the conversion among different land uses (Bakker *et al.*, 2009). In India, the pressure exerted by the growing economy on land and other natural resources have intensified in post-liberalisation period and in the phase of burgeoning population the demand for the conversion of farm land for non-agricultural uses increases (Bardhan *et al.*,2010). Despite the fact that conversion of farm land has serious implication on national food security, ecological security, as well as sustainable land resource use, the conversion of farm land for non-agricultural purposes is continuing in India (Manikandan, 2016).

Land-use change has broad lines of impact, with a potential for influencing economic growth, quality of life, management of environmental resources, and national food supply. FAO defines the land use as "the human activities which are directly related to land, making use of its resources, or having an impact on them". Land use pattern is the layout or arrangement of the uses of the land. The land may be used for agriculture, forest, pasture etc. Simply it is the "The management of land to meet human needs".

Evolution of Land Use Statistics

- The evolution of land-use statistics in India dates back to 1866 when the British administration took interest in the compilation of land data to enhance its revenue collection.
- The recommendations of the Royal Commission on Agriculture in 1928 further strengthened the statistical system and increased the coverage.
- The need for reliable data on area under food crops and food production was felt when there was shortage of food and the great famine of India just after the Second World War.
- The statistical system of the erstwhile British era identified 5 board indicators like 1) Forest, 2) area not available for cultivation, 3) other uncultivated land excluding current fallows, 4) fallow land and 5) net area sown.
- A "Technical Committee on Coordination of Agricultural Statistics" constituted by the Ministry of Agriculture in 1949 suggested to add four more categories to make it a 9-fold classification of the total land available.
- Those nine categories also have some deficiencies like we will not get the information on land under socially forestry, marshy land etc, which are actually important for local development plans. So there are suggestions to enlarge these 9 categories too.

Table 1: Land Use Classification

Sl. No	Category	Definition
1	Forest	All area classed as forests under any legal enactment or administered as forests, whether State- owned or private.
2	Land put to non-agricultural uses	All lands occupied by buildings, roads, railway, under water e.g. rivers, canals, etc
3	Barren and uncultivable land	Land under mountain, desert, etc
4	Permanent pastures and other grazing land	All pastures and grazing lands permanent or not
5	Land under miscellaneous tree crop	All cultivated land which is not included under 'net area sown' but put to some agril. uses (bamboo bushes, thatching grasses and other grooves)
6	Cultivable waste	Land available for cultivation whether taken up or not taken up for cultivation once, but not cultivated during last 5 years or more in succession.
7	Fallow other than current fallow	All land which was taken up for cultivation but is temporarily out of cultivation for a period of not less than 1 year and not more than 5 years.
8	Current fallow	Cropped area which is kept fallow during the current year
9	Net area sown	Area sown with crops and orchards etc.

For simplicity, 1) Area under non-agricultural use 2) Barren and uncultivable land are together called as "Area Not Available for Cultivation " and 1)Permanent pasture 2) Land under miscellaneous tree crop 3) Cultivable waste are called as "Other uncultivated land excluding fallow land".

India which is the seventh-largest country with an area = 3,287,263 sq.km, occupies 2.4 % of the total land area of the world and supports 18 percent of the world population. Out of a geographical area of 329 million hectares (ha), statistics are available only for 305-307 million ha which makes some areas to the extent of 7% still not covered or classifiable under the nine-fold classification. Because for some parts of Arunachal Pradesh data is not available due to issues with China and also for parts of Jammu and Kashmir due to issues with Pakistan.

When we compare some parameters between years just after the independence and for now like Population density(people per square km) was 114.48 in 1950 and now it is 423.8, Per capita availability of agricultural land was 0.48 ha in 1950 and now it is 0.12ha. This shows that how crucial the land is becoming year to year.

Importance of Studying the Land Use Pattern

- It is a source of information for planning of agricultural production.
- It helps in assessing direction & extent of land utilisation.
- To frame policies to regulate land use.
- An analysis of structural changes in land use pattern over the period of time provides the scope for planned and judicial management of land.

Table 2: Land use pattern in India ('000 ha)

Land use category	1980-81	1995-96	2019-2020
Area under forest	67,460 (22.18)	68,817 (22.57)	71,750.9 (23.41)
Barren and uncultivable lands	19,958 (6.56)	19,009 (6.24)	16,541.6 (5.40)
Land put to non-agricultural uses	19,596 (6.44)	22,362 (7.33)	27,777.2 (9.06)
Permanent pastures and other grazing lands	11,989 (3.94)	11,064 (3.63)	10,479.8 (3.42)
Cultivable wastes	16,744 (5.51)	14,098 (4.62)	11,945.3 (3.90)
Miscellaneous tree crops	3578	3481	3,133.9

and groves	(1.18)	(1.14)	(1.02)
Current fallows	14,826 (4.87)	13,831 (4.54)	13,769.5 (4.49)
Fallows other than current fallow	9720 (3.20)	10,016 (3.29)	11,242.2 (3.67)
Net area sown	1,40,288 (46.12)	1,42,197 (46.64)	139,902.3 (45.64)
Total reported area	**3,04,159 (100.00)**	**3,04,875 (100.00)**	**306,542.8 (100.00)**

Note: Figures in parentheses indicate percentages to the total reported area
Source: Directorate of economics and statistics, MoAFW, GOI.

The share of "Area under non-agricultural use" has seen a drastic increase from 6.4% in 1980-81 to 9.1% in 2019-20, owing to rapid industrialization and urbanization. Whereas, the share of area under "cultivable wastes" has decreased.

State Wise Scenario of Land Use

Among all states Madhya Pradesh has the largest forest cover in the country with a share of 12.09 %, the thing that is helping the state to conserve its forest resource is "Joint Forest Management". For most of the remaining land use categories, Rajasthan has the highest share among all states since it is the largest state and we did not give consideration to the size of the state in this calculation.

Estimation of Location Coefficient

Location coefficient (L) is useful to identify the pattern of distribution of the given category of land across different regions of a country or state. This is defined as follows:

$$L = \frac{L_{ij} / L_i}{L_j / L_s}$$

Where Lij = area of j^{th} category of land in i^{th} State,

Li = area of all categories of land in the State (Reported area of the state).

Lj = area of j^{th} category of land in the country,

Ls = area of all categories of land in the country (Reported area of the country).

- A higher value for location coefficient for a State or region indicates the higher concentration of that particular category of land in that district or the region.

Table 3: Location Coefficient

States/Category	Forest	Not available for cultivation	Other uncultivated land excluding Fallow Land	Fallow Lands	NSA
Arunachal Pradesh	**3.97**	0.06	0.19	0.16	0.07
Chandigarh	0.94	**4.07**	0.23	0.14	0.28
Himachal Pradesh	1.05	1.71	**4.42**	0.27	0.25
Jharkhand	1.20	1.15	0.97	**3.81**	0.36
Punjab	0.21	0.75	0.05	0.23	**1.80**

Author's calculation
Source: Directorate of economics and statistics, MoAFW, GOI.

This calculation shows that Forest is highly concentrated in Arunachal Pradesh with Location coefficient value of 3.97, least concentrated in Punjab with L.C value 0.21.Area not available for cultivation is highly concentrated in Chandigarh and less concentrated in Arunachal Pradesh. Other uncultivated land excluding fallow land is highly concentrated in Himachal Pradesh and less in Punjab. Similarly, fallow land is highly concentrated in Jharkhand and less in Chandigarh and net sown area is highly concentrated in Punjab and less in Arunachal Pradesh.

Conclusion

Land is the basic resource; its allocation depends on population, technological changes and pace of economic development. From calculation it has been found that, land put to non-agricultural uses and fallow lands have shown a rising trend while net sown area is decreasing. Land use provides many economic & social benefits but at a substantial cost to the environment. With the increasing pressure of population, the only prospect of increasing food grain production and meeting the needs of food lie in expansion of cultivated area, reduction of fallow land, increase in net sown area and enhancing per unit yield of crops.

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UNVEILING THE POTENTIAL OF AI AND ML TO TRANSFORM THE LIVESTOCK INDUSTRY INTO A MORE SUSTAINABLE, EFFICIENT AND PRODUCTIVE SECTOR

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The world is witnessing a technological revolution that is transforming countless industries, and the livestock sector is not immune to this change. With the ever-increasing global demand for animal-based products, the necessity for sustainable and efficient practices in animal husbandry is more crucial than ever before. Artificial Intelligence (AI) and Machine Learning (ML) offer a paradigm shift in livestock management by providing data-driven insights and automation in various aspects of animal care. In this article, we delve deeper into the captivating world of AI and ML applications in livestock and explore how they are revolutionizing the industry, paving the way for a more sustainable and efficient future.

Precision Livestock Farming

Imagine a world where the individual needs of each animal are meticulously monitored and catered to, resulting in healthier livestock, reduced waste, and higher productivity. Precision Livestock Farming (PLF) is turning this vision into reality by using AI and ML to monitor and analyse animal behaviour, health, and productivity in real-time. Sensors, cameras, and IoT devices collect data on parameters like body temperature, weight, and movement patterns. This data is then processed by AI algorithms, providing farmers with actionable insights to optimize feeding, breeding, and medical interventions (Berckmans 2014).

Not only does this enable farmers to make well-informed decisions, but it also helps them maximize their resources and minimize environmental impact. For instance, AI-driven PLF systems can monitor and control the microclimate within livestock facilities, ensuring optimal temperature, humidity, and air quality. This not only improves animal welfare but also reduces energy consumption and greenhouse gas emissions (Norton et al., 2019).

Disease Detection and Prevention

Early detection of diseases is crucial for maintaining animal welfare and minimizing economic losses. AI-powered tools can analyse visual, thermal, and audio data to identify early signs of illness or stress in animals. For example, computer vision algorithms can detect skin lesions, lameness, or changes in behaviour, enabling farmers to take timely action (Halachmi et al., 2019). Furthermore, ML can help predict disease outbreaks by analysing historical data and identifying patterns, allowing for preventative measures to be implemented.

AI-driven diagnostic tools are also transforming veterinary medicine. For instance, machine learning algorithms can analyse blood, milk, or tissue samples to rapidly detect pathogens or biomarkers, leading to more accurate and efficient diagnoses (Raszek et al., 2016). This enables targeted treatments and reduces the unnecessary use of antibiotics, which helps combat the growing problem of antibiotic resistance.

Automated Milking Systems

The dairy industry has seen significant innovation with the introduction of automated milking systems (AMS) that utilize AI and robotics. These systems can identify individual animals, record their milking history, and adapt the milking process to optimize yield and animal comfort (Hogeveen et al., 2010). By streamlining operations and reducing labour requirements, AMS can lead to increased efficiency and improved working conditions for farmers.

AI-powered analytics can further enhance the benefits of AMS. By analysing milking data, farmers can gain insights into factors affecting milk yield and quality, such as nutrition, health, and breeding. This information can then be used to optimize herd management and maximize profitability (Rutten et al., 2010).

Optimizing Breeding Programs

Genomic selection is a game-changing approach to animal breeding, using AI and ML to analyse vast amounts of genetic data. These techniques help identify animals with the most desirable traits for breeding, such as high productivity, disease resistance, or improved feed efficiency. By accelerating genetic progress, AI-driven breeding programs can lead to healthier, more productive livestock populations.

AI and ML can also play a crucial role in managing genetic diversity within livestock populations. By analysing complex genomic data, these tools can help farmers

Identify and maintain an optimal balance of genetic traits, ensuring long-term sustainability and adaptability of the herd.

Environmental Impact Reduction

Livestock farming is a significant contributor to greenhouse gas emissions, and AI and ML can play a crucial role in mitigating this impact. By optimizing feed formulations and management practices, these technologies can help reduce methane emissions from enteric fermentation and improve overall resource efficiency (9). For example, AI-driven systems can analyse data on individual animal performance, feed composition, and environmental factors to recommend optimal feeding strategies that minimize waste and emissions.

Additionally, AI-driven pasture management systems can help maintain soil health and prevent overgrazing, contributing to a more sustainable livestock industry (Berckmans 2014). By combining satellite imagery, weather data, and IoT sensor information, these systems can help farmers make data-driven decisions on grazing rotations, fertilizer application, and irrigation scheduling.

Supply Chain Optimization

AI and ML can also streamline the livestock supply chain, leading to increased efficiency and transparency. For instance, AI-driven traceability systems can track animals throughout their life cycle, providing valuable information on health, welfare, and environmental impact. This data can be used by farmers, processors, and retailers to optimize operations and ensure the highest standards of quality and sustainability are met.

Furthermore, AI-powered demand forecasting and inventory management systems can help reduce waste by predicting consumer demand and optimizing supply chain logistics. By minimizing spoilage, transportation costs, and resource consumption, these tools can contribute to a more sustainable and profitable livestock industry.

Conclusion

The applications of AI and ML in livestock management hold immense potential for a more sustainable, efficient, and humane future. By embracing these cutting-edge technologies, farmers can ensure the well-being of their animals while meeting the ever-increasing global demand for animal-based products. As we continue to explore the possibilities offered by AI and ML, the livestock industry will be at the forefront of innovation, paving the way for a brighter and more prosperous future. Let us gear up and witness the remarkable transformation of the livestock sector, driven by the power of Artificial Intelligence and Machine Learning.

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FARM TECHNIQUES TO CARBON SEQUESTRATION

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By volume, the earth's atmosphere (dry air) is made up of 78.09% nitrogen, 20.95% oxygen, 0.03% carbon dioxide, and trace quantities of other gases. Carbon is found in all living species and is the primary component of life on Earth. Carbon is cycled between reservoirs, the atmosphere, seas, terrestrial and marine biota, and other reservoirs in the form of carbon dioxide, carbonates, organic molecules, and so on. According to Stewart and Hessami (2005), natural processes such as photosynthesis (the intake of carbon dioxide by plants), respiration (the release of energy and carbon dioxide), dissolution, and carbonate precipitation assist carbon exchange. Climate change is becoming an increasingly serious problem as the amount of greenhouse gases (GHGs) in the atmosphere increases. It might be regulated by reducing GHGs, particularly carbon dioxide, and sequestering carbon in the soil. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide are the three most significant GHGs (N_2O). Human activities have raised the concentrations of CO_2, CH_4, and N_2O in the atmosphere by 30%, 145%, and 15%, respectively, since the industrial revolution (IPCC, 2007). CO2 is a unique GHG that traps long-wave radiation reflected from the earth's surface and is likely the only one that has a significant influence in plant physiology. CO_2 is responsible for 7.5% of overall global warming, because of the massive amounts of carbon dioxide already stored in these pools and their ability to continue soaking up carbon dioxide, soil, vegetation, and the ocean are all considered potential carbon dioxide sinks. Photosynthesizing plant absorbs carbon dioxide and stores it as biomass carbon in the terrestrial environment. When dead biomass decomposes through roots, carbon dioxide enters the soil carbon pool. Although the seas hold the majority of the earth's carbon, soils contain around 75% of the carbon pool on land, which is three times more than the amount stored in living plants and animals. As a result, soils play a critical role in sustaining a balanced global carbon cycle. Soil carbon sequestration is the process of transporting carbon dioxide from the atmosphere into the soil via crop leftovers and other organic substances in a non-reemitted state. This carbon transfer, also known as "sequestration," serves to offset emissions from fossil fuel burning and other carbon-emitting activities while improving soil quality and long-term agronomic production. Soil carbon sequestration may be achieved by management strategies that contribute large amounts of biomass to the soil while causing little soil disturbance, conserving soil and water, improving soil structure, and increasing soil fauna activity. Conservation agriculture, minimum/zero tillage, cover crops, crop residue, and organic agriculture are all management approaches for carbon sequestration in soils.

Conservation Agriculture

Conservation agriculture has demonstrated the ability to transform many soils from carbon sources to carbon sinks by sequestering it in soil. Conservation agriculture benefits agriculture by lowering erosion, increasing water infiltration, enhancing soil surface aggregates, reducing compaction through biological tillage promotion, increasing surface soil organic matter and carbon content, and regulating soil temperatures.

Minimum or Zero Tillage

Tillage should be kept to a minimum or non-existent. The primary goal of tillage is to provide a favourable soil environment for plant development. It is one of the key causes causing soil carbon reserves to deplete. When soil organic matter is exposed to air during tillage, it oxidizes, resulting in a decrease in organic matter (OM) content unless extra OM is returned to the soil via residues, compost, or other sources. Tillage destroys the pores left behind by roots and microbial activity. The impact on below-ground biology is not fully understood. As the energy from raindrops is dispersed, the bare surface-exposed following ploughing is prone to soil aggregate collapse. As a result, soil pores get clogged, water penetration decreases, and runoff increases.

Crop Residue

It is also feasible to transport carbon dioxide from the atmosphere into the soil by mixing crop wastes. This carbon transfer, also known as "sequestration," serves to offset emissions from fossil fuel burning and other carbon-emitting activities while improving soil quality and long-term agronomic production. Soil carbon sequestration may be achieved by management strategies that contribute large amounts of biomass to the soil while causing little soil disturbance, conserving soil and water, improving soil structure, and increasing soil fauna activity.

Cover Crop

The use of crops such as legumes and small grains for protection and soil enhancement between times of normal crop production is known as cover cropping. Cover crops increase carbon sequestration by improving soil structure and contributing organic matter. Nair *et al.* (2015) reported in their studies on six winter and summer cover crops grown in phytotrons at three temperatures in two soils, gravelly loam soil (GL) and fine sandy soil (FS), that among winter cover crops, the highest and lowest amounts of C accumulated were 0.597 kg/ m2 by *Vicia faba L.* and 0.149 kg/ m2 by white clover, respectively, in the FS soil. Sunhemp (*Crotalaria juncea L.*) gathered the most C (0.481 kg/m2) among summer cover crops, whereas castor bean (*Ricinus communis*) accumulated the least (0.0102 kg/m2) at 30^{o}C on GL soil. Following a full cycle of winter and summer cover crops, the mean SOC in the GL and FS soils rose by 13.8 and 39.1%, respectively, as compared to the respective soils.

Organic Matter

Organic agriculture is a comprehensive production management method that avoids the use of synthetic fertilisers, pesticides, and genetically modified organisms, reduces pollution of air, soil, and water, and improves the health and productivity of interdependent communities of plants, animals, and humans. FYM has long been regarded as a good source of organic matter for improving soil fertility. Potter *et al*. (1998) discovered that manure treatment resulted in the greatest quantity of C sequestration over a wide variety of soil and climatic conditions. Clay soil has the fastest rate of sequestration. Manure soils showed higher levels of soluble C and a slower turnover rate than control or treated plots.

Conclusions

Sustainable agricultural production methods are being encouraged due to the rising human needs and their effects on the environment. Using less-intensive and wisely planned farming techniques can stabilise the dependence of agricultural output on climatic change. In order to find farming systems that can manage the delicate balance between climatic change and agricultural productions, the agro-environmental attributes must be taken carefully into accounting this context; carbon farming offers a comprehensive and sustainable approach to managing land usage that is good for both the environment and society. It is well-known for its decreased GHG emissions and carbon sequestration, which mostly depend on the temperature, soil properties, vegetation, and land-use practices.

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HYDROPONICS FODDER CULTIVATION

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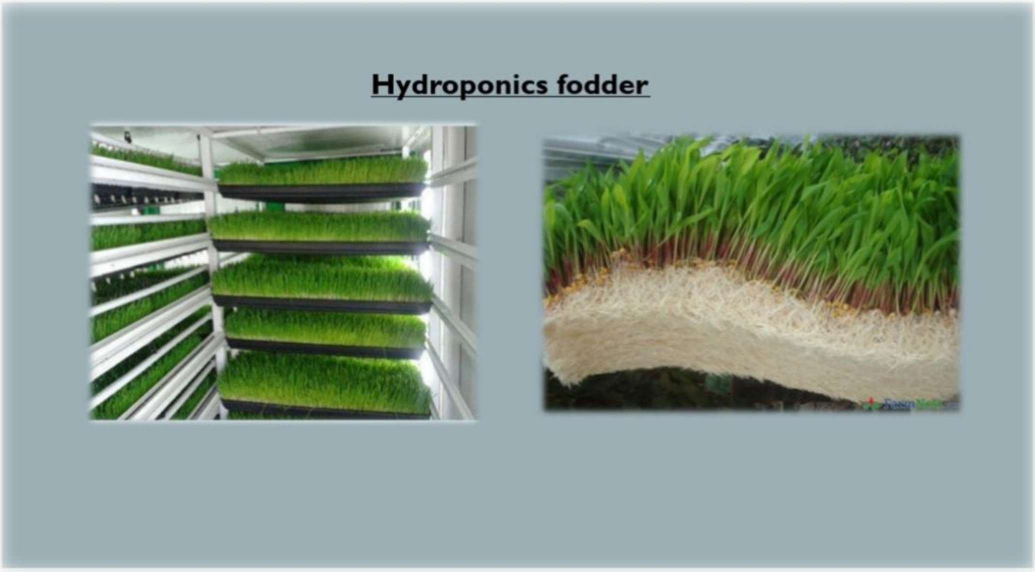
Hydroponics comes from the Latin language, 'Hydro' means water and 'Ponos' means labour. Hydroponics is a technology of growing plants without soil but in water or nutrient rich solution for a short duration in an environmentally controlled house or machine.

What is Hydroponics Fodder?

Fodder mainly refers to coarse food for livestock, composed of entire plants, including leaves, stalks, and grain, of such forages as corn and sorghum. And when the fodder is cultivated by growing seed without any soil but in water or nutrient rich solution known as hydroponics fodder. Within six-seven days, the seeds are sprouted, the seedlings will be up to 30-35 cm tall and provide highly nutritious fodder.



Characteristics of Hydroponics Fodder

1. Highly rich in vitamins, minerals and enzymes
2. Highly digestible (85% to 90%)
3. It contains high moisture which prevents colic
4. High energy content
5. It is a high quality protein source

Advantages of Hydroponics Fodder Cultivation

1. Saves water: It consumes 98% less water than other conventional methods and the water is reused.
2. Reduced growth time: It takes only 8 days to develop from seeds to fodder which is very much less than conventional methods (45 days).
3. Marginal land usage: By this method 1000 Kg green fodder can be produced from 480 sqft area daily which is equivalent to conventional fodder produced in 25 acres of cultivable land which is 99% less land than from conventional methods.
4. It requires minimal manpower and time, only 2 to 3 hours work daily.
5. Reduce the need for equipments and fuel used to plant, grow, harvest, transport and store feed.
6. Optimal production cost
7. Reduced feed cost: Hydroponics fodder contains more crude protein as compared to conventional fodder. It reduces the feed cost spent on the concentrate feed.
8. More nutritious: As the fodder contains seed along with fodder, it has higher crude protein content than conventional green fodder. Hydroponics green fodder with seed and root (sprout mat) is highly rich in protein (10% to 17%) and ideal nutrients enriched fodder for livestock.
9. Hydroponics fodder is grown by completely natural method without any chemicals or pesticides.
10. Constant supply: Fodder can be produced round the year irrespective of seasons, natural calamities, man power, unavailability of land which promotes the sustainable agriculture and livestock production.

Which Seeds can be grown as Hydroponics Fodder?

- Yellow Maize
- Jowar

- Bajra
- Ragi
- Cowpea
- Horse gram
- Foxtail millet
- Sunhemp

Requirements for Hydroponics Fodder Production

- Certain area for production of green fodder daily
- Hydroponics machine
- Clean water
- Uninterrupted power supply
- Seeds with good germination capacity
- Good sanitation
- Two labours

Protocol for Hydroponics Fodder Cultivation

1. **Seed storage and preparation:**

   i) One day prior to seed washing dry the seeds under direct sunlight.

   ii) Remove the broken seeds and dirt clean the seeds properly.

   iii) Store the seeds in a dry and safe place.

2. **Seed washing:**

   i) Take the good quality seeds and wash the seeds with proper scrubbing by hand then keep it 5 minutes for settling.

   ii) Remove the light weight floating seeds.

   iii) Drain out water and again add water. Stir manually by wooden stick for 5 minutes, keep settling for 5 minutes.

   iv) Drain water and repeat the above steps until dirt and dead seeds remove completely.

3. **Seed cleaning:**

   i) Prepare 0.1% cleaning solutions in a plastic chamber.

ii) Add washed seed to this prepared cleaning solution.

iii) Stir manually by wooden stick for 5 minutes.

iv) Keep for one hour and drain the he cleaning solution.

4. Seed soaking:

i) Prepare stimulant solution in the soaking chamber.

ii) Add seeds from the above step to soaking chamber.

iii) Close the lid and keep it for soaking for few hours.

iv) After soaking drain the stimulant solution.

5. Seed germination:

i) Place the 'after soaking seeds' within the fumigated gunny bags and keep it away from direct sunlight.

ii) Keep the lid open and keep for germination for number of hours.

iii) Sprinkle water on gunny bags every 2-3 hours so that gunny bags remain wet.

iv) After given hours remove the seeds from gunny bag and take weight.

v) About 35-40% increase in weight happen with 90+% seed germination.

6. Loading the seeds in trays:

i) The germinated seeds are loaded in a clean dry tray and distributed evenly. Put them in sprout section (lower section where the hight between two rows is around 5 inches) of machine.

7. Shifting of trays:

i) Shift trays to next level daily so that it moves one step ahead in the growth cycle.

ii) Take the last tray out from every row and put it back on the front side of the same row.

iii) Ensure that all trays receive sufficient water.

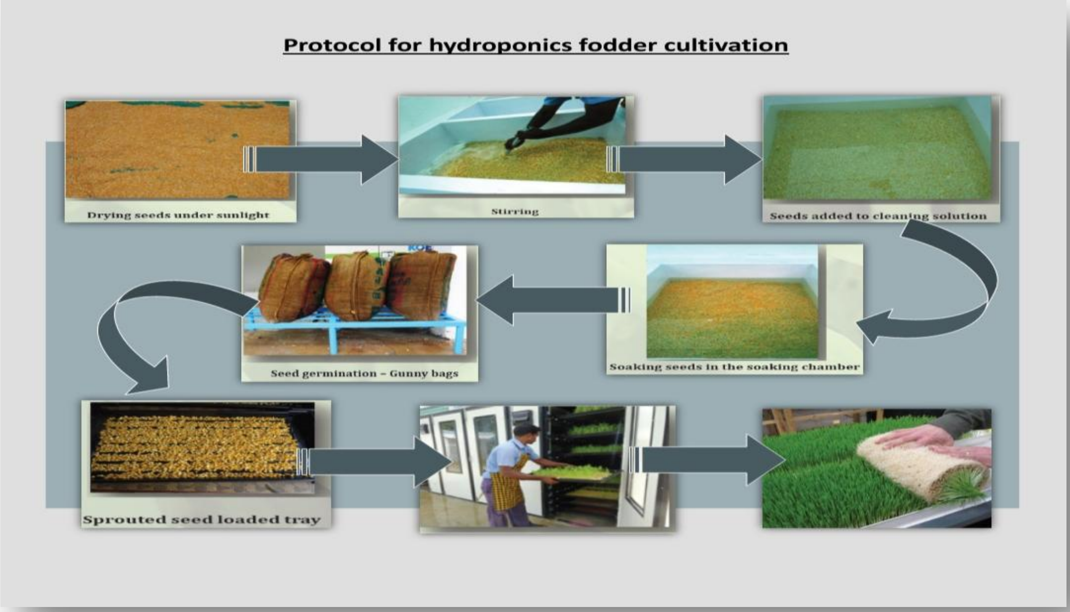
iv) If left side of the tray (in any tray) shows growth more than right side (or vice-versa) then rotate the trays such that left side comes to the right side and right side of the tray goes to the left side.

8. Harvesting (Day 9):

i) Trays on the 8th day it is ready for harvesting on next day.

ii) Take out the fodder mats from trays to feed livestock

iii) Wash the tray in cleaning solution before reusing it for next cycle.



Importance of Hydroponics Fodder in Animals as a Source of Feed

Hydroponics fodder sprouts are tender and young, the equivalent of fresh green grass. They are more palatable and nutritious to all types and classes of livestock. On a dry matter basis, hydroponic fodder compares favourably with other nutritious feed-stuffs. The fodder is suitable for meat animals also like sheep, goat, horses, rabbit, pig and poultry. Hydroponics fodder helps young ones to faster weight gain, improves the carcass quality. In adults it helps to increase litter size, increase fertility and ensure the high conception rate. In lactating animals, fodder increase the lactation period, helps in higher milk yielding and the milk contains high fat percentage. Incase of poultry 7 days old hydroponics fodder is little bit tough to digest. 4 days old fodder is best for poultry digestion. If fodder fed after 7 days, the farmer fed to chicken with any dry commercial feed in flour form is good. Usually mix it up at a ratio of 100g of hydroponic fodder to 30g of commercial feed. The chicken has responded well to this, with a faster weight gain, larger eggs and certainly no constipation. All this with the added advantage of reducing the feeding cost.

Sl. No	Type of hydroponic fodder	Day of growth	Moisture %	% Dry matter basis				
				CP	CF	EE	TA	NFE
1.	Maize	8	76.75	10.55	5.51	4.62	1.80	77.52
2.	Horse gram	4	90.18	30.26	13.00	2.06	5.43	49.25
3.	Sun hemp	4	77.07	38.73	13.11	4.64	4.48	39.04
4.	Cowpea	4	77.93	27.84	6.51	1.93	4.88	58.84
5.	Bajra	4	74.80	9.22	4.16	4.57	1.49	80.56
6.	Ragi	4	87.86	10.62	8.80	2.52	2.95	75.11
7.	Foxtail millet	4	75.08	14.69	12.11	5.38	3.59	64.23
8.	Jowar	8	90.06	13.27	13.39	4.99	2.98	65.37
9.	Moth bean	8	94.37	38.83	18.91	2.63	6.61	33.02
10.	Saamai (Little millet)	8	83.60	13.46	15.74	4.75	8.11	57.94
11.	Varagu (Kodo millet)	8	80.97	8.87	15.21	3.15	4.08	68.69
12.	Kuthiraivaali (Sanwa millet)	8	86.40	10.70	19.61	4.39	11.60	53.70

Proximate analysis was done as per methods of AOAC, 2000.

Table 1: Nutritional composition of hydroponics fodder at different stages of growth

Conclusion

Hydroponics is a technology for soil less growth of plants, taken up in a big way by the dairy and poultry farmers, especially, by those who have less land as well as scarce conditions for fodder production. It can be concluded that hydroponics fodder can be used as an ideal source of green fodder for livestock, poultry and other meat animals, effective in improving growth performance, digestibility, milk yield, reduces the feeding cost.

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IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTIVITY

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Climate changes are referred to as shifts in average conditions in normal temperature and the weather pattern. According to FAO, the livestock sector contributes 40% to the agricultural GDP which provides 33% of total global protein and 17% of total global calories consumed. In addition to this, livestock provides livelihood, food & income source for parts of the community. Demand for foods of animal origin is highly growing due to increasing population and its urbanisation which implies that the livestock sector needs to expand. Climate change is mainly associated with an increase in global temperature. Studies suggest that mean global temperature may be 1.1-6.4ºC warmer by the year 2100 than in 2010. As the organ system of livestock is sensitive to change in physical, chemical, biological and climatic stimuli from the surroundings, change in climatic normal values affects the growth, milk & meat production, wool production, adaptation capacity and reproduction rate of the livestock which may result in retrogressive graphs in productivity of livestock. The difficulty faced by livestock is due to extreme weather conditions such as floods, intense heat waves and droughts, which count as direct effects which can lead to production losses as well as events like livestock death. Climatic fluctuations and extreme conditions can lead to retrogressive change in quality and quantity of herbages which livestock consume, which count as an indirect effect, ultimately lead to deterioration of livestock health and productivity. Also, livestock contribute to emission of greenhouse gases (GHGs) directly or indirectly. In this article, we have included the adverse impact of climatic changes on livestock productivity which will help in better understanding of the reasons and its effects.

Effects of Climate Change on Livestock

A) Direct Effect

Direct effect of climate change on animals is through “Heat stress”. This involves humidity, air temperature and air movement altogether.

1. **Effect on feed intake-** 1. Heat stress lowers the feed intake and feed conversion ratio which causes a decrease in average daily weight gain of the animal. Which ultimately leads to low body condition scoring. This results in hindrance in normal growth of the animal. 2. In poultry birds, increase in temperature can lead to a 9.5% decrease in feed intake and ultimately leads to lowering of feed conversion efficiency.

2. **Effect on animal production-** 1. Heat stress affects not only milk quantity but also deteriorates milk composition. 2.In lactating animals, an increase in temperature activates the stress response system. In response to this, the dry matter feed intake of dairy cows decreases. This results in negative energy balance in them. Also, during heat stress, most of the energy is used by animals to adapt to the increasing temperature. So, the energy requirement would not be enough to cover the daily requirement for milk production.3. Decline in milk yield, low solid not fat (SNF) low protein content.

3. **Effect on animal reproduction-**1. Temperature decreases the oestrus expression and conception rate which leads to low rate of fertilisation.2. In males as spermatogenesis is temperature sensitive, rise in temperature causes low semen quality, low testicular volume and a poor sperm fertility rate. 3.Poultry reproduction also seems to be affected by heat stress. Environmental stress can delay the process of ovulation, results in reduction of yolk quality and affects hatchability.

4. **Adaptive effects-** 1. The adaptive effects such as, increase in water intake,rise in rectal temperature, rise in cortisol level are evident.

5. **Effect on development of pathogens/ susceptibility to disease -** 1. Rise in temperature may cause an increase in rate of development of pathogens or parasites that spend some of their life cycle outside their animal host. 2.Due to high temperatures, many countries become susceptible to increase in animal diseases and

poor countries become more prone to emerging diseases. This lowers the graph of productivity of livestock.

6. **Morbidity and mortality effects-** 1. Livestock become more susceptible to diseases such as mastitis,tick borne diseases as heat stress negatively affects the immunity of the animal. This leads to increased morbidity and mortality in livestock.

B) Indirect Effects

As for growth and development of animals, good quantity and quality of forage must be fed to them. Adequate water content in the body gives quality milk and meat products. Feed of livestock includes forages and grain or oilseed crop plants mostly. Production of these is affected by change in temperature, water supply, soil moisture, etc which ultimately changes the productivity of livestock.

1. **Forage quality -** 1. Proper weight gains and good production and reproduction in animals requires good nutrition, both in quality & quantity. Change in climatic conditions from their favourable ones can lead to increased content of lignin and results in reduced digestibility in animals. 2. Some plants (C4) show a retrogressive effect of increased $CO2$ concentration too, which lowers the availability and quality of crops. It also produces toxicity in plants & decreases proteins and minerals in plants. This combined results in ingestion of poor quality of feed by livestock.

2. **Water resources -** 1. Water requirements of plants and animals increases as the hotter and drier conditions in the environment appear, especially in the water stressed regions.2. In the extreme conditions like drought and floods, the quality of water consumed by the animal decreases, through increased salts, sediments, nutrients, toxic substances, and pollutants in water. This results in poor health and toxic effects on livestock.

C) Effect of Emission of GHGs From Livestock Production Itself

How does livestock farming contribute to greenhouse gas emission?

- In the livestock farming practice mainly two gases are produced which are, Methane & nitrous oxide.
- According to studies, Animals which are raised for food add to about 16.5 percent of greenhouse gas pollution globally.

- Ruminant animals which are reared for food purposes emit methane through "enteric fermentation" process during digestion of feed.
- Digestive part of these animals decomposes and ferment the parts of plants like starch, fibre and sugars. During this process, a toxic gas that is methane is released into the atmosphere predominantly through burps.
- Release of methane from livestock manure is also a source of emission.
- Various farm practices contribute to nitrous oxide pollution through application of fertilisers (Synthetic and Organic) for growing food for animals and humans both.
- An intensive grazing practice can lead to extensive deposition of large amounts of Nitrogen via animal excreta through faeces and urine, which is used to produce manure.
- Nitrification and denitrification of nitrogen present in manure leads to emission of N2O. This is how livestock production practices can lead to GHGs emission which ultimately leads to increased global temperature and has detrimental effects on them itself.

Conclusion

Climate change has an adverse effect on livestock production and productivity both in- direct and direct ways. Ever increasing population coupled with rapid industrialization play an important role in changing climatic scenario as evidenced with frequent occurrence of natural calamities, un-timely and inadequate rainfall. Agrarian country like India where more than 70% people depend upon agriculture and allied sector for their livelihood sustenance will face many adverse consequences due to the ongoing climatic change which needs to be addressed by the policy holders as well as all stake holders by adopting suitable necessary precautionary measures in times to come.

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