DRAFT DOCUMENT

ON NATURAL FARMING COURSE CURRICULLA FOR UNDER GRADUATE PROGRAMME

CONENT

33. Beneficial insects	Credits: 3 (2+1)	101-102
34. Bio-inputs for pest management	Credits: 4 (2+2)	103-104
35. Bio-resources and agricultural waste management	Credits: 3 (2+1)	105-106
36. Standards and certification for natural farming	Credits:3 (2+1)	107-108
37. Value chain management in natural farming	Credits: 3 (2+1)	109-110
38. Cow based natural farming	Credits: 3 (2+1)	111-112
39. Livestock and poultry production	Credits: 4 (3+1)	113-116
40. Goat and sheep based natural farming	Credits: 3(2+1)	117-118
41. Management of plant diseases	Credits: 3 (2+1)	119-120
42. Post harvest management i	Credits:3(2+1)	121-122
43. Post-harvest management ii	Credits 3(2+1)	123-124
44. Environmental studies and disaster management	Credits: 3 (2+1)	125
45. Communication skills and personality development	Credits 2 (1+1)	126
46. Agro-eco system analysis for natural farming	Credits: 2(1+1)	127
47. Indian Treditional Knowledge	Credits: 2(2+0)	128
48. Medicinal Plants	Credits: 3(2+1)	129-130
49. Valuation on ecosystem services	Credits: 3(2+1)	131
Total credits	**137**	

Executive summary

Agriculture is the science, art, or practice of cultivating the soil, producing crops and raising livestock and in varying degrees the preparation and marketing of the resulting products in congruence with the laws of nature.

Today, conventional farming is a common method of farming using external inputs and use of chemicals and fertilizers giving more emphasis on yield maximization rather than yield optimization leading to soil fatigue, high cost of production, declining factor productivity and causing imbalance in the ecosystem and lead to high dependency of the farmers on the market forces. Looking to the agro-ecological conditions and resources with the small and marginal farmers in India, natural farming is emerging as an alternative farming focusing on optimum utilization of native local resources according to principles of agro-ecology which are based on the cause and effect theory prevalent in the given niche land scape but in the same time follows the universal laws of nature for maintain balance among the components of ecosystem and wellbeing of human beings. Practices of natural farming are rooted in the concept defined by the Vrikshayurveda, the ancient Indian Science of plant life. The natural farming is gaining momentum in India and is being practiced over 6.5 lakh hectares of agricultural land in 11 states of the country (NITI Aayog).

As modern agriculture deals with the optimization of four elements of the nature viz. land, water, air and energy over a given space which has been is well described in the Vedic Agricultural System of India which considers the importance of rain, cloud, water, earth and land, heat or tejas and space. Without space crops cannot take shape. So, agriculture depends on all the natural phenomenon. Hence the *Śatpatha Brāmaṇa* says: *sarvade vatyā vai kṛṣiḥ (Vedic Heritage.* Ministry of Culture, Govt. of India*)*

Natural Farming emphasisze on use of chemical free practices and easily available farm resources which are manageable for better economy and conservation of nature in long term. It considers the principles of agro-ecology in its centre integrating crops, trees and livestock with functional relationship fulfilling the need of all living organisms. It helps to reduce dependency on purchased inputs and will help to ease smallholder farmers from s burden of high cost of inputs and promotes sustainable life. Natural farming is being promoted through Bhartiya Parmparagat Krishi Pariyojna (BPKP) in India to enhance production, sustainability, saving of water use, improvement in soil health and farmland ecosystem. The important aspects of natural farming it is considered as a cost- effective farming suitable for livelihood of large numer of farmers and rural development.

This type of farming practices based on ecological principles and laws of nature are being advocated by United Nation to promote sustainable food systems to enhance food and nutrition security. Under the alarming risk of climate change on agriculture, the practices of natural farming are the need of hour for sustainable agriculture and creating the green economy. India having the diverse agroclimatic conditions have many niche areas where natural farming principles can play a vital role to promote sustainable livelihood and reduce the risk of high input agriculture under given agroclimatic conditions and unpredictable shift in market based management of basic amenities of life.

Natural farming is based on the laws of nature which covers the universal laws of existence of the universe and its interaction with many cause and effect theories. The laws based on the various theories which are proven by the scientific facts may be in the past or in the present or in future but at the same time the practices following different theories should be the ultimate part of universal laws of nature. In this regard, Natural Farming as practice of farming is based on the adoptable and doable practices of farming in a given agroecology which covers the theories of science, a set of practices in the land scape for management of production processing, distribution and marketing and a social movement and has evolved over recent decades to expand in scope from its focus on fields and farms to encompass whole agriculture and food systems. Natural farming is a broader term which not only covers agro-ecological science but involves the other transdisciplinary fields encompassing socio-cultural, technological, economic and political dimensions of food systems from production to consumption. Natural farming, therefore involves all aspects of living harmony with nature based on the foundation of agro-ecological principles in context to setting up the universal sustainable food systems and healthy life.

Vision, Mission and Goals of Natural Farming

Vision

Ensuring a regenerative use of natural resources and ecosystems and thereby foster a socially equitable and sustainable global food system

Mission

Sustainable agriculture production with eco-friendly processes and practices in tune with nature.

Goals

1. To evolve a teaching-learning ecosystem for a comprehensive knowledge and skills of eco-friendly agriculture practices in its totality as a science, a set of practice and a social movement.
2. To develop a mechanism for teaching and study of a transdisciplinary science, combining different scientific disciplines to seek solutions to real world problems in agriculture at landscape-scale level, encompassing landscape ecology and, more recently, social science and political ecology related to the development of equitable and sustainable food systems.
3. To ensure application of a set of practices for harnessing the ecological processes as a system approach for the production system being equitable, environmentally friendly, locally adapted and controlled.
4. To focus on a system approach embracing management of interactions among components, rather than focusing only on specific technologies in agriculture.
5. To create a knowledge, innovation and entrepreneurship support system for nature based farming through a collaborative community of different stakeholders in the society.
6. To focus on technology upgradation and capacity building of youth and stakeholders in natural farming.

1. Introduction

Education is vital for each individual in the country as it is not only for creating awareness of a subject matter but also for broadening scope of work. As per NEP-2020, the education should provide all opportunities to children and youth for being skilled and be more flexible for better life opportunities. The centre of education must help the students and the educators to flower naturally. It should be realistic, otherwise education becomes nearly a mechanical process oriented to a career, to some kind of profession.

Career and profession, as society now exists, are inventible, but if we lay all our emphasis on that, then the freedom to flower will gradually wither and if right kind of education imbibing culture and civilization is not provided to youth, the narrow conditioning of youth with limited background and approach will give narrow grooming to teaching and learning.

Creating new and sustainable food systems that can support the world's population is going to mean rethinking the fundamentals of farming, from the resources used, to where it happens and its basic relationship with nature.

There are few human activities that have changed the world's landscapes and environment more than farming. Fields of crops and pastures for animals occupy an extraordinary 40% of available global land. But the way we grow food on these vast swathes of land is putting increasing pressure on nature.

Growing demand for food has polluted much of the world's water, soil and air with excess fertilisers and chemical sprays, which are remarkably inefficient. Up to 98% of a crop spray won't stay on the plant but will instead bounce straight off, accumulating in the soil and eventually running off into waterways. At the same time, conversion of land from wild spaces to farming is driving biodiversity loss, as wild plants and animals have less space to live in.

Is it possible to transform the way we farm so that agriculture doesn't compromise the natural environment? Because of the sheer scale of the world's agriculture, it seems like a gargantuan task. But farmers and researchers are already developing the tools that will be needed to make it happen. The practices of natural farming based on ecological principles, used wisely, is one of them.

The country adopted the Green Revolution model—an input- and chemical-intensive model—in the 1960s to increase food production. The focus was on development of new seed

varieties and increased use of synthetic fertilizers and irrigation for increasing food production. This approach succeeded in increasing food production but failed the test of sustainability.

UNO and FAO have urged to adopt strategies achieving sustainable goals by 2030 by all the countries. It is very important to mention that out of 20 SDGs, 11 SDGs are based on the overriding concern for nature and protection of natural resources. The modern agriculture in the world and India has resulted in high productivity of crops and thereby ensuring the food security but at the same time it has resulted into problems of declining soil fertility, over use of water, pesticide pollution, decreasing biodiversity, high cost of production, crop failure and indebtedness among farmers besides inequity and inequality in society and greedful competition for maximization of yield and income without concerns of nature.

In this background, the concept of Return Towards Nature, "Family Farming" Alternative Agriculture, Ecofriendly Agriculture, Organic Farming, Natural Farming, "Green Economic Development" have been advocated at national and international level. These alternative forms of agriculture have been the part of on-going B. Sc. (Ag.) degree courses, PG & Ph. D. courses implemented by different SAUs/ Institutions under Agriculture Education Division of ICAR, New Delhi. However, looking to the Internationally & Nationally perceived 'Resource Danger', India being the country of maximum youth population, the change of mindset of youth and large population, there is a need of realization for development of a focused curricula giving overriding concern for nature and its resources as a way of agriculture practices, as a way of profession and as a way of life. This requires that the whole teaching and learning environment need to get a new dimension which can lead to better awareness, skill development and experience in agriculture development through natural farming emphasizing harmonization of five basic elements of universe (Air, Fire, Water, Land & Space). This includes maximization of production and ecosystem health and wellbeing based on ecological principles and law of nature. It is a challenging one but India has a glorious ancient history in agriculture which will give the way for wholesome life development for world community. We envisage & reemphasize the concept of "Vasudhaiva Kutumbakam" which means "The world is one family" and emphasizes on integration of all human developmental activities with nature and lead to harmony of all components on this earth system. Proper education in society towards commitment for nature can bring a new paradigm shift in farming throughout the world. New ecological innovations and business models are emerging throughout world to redesign the global food system which is more sustainable with zero harm to nature. In this background, the degree course on Natural Farming has been envisaged.

2. The context of Indian agriculture

Agriculture is the basis of livelihood of more than 58 per cent of population in India. It is the largest private profession in our country. It contributes about 20 per cent to the GDP of the country. India has an advantage of demographic dividend having 52 per cent of total population as youth.

The food grain production, which was merely 51 million tons (Mt) in 1950/51 increased over 6 times to over 314 Mt in 2022. The country has also become the largest producer of milk, pulses and jute and second largest producer of rice, wheat, cotton, fruits and vegetables in the world. India is also one of the leading producers of spices, fish, poultry, livestock and plantation crops. However, Indian agriculture continues to battle several intimidating challenges of increasing productivity, profitability and resilience at the backdrop of increasing population, depleting natural resource base, aggravating climate change and reducing farm income. We are now reimagining the Indian agriculture and prioritized for enhancing farmers income (200%), reducing fertilizer use (25%) and water use (20%), increasing use of renewable energy (50%), reducing greenhouse gas emission intensity (45%) and rehabilitating degraded land of 26 million ha (mha).

India, being a signatory and prominent member of the United Nations, has several international commitments such as Panchamrit and carbon neutrality, land degradation neutrality, biodiversity conservation, regional agricultural development and Sustainable Development Goals (SDGs). Fortunately, over the years, the concerns for environment, health and ecosystem services have opened new avenues for addressing the challenges and fulfilling the priorities and commitments in right of over riding concern for law of nature in farming and management. The main aim for promotion of Natural farming is elimination of chemical fertilizers and pesticides usage and promotion of good agronomic practices. Natural Farming also aims to sustain agriculture production with eco-friendly process in tune with nature to produce agricultural produce free of chemicals. Soil fertility and soil organic matter is restored by natural farming practices. Natural farming systems require less water and are climate friendly (Economic Survey, 2021-22).

3. Issues and challenges for Indian agriculture

3.1 Declining numbers of farmers in the country

While the share of Indians working in the agriculture sector is declining, agriculture—along with its allied sectors such as livestock, forestry and fisheries—is still the largest source

of livelihood for India. As per the Lok Sabha Standing Committee on Agriculture (2019–20), agriculture and allied sectors employed 54.6 per cent of the total workforce in India. About 70 per cent of rural households still depend primarily on agriculture for their livelihood. As per the Agriculture Census of 2015–16, about 146 million farming families in India have operational landholdings for agriculture use. Around 85 per cent of these farmers are small and marginal, with landholdings of 2 ha or less. The share of agriculture and allied sectors in the Gross Value Added of the country at current prices—the value of goods and services produced in an area, industry or sector of an economy—has declined from 18.2 per cent in 2014–15 to 16.5 per cent in 2019–20.

As the agricultural development progressed, the food production increased substantially but with a heavy cost to soil health and the environment. Widespread land degradation, spatial and temporal variability of monsoon rainfall resulting in frequent drought and floods, deteriorating soil health, low nutrient and water use efficiency, low water productivity and less remunerative prices to farmers are some of the major challenges in the agriculture today. As the Indian agriculture is typified as small holders farming, the major burnt of these challenges are faced by this vulnerable class of farmers. The vulnerability of these households to climate change is very high due to diversity and less capacity to purchase the inputs. These factors have forced the farmers to leave the agriculture.

3.2 Farmers' livelihood

According to a 2013 National Sample Survey Organisation (NSSO) survey, 52 per cent of the farm households in India are in debt. The disparity between farm incomes and non-farm incomes is high—those who work outside agriculture are progressing much faster than those who work within it. The cost of cultivation has risen much faster than prices of farm produce, and the government's policies push for the low prices of food produce.

As per the survey, net savings of around two-thirds of agricultural households of India is negative, i.e. their expenditure is more than their earnings. The rising cost of cultivation, non-remunerative prices for farm produce, indebtedness, farm-related suicides, lack of interest in agriculture among rural youth, migration of agricultural labour to non-farm jobs and labour shortages have clearly emerged as the main issues. The climate emergency has further aggravated the farm situation due to increased incidence of crop losses related to extreme-weather events.

Depopulation of rural areas results in a reduction of the agrarian population needed to produce food, with a projected reduction of ~12% between 2018 and 2050. For example, as per ISRO, human injudicious use of inputs and mismanagement of land continues to degrade

quality of 2.4 lakh ha farm area in India. Translated into food grain production, land degradation deprives India annually of 0.36 million tons. Migration of population to urban areas from villages results in a reduction of the agrarian population needed to produce food, with a projected reduction of ~12% between 2018 and 2050. Therefore, sustainable food production is crucial for ensuring food and nutritional security, overall development of human beings and is one of the underlying philosophies of the "2030 Agenda for Sustainable Development".

3.3 Imbalance and excessive use of pesticides and fertilizers affecting human health and environment

Use of synthetic fertilizers has been a major source of yield gains in agriculture as well as of environment pollution resulting both from their manufacture and their use in farming. The economic cost of environment pollutions in context where large quantities of fertilizer have been applied have often outweighed the economic value of increased agricultural yield. Use of fertilizer, often associated with pesticides and modern crop varieties, has been and still is subsidized in many contexts. Where inorganic fertilizer is used without organic additions, soil structure and biotic function may decline, contributing to land degradation. Small-scale farmers using recommended purchased inputs have sometimes become vulnerable to debt, especially where climate change exacerbates the risk of crop failure, while the use of fertilizer has been the foundation for other farmers to exit poverty. Knowledge gaps have been observed on locally appropriate strategies for maintaining soil fertility that are environmentally sustainable at the same time as being economically viable for farmers.

Although the 'Green Revolution' technologies had considerable positive impact initially, excessive use of chemical fertilizer in the states like Punjab and Haryana has caused destruction of useful microorganisms, insects and worms in soil. This has not only disturbed soil texture and its physico-chemical properties, but also caused serious damage to the sector in respect of both quantity and quality of production. For example, growth of agriculture sector in Punjab has stagnated since the 1990s largely due to improper combination of various inputs like chemical fertilizers. There was huge demand for foods in one hand and the farmers' aspiration for high profit on the other. As a result, the farmers used unlimited ground water as well as excessive chemical fertilizers and pesticides to increase production and yield. Positive effects of chemical fertilizers on production and yield motivated the farmers further towards greater use of these inputs. The consequence of such excessive use of chemicals beyond the limit of consumption of the plants has been absorption of the same by the soil causing secondary effects to the soil itself and the plants.

Today, pesticides have become the cornerstone of the predominant agricultural systems. The widespread use of persistent and systemic pesticides has become one of the main drivers of the decrease in ecosystem services and natural pest control, which fosters the use of even more pesticides. In parallel, the development of pesticide resistance, related to their high use, has also led to an increase in their use. This has resulted in the emergence of a "pesticide treadmill". Related to the simplification of cropping systems, pesticides are currently the main tool used to decrease the risk of production losses. In addition, the increase in farm size and the decrease in the relative share of family labour in relation to land and capital has continued throughout the last decades and resulted in an increasing recourse to external workforce. The low share of family labour in total labour force and the use of contract work are often accompanied by a greater use of pesticides. The objective of maximizing yield, which is not always led by economic rationality, can also contribute to high levels of pesticide use.

Furthermore, extension services remain dominated by approaches oriented to finding one solution to each problem, with little emphasis on systemic approaches that address a set of problems or propose changes in several aspects simultaneously. In addition, the lack of value chains for new crops that would help diversify crops is often identified as a main obstacle to agroecological transition and pesticide reduction. Beyond this issue, the lack of creating added value across all sectors is the factor that limits implementation of pesticide-free practices the most. Since the products from these practices are not sold at higher prices that conventional ones, farmers have no incentive to implement them. In specific sectors (e.g., fruits and vegetables), implementing pesticide-free practices can also be compromised by market demands for undamaged products. Undoubtedly, the market does seldom consider the impact of pesticides on human health or the environment.

Indeed, profound and disruptive changes in the entire agri-food sector are necessary to achieve this goal, from cropping systems to value chains. Agronomic, technological and organizational innovations must be developed along with appropriate economic incentives.

In contrast, our goal for research, and the agricultural sector in the longer term, is to stop using pesticides. Moving from curative crop protection to prophylaxis and pest regulation based on agroecological principles and targeting the entire upstream and downstream value chains are the basic principles of this new goal.

3.4 Sustainable food production

Increased use of irrigation, synthetic fertilizers and agrochemicals, especially since the Green Revolution in India, have resulted in inefficient use of resources, with IGP of India highlighted as a global hotspot for low water and nutrient efficiency. By 2016 in India, 60% of

the total land area was already under agriculture and a maximum of only 16% of the land area remains for potential conversion to agriculture, and much of this is unsuitable for cultivation. Per capita water availability has already decreased by 73.8% between 1950 and 2005 and is likely to decline further to 77.8% in 2050. Therefore, to meet increased demands for food on a shrinking area of available land and water resources, efficiency of crop production must increase. This needs on over riding concern for natural resource based self-sufficient food production. The agricultural growth in post-GR period has witnessed a 'Technology Fatigue' or 'Yield Fatigue', which will need a change in strategies giving focus on farming with ecological principles.

3.5. Declining soil health

The fertilizer response ratio (kg grain per kg nutrient) decreased by nearly four times (from 13.4 in 1970 to around 3.2 in 2010) in irrigated areas of the country. This ratio has further declined to 2.8 in recent years (Chaudhari *et. al.,* 2015). The organic carbon content has declined in Indian soils and in most of the soil organic carbon is less than 0.5%. Our soils are not only low in soil fertility but there is inadequate and imbalanced nutrient use. The current gap between annual drain of nutrients from the soil and inputs from external sources is about 10 Mt, which is likely to grow further. The excessive removal of native nutrients from the soil is one of the major causes resulting in poor soil health.

Indian agriculture is operating at a net negative balance of plant nutrients resulting in chemical degradation and poor soil health. Furthermore, the soils are also getting continuously depleted of secondary plant nutrients and micronutrients. It is pertinent to mention that the micronutrient deficiency in Indian soil is in the order of 36, 44, 23, 13, 8 and 4% for Zn, S, B, Fe, Mn and Cu, respectively (Shukla *et. al.,* 2018).

Worldwide, nutrient use efficiency (NUE) for cereal production (wheat, rice, maize, barley, sorghum, millet, oat and rye) is as low as 33%. The unaccounted 67% represents an annual loss of N fertilizer worth up to 72,000 crores in monetary terms (NAAS, 2005) and this can be reduced to a great extent by making application of organics (FYM/compost) and good agronomic practices.

3.6 Effect of climate change

World Bank revealed that India would lose 2.8% of its GDP by 2050 on account of climate change impacts causing significant reduction in living standards (Mani *et al.*, 2018). The major challenges for sustainable agriculture in the coming years include increase in rainfall, high inter-annual variability, intense and frequent heat waves, increase in temperature (1.5 to 4.0^{o}C) and rise in sea level (IPCC, 2021). According to the Government of India flagship

project ‘National Innovations in Climate Resilient Agriculture’ (NICRA), climate change in the absence of adaptation measures is projected to decrease yields in major crop which is 20 to 47% in rainfed rice, 3.5 to 5% in irrigated rice, 19.3 to 40% in wheat, and 18 to 23% in maize between 2020 and 2080. By 2005, according to NBSS&LUP revised estimate, ~147 million ha (45.3%) of India’s land area was already degraded. These stresses may hit the small farmers the most. India has ~23% of small farms of the world. Hence, production systems of the small holders are risk prone and challenging. However, diversified agriculture and low cost nature based farming practices could help sustaining the natural resources and increase the income of small farms.

3.7 Risk prone rainfed agriculture

Currently, rainfed agriculture, which is rain-dependent, accounts for 55 per cent of the net sown area (139.42 M ha), and 61 per cent of India's farmer population. Rainfed agriculture is crucial to the country's economy and food security. Presently, it accounts for around 40 percent of the total food grain production, (85, 83, 70 and 65 per cent of nutri-cereals, pulses. oilseeds and cotton, respectively); supports two-thirds of livestock and 40 per cent of the human population. Further, the livelihoods of 80 per cent of small and marginal farmers is impacted.

Crop diversity in rainfed regions is striking with almost 34 major crops grown annually compared to 4 to 5 major ones in irrigated areas. Rainfed farmers follow a diverse portfolio of economic activities including horticulture, agroforestry, seed spices, medicinal & aromatic plants, fishery, livestock and beekeeping etc. This diversity in the production system imparts greater resilience to the country's rainfed agriculture, and diversifies the consumption plates necessary to address concerns of malnutrition. Rainfed agriculture is practised under a wide range of soil types, agro-climates, topography and rainfall conditions ranging from 400 mm to 1600 mm per annum. India's rainfed regions are characterized by complex climatic challenges, manifested as water scarcity for rainfed crop production. Rainfall is highly unreliable, both in time and space, with strong risks of dry spells at critical growth stages even during good rainfall years. Rainfed crops are prone to breaks in the monsoon during the crop growth due to water stress. In such areas, emphasis on nature based farming practices and easily adoptable good agronomic practices will help to reduce the risk of crop failure as well as reduce cost of production.

3.8 Poor productivity of livestock

Animal husbandry is an integral component of farming systems in India and is a significant source of revenue for farmers. Rearing of livestock - both large and small ruminants, serves as a source of liquidity and an economic cushion for rural farming communities. Livestock contribute 10 to 45 per cent to the agricultural GDP in the developing world and it is one of the fastest growing sub-sectors in agriculture (World Bank, 2009). They play an important multifunctional and socio-economic role. It is estimated that 70 to 90 per cent of the ruminant livestock (buffaloes, cattle, goats and sheep) are found in the rainfed mixed farms. The low productivity of livestock in rainfed agriculture is due to water scarcity resulting from the collapse of traditional water harvesting systems, and shrinking of common grazing resources leading to scarcity of fodder. Promotion of community based ecological and natural farming with protection of soil, water and vegetation will help in enhancing the productivity of livestock.

3.9 Resource poor farmers and inadequate credit availability

Marginal and small farmers are dependent mostly on informal sources of credit in almost all the states. The percentage of investment credit that is met from informal sources is 40.6 per cent, 52.1 per cent, and 30.8 per cent, for the landless, marginal farmers, and small farmers, respectively. This shows a lack of access to credit facilities and formal financial mechanisms for the majority of rainfed farmers who need it the most.Farming based on utilization of local resources and native ecology will help to earn livelihood to farmers at low investment.

3.10 Lack of remunerative marketing

Smallholder farmers in agriculture not only suffer from many production risks due to climatic vulnerability, but are also subject to market risks (high market and price fluctuation) that lead to unstable incomes. Further, farmers often sell their produce at low or sub-optimal prices due to unreliable market channels and unregulated markets and their poor withholding capacity arriving from their low rate of savings. This is further compounded by inadequate post-harvest handling and storage facilities which prevent farmers from stocking up and selling at the right time and accessing other markets. This necessitates strong infrastructure, institutional mechanisms, and support systems for farmers practicing agriculture based on eco-friendly practices and promote sustainability and social equity in society.

4 The need for paradigms shifts in the agriculture production strategy

4.1. A different policy framework than that of the dominant green revolution GR paradigm

The Green Revolution was designed around growing high-yielding varieties of wheat and paddy that responded to intensive use of water and agro-chemicals. The rainfed area were an obvious causality. The entire Green Revolution framework designed to fit the context of dependable availability of water is not a sustainable option in the rainfed system. Ironically, its adoption by farmers in rainfed areas due to the lure of assured markets, has only resulted in further ecological degradation and malnutrition. The agro-ecological and economic consequences of "a conscious Green Revolution strategy of 'betting on the strong' have long been clear", but to redress these persistent imbalances will require a strong, conceptually clear, self-reliant production and livelihood policy which keep the small and marginal farmers in centre and evolve the holistic development based on native ecology, local farms and community resources. Location based chemical free low cost agriculture emphasizing good agronomic practices in niche areas is the need of hour for sustainability and equity in agriculture.

4.2. The nutritional imperative

Despite overall economic growth in recent years, pockets of the Indian population suffer from hunger and malnutrition. The Global Hunger Index reveals that since 2016, hunger in India is growing and its 2021 rank is 101 out of 116 countries. India counts among the 31 nations in the world where hunger has been classified as "serious." Nutrition challenges that India faces, especially its women and children are expressed as low body mass index, under nutrition, anemia, wastage, stunting, and high infant mortality. A diversified and affordable agriculture production system with integration of crop, livestock, fruit vegetables and grass-based cropping system need to be promoted.

4.3. Farmers' distress and dire need for taking local, indigenous knowledge into account

Indian agriculture in the gamble with monsoon. More than 50 percent of land areas of the country are bestowed the most variable and unpredictable environments which render agriculture a risky proposition and less remunerative. Yet, there is rich cultural heritage and enough evidence to show, that traditionally, the rural communities knew how to harness this variability to support their economies, societies, and agro-ecosystem carefully breeding livestock and varieties of crops that can thrive in these vulnerable agriculture areas. Resource use practices and knowledge regarding the behaviour of complex ecological systems in diverse locations, that have evolved over generations through observation, verification and validation

within communities, need to be integrated as crucial inputs for decisions on rainfed agro--ecosystem. With ignorance of this wealth of knowledge within the policy framework, the general thrust of public investments into agriculture in India and market forces have led to a replacement of traditional land use practices with modern techniques. The nominal income returns and the risks associated in agriculture are seen to be resulting in seasonal distress migration as they realize higher income from wages in alternate non-farm activities. Therefore, rerouting of Indian agriculture with focus and attenution on community based natural resource integration with agriculture is the need of hour.

4.4. A holistic policy for accelerating the growth of rainfed agriculture with multiple social benefits

Agriculture is not only profession but a way of life in India. Agricultural practices in India in rural areas are fast changing due to modernization of habitats, food system mechanization. However, this has led for high cost of living and pressure of increasing the income from limited resources with the farmer and forcing them for technology intensification unaware of long-term risk and failure of production. As accelerating the growth of agriculture, a comprehensive approach for combating climate change, securing livelihoods, and improving nutrition is needed along with change in mindset for ethical use of natural resources. This policy will give direction to design programmes specifically for agriculture. Proportionate investments would be needed for the agricultural transformation of risk prone and less developed areas. The 3Es, namely Ecology, Economics, and Equity should guide the aims and objectives new agricultural policy. A robust policy and a structured framework for public investments would bring about an agricultural regeneration of arid, semi-arid and sub-humid areas resulting in multiple social co-benefits such as growth of agricultural income and generation of rural employment as well as reduction of poverty and malnutrition. The concomitant advantage expected is the reduced stress on irrigated systems, which are now asked to meet the increasing demand for food grains, which obviously results in resource extraction beyond sustainable levels. In this regard, ecological based agriculture through community participation can provide the long-term solution to social and livelihood problems also.

4.5 Growing awareness and demand for pesticides free and safe foods

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Natural Farming

Within the generic term 'Natural Farming', there are many sets of practices that could be labelled as agro-ecological or natural is not clear as scientific validation of such practices has been done as a part of common agriculture practices or as a part of organic farming but not as such based on the true principles being followed by many natural farming practitioners and proponents in abroad and India. So, there is a need to codify it in a broader basket of natural farming based on the ecological principles and practices in tune with nature.

There are many sets of natural farming practices which follow the law of science and agro-ecology and they are situation specific and cannot be replicated as such. As the scale of practices of natural farming increase in time and scale, advantage of natural farming increases. Natural farming principles also allows all the innovations which converge with the natural processes and domain of agro-ecological landscape. There is a difference in approaches for use

of external inputs and use of set of standards between organic and natural farming, though both have many common principles and practices.

Agriculture is agreeing with the culturing intelligence of Total Natural Law." defines agriculture as "The science and art of agreeing with the culturing intelligence of Total Natural Law in order to create fully nourishing and vital food, the basis of perfect health for the individual and the nation." Maharishi Mahesh Yogi.

Agro-ecological approaches and natural farming at the global level

In this context, in October 2017, the UN Committee on World Food Security (CFS) requested its High-Level Panel of Experts (HLPE) on Food Security and Nutrition (FSN) to produce a report on "Agroecological approaches and other innovations for sustainable agriculture and food systems that enhance food security and nutrition" to inform its discussions during the Forty-sixth CFS Plenary Session in October 2019. The report by The High-Level Panel of Experts on Food Security and Nutrition (HLPE), July 2019, indicated the need for the following transition pathways towards sustainable food systems that enhance food security and nutrition (Agroecological and other innovative approaches. A report by The High-Level Panel of Experts on Food Security and Nutrition. July 2019. HLPE Report 14):

1. Agroecology is a dynamic concept that contributes to transforming food systems by applying ecological principles to agriculture and ensuring a regenerative use of natural resources and ecosystem services while also addressing the need for socially equitable food systems. Agroecology embraces a science, a set of practices and a social movement and has evolved over recent decades to expand in scope from a focus on fields and farms to encompass whole agriculture and food systems. It now represents a transdisciplinary field that includes all the ecological, sociocultural, technological, economic and political dimensions of food systems, from production to consumption.
2. Agroecology is a transdisciplinary science, combining different scientific disciplines to seek solutions to real world problems, Initially the science was focused on understanding field-level farming practices that use few external inputs but high agrobiodiversity, emphasize recycling and maintenance of soil and animal health, including managing interactions among components and economic diversification. The focus has since expanded to include landscape-scale processes, encompassing landscape ecology and, more recently, social science and political ecology related to the development of equitable and sustainable food systems.

3. Agroecological practices harness, maintain and enhance biological and ecological processes in agricultural production, in order to reduce the use of purchased inputs that include fossil fuels and agrochemicals and to create more diverse, resilient and productive agroecosystems. Agroecological farming systems value, inter alia: diversification; mixed cultivation; intercropping; cultivar mixtures; habitat management techniques for crop-associated biodiversity; biological pest control; improvement of soil structure and health; biological nitrogen fixation; and recycling of nutrients, energy and waste.
4. There is no definitive set of practices that could be labelled as agroecological. Agricultural practices can be classified which:
    i. rely on ecological processes as opposed to purchased inputs;
    ii. they are equitable, environmentally friendly, locally adapted and controlled; and
    iii. they adopt a systems approach embracing management of interactions among components, rather than focusing only on specific technologies.
5. Social movements associated with agroecology have often arisen in response to agrarian crises and operated together with broader efforts to initiate widespread change to agriculture and food systems.
6. There have been many attempts to set out principles of agroecology in the scientific literature. This report suggests a concise and consolidated set of 13 agroecological principles related to: recycling; reducing the use of inputs; soil health; animal health and welfare; biodiversity; synergy (managing interactions); economic diversification; co-creation of knowledge (embracing local knowledge and global science); social values and diets; fairness; connectivity; land and natural resource governance; and participation.
7. An agroecological approach to Sustainable Food Systems (SFSs) is defined as one that favours the use of natural processes, limits the use of external inputs, promotes closed cycles with minimal negative externalities and stresses the importance of local knowledge and participatory processes that develop knowledge and practice through experience, as well as scientific methods, and the need to address social inequalities. This has profound implications for how research, education and extension are organized. An agroecological approach to SFSs recognizes that agri-food systems are coupled with social-ecological systems from the production of food to its consumption with all that goes on in between.
8. Agroecology is practised and promoted in various locally adapted forms by many farmers and other food system actors around the world. This debate revolves around the following three critical issues.

i. How much food needs to be produced to achieve Food Security and Nutrition (FSN); centred on whether FSN is mainly a problem of availability or more an issue of access and utilization?

ii. Could agroecological farming systems produce enough food to meet global demand for food?

iii. How to measure the performance of food systems, taking into account the many environmental and social externalities that have often been neglected in past assessments of agriculture and food systems?

9. There is no single, consensual definition of agroecology shared by all the actors involved, nor agreement on all the aspects embedded in this concept. There are emerging efforts to define which agricultural practices are agroecological or not, allied to discussions about convergence or divergence with organic agriculture, which is more prescriptive, and about the development and use of certification schemes.

10. There has been much less investment in research on agroecological approaches than on other innovative approaches, resulting in significant knowledge gaps including on: relative yields and performance of agroecological practices compared to other alternatives across contexts; how to link agroecology to public policy; the economic and social impacts of adopting agroecological approaches; the extent to which agroecological practices increase resilience in the face of climate change; and how to support transitions to agroecological food systems, including overcoming lock-ins and addressing risks that may prevent them.

11. Five phases have been identified by Gliessman (2007) in making agroecological transitions towards more sustainable food systems. The first three operate at the agroecosystem level and involve:

i. increasing input use efficiency.

ii. substituting conventional inputs and practices with agroecological alternatives; and

iii. redesigning the agroecosystem on the basis of a new set of ecological processes.

The remaining two steps operate across the whole food system and involve:

iv. re-establishing a more direct connection between producers and consumers; and

v. building a new global food system based on participation, localness, fairness and justice.

While the first two steps are incremental, the latter three are more transformative.

Present status of natural farming in India

Natural Farming is rooted in ancient Indian science, pointing out that "principles of natural farming are rooted in concepts defined by Vrikshayurveda, the ancient Indian Science of plant life", and over 6.5 lakh hectares of agricultural land in 11 states were already under this form of farming (Senior Adviser, NITI Aayog).

In Vedic Agricultural System, since rain is most essential for agriculture, Cloud is praised as personified deity (*takkṛṣiḥparjanyo devata*). Agriculture depends not only on water but also on all the five primal elements. For production of crops, all these *pañcamahābhūtas* are most essential in different forms. Earth or land or soil is the primary need for sowing seeds. Water supplies the essential sap for growing the plants, in the form of *rainfall* or irrigation from river etc. Without heat (*tejas),* growth is impossible. Air (*Vāyu)* is essential for fertility. *Maruts* are praised as grinder of soil (*pipiṣvatī*). Without space, crops can not take shape. So, agriculture depends on all the natural phenomenon. Hence, the *ŚatpathaBrāmaṇa* says: *sarvadevatyāvaikṛṣiḥ (Vedic Heritage.* Ministry of Culture, Govt. of India*)*

"Natural Farming will be promoted throughout the country, with a focus on farmers" lands in 5- km wide corridors along river Ganga, at the first stage. "States will be encouraged to revise syllabi of agricultural universities to meet the needs of natural, zero-budget and organic farming, modern-day agriculture, value addition and management" (India Budget 2022-23, Minister of Finance, February 1, 2022).

NITI Aayog (National Institution for Transforming India) explained natural farming as a chemical-free alias traditional farming method. It is considered as agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. In India, Natural farming is promoted as *Bharatiya Prakritik Krishi Paddhati Programme* (BPKP) under centrally sponsored scheme- *Paramparagat Krishi Vikas Yojana* (PKVY). BPKP is aimed at promoting traditional indigenous practices which reduces externally purchased inputs. It is largely based on on-farm biomass recycling with major stress on biomass mulching, use of on-farm cow dung-urine formulations, periodic soil aeration and exclusion of all synthetic chemical inputs. Referring to HLPE Report, NITI Aayog indicated that natural farming will reduce dependency on purchased inputs and will help to ease smallholder farmers from credits burden.

The BPKP programme has been adopted in State of Andhra Pradesh, Madhya Pradesh, Chhitisgarh, Karnataka, Himachal Pradesh, Gujarat, Uttar Pradesh and Kerala. Several studies have reported the effectiveness of natural farming- BPKP in terms of increase in production,

sustainability, saving of water use, improvement in soil health and farmland ecosystem. It is considered as a cost- effective farming practices with scope for raising employment and rural development.

NITI Aayog along with Ministry of Agriculture & Farmers Welfare had convened several high-level discussions with global experts on natural farming practices. It is roughly estimated that around 2.5 million farmers in India are already practicing regenerative agriculture. In the next 5 years, it is expected to reach 20 lakh hectares- in any form of organic farming, including natural farming, of which 12 lakh hectares are under BPKP (Natural Farming: Initiative).

Definition

"***Natural Farming in the Indian context is a holistic agricultural production system in tandem with the laws of nature to provide food for all living beings ensuring production without harming the panchmahaboota or panchtatva (Prithvi, Agni, Jal, Vaayu and Aakash)***.

Principles of Natural Farming

Based on philosophy and application factors, cause and effect relationship, natural farming has following four principles-

a. Principle of improved natural resource efficiency
b. Principle of self sustainability/no dependency
c. Principle of resilience
d. Principle of social equity/responsibility

Law of nature, in the philosophy of science, a stated regularity in the relations or order of phenomena in the world that holds, under a stipulated set of conditions, either universally or in a stated proportion of instances.

Laws of nature are of two basic forms: (1) a law is universal if it states that some conditions, so far as are known, invariably are found together with certain other conditions; and (2) a law is probabilistic if it affirms that, on the average, a stated fraction of cases displaying a given condition will display a certain other condition as well. In either case, a law may be valid even though it obtains only under special circumstances or as a convenient approximation. Moreover, a law of nature has no logical necessity; rather, it rests directly or indirectly upon the evidence of experience.

Source: Britannica, The Editors of Encyclopaedia. "law of nature". Encyclopedia Britannica,

Scope of Natural Farming (NF)

- **NF as a science:** Many practices like Organic Farming, Regenerative Agriculture, Rishi Krishi, Permaculture, Biodynamic Farming, Yogic Kheti, No till farming etc are based on the principles of agro-ecosystem approach and harnessing the natural cycles and inputs based on long term observations.
- **NF as a set of practice:** Low input based agriculture producers as well as small & marginal farmers have evolved many practices to reduce risk of crop failure and minimise cost of production. They have evolved the ecological practices over the years which are affordable and can be accomplished within resources available with them.
- **NF as a social movement:** Community based natural farming in Andhra Pradesh & Karnataka is being promoted by local bodies through community participation and has good potential in future. Now nature based farming practices are being promoted at global level for as an agro-ecological initiative in agriculture food system.
- **NF as an innovative approach** to sustainable food systems for food security and nutrition.
- **NF for convergence with organic agriculture:** NF practices are mostly part of organic farming standards and hence has a good scope of market opportunities and convergence.
- **NF for trade off advantages in carbon trading and climate mitigation:** NF helps to reduce ecological footprints and by registering NF farmers with carbon trading agencies, trade off benefits can be achieved.
- **NF for knowledge generation and sharing for achieving SDG by 2025:** Out of 17 SDGs set by UNO, 7 SDGs are directly linked with NF and hence have lot of international attention & opportunities for funding.
- **NF for risk management under low input resource conditions for small land holders:** NF helps in soil and water conservation, biodiversity promotion, carbon sequestration, enhanced water holding capacity and better ecological services. Community based natural farming can help to both and small land holders as well as to meet out national priority for ecological, food and nutritional security.

Advantages of Natural Farming

1. The main aim for promotion of natural farming is elimination of chemical fertilizers and pesticides usage and promotion of good agronomic practices. Natural Farming also aims to sustain agriculture production with eco-friendly process in tune with nature to

produce agricultural produce free of chemicals. Soil fertility and soil organic matter is restored by natural farming practices. Natural farming systems require less water and are climate friendly.

2. It aims to rural development as it improves the value of all forms of life including rural communities, by satisfying and sustaining their socio-economic and traditional aspirations besides firming their social association, while protecting natural resources.
3. It brings in the aspect of rural development as it combines tradition, innovation and science to help the environment, promote impartial relationships and thereby a superiority of existence for rural people.
4. Holistic approach to natural farming adds to rural progress in many ways and most important are:

- **Enhanced governance:** Farmer is kept at the centre of the farming strategy, reinstating a decision- making part to native groups, guarantees their right to manage their individual resources and gives them freedom for engaging themselves and actively participates in value-added sustenance.
- **Vibrant economic space:** Diversified production decreases the effects of crop failures and increases marketing chances. Income and food security is realized through multiplicity of crops and options under natural farming.
- **Healthy environment:** Integrity of the ecosystem and the productivity of natural resources are maintained through ecological approach being adopted under natural agricultural systems. It conserves natural and wild resources, reinstates life to soils and upholds agrobiodiversity. Ecological based agriculture practices provide a healthier working environment to farmers by reducing the use of chemical inputs.
- **Social capital for rural areas:** Being knowledge and skill intensive, rather than capital and resource intensive, it uses traditional information and promotes farmer-to-farmer interchange. Provides tools for review and control that strengthen social organization and authorize rural groups.
- **Sustains traditional food systems:** More and more farmers are dependent on only a few crops which demand considerable investments and create requirement on sometimes inaccessible and unsuccessful agri-inputs. Input costs are high and market prices remain to decrease making farmers and labors to think twice on cultivation. Farmers' knowledge of biological systems, setting and their conventional understanding play more role in making farming more sustainable.

- **Decreased damage to natural resources:** Using large quantities of chemical fertilizers and pesticides under monocultures provoke degradation of land and water, resulting in the loss of productive lands and ecological biodiversity can be avoided if local input based natural farming is adopted by the farmers.
- **Manages migration:** Migration to cities is increasing mainly on account of search of alternative avenues for employment leading to marginal urban communities there by reducing the ability to purchase quality food. Natural farming with a principle of crop diversity and reduced usage of agro-chemicals ensures the quality products at affordable rates for the rural communities with several options such as value addition, cottage industries and local employment etc.

Important considerations for natural farming in context of Agricultural Education System in India

- The current agri-food chain greatly depends on intensive use of inputs leading to adverse effects on health and environment. It has led for disruptive paradigm shift for ecological based solutions for problems in agriculture and ecosystem. This needs that interdisciplinary, focused, combined, shared & renewed knowlwdge and research in natural farming and thereby will require a profound and coordinated change in agricultural education paradigm too.
- Adoption of nature based farming requires the sound knowledge of agro-ecology and need long experience & skill to manage PanchaMahaBhootTatva (Air, fire, water, land and space) in a given space and ecosystem. It needs not only descriptive but analytical knowledge too for individual ecology and production system.
- Scale of operation in natural farming and its dependence on community participation decides the tangible and non-tangible benefits.
- Profitability in natural farming is not directly comparable to conventional commercial farming as it provides the ecosystem services and other opportunities for wellbeing of people and environment.
- Standard technologies for management of crops through natural farming in different ecologies need to be generated and documented for verification and replication.
- Standards for products of natural farming may be opted for value marketing and promotion of core principles of natural farming for ethical support to promoters of nature based life style and human civilization.

- It has a principal of self-dependency and inclusiveness of practices which is labour intensive and need personal care &long term planning for success.
- Planning and structural changes for sufficiency in indigenous cowdung, urine and other inputs in native ecology need effective policies and people's cooperation.
- Possibility of lower yield at different input levels and agro-climatic conditions during conversion period from conventional agriculture practices and mindset need Government and consumer's support.
- It needs more time for farm management and preparation of on farm inputs.

During the first meeting held at Education Division of ICAR at New Delhi on 11th April 2022, it was decided that the committee primarily focused on the definition of Natural Farming and to identify the components and sub components around which the proposed syllabus is to be developed. During the second meeting held at CAU Ranipool (Gangtok) Sikkim on 5th and 6th May 2022 finalization of definition and components and sub components to be covered for under Graduate programme and distribution of assignment with a provision to add/delete as the Syllabus evolved. During this meeting experts within the committee were identified and components were allocated to develop the syllabus. During the third meeting held at KVK Kolhapur on 22-23 May 2022, the syllabus developed by the committee was discussed in detail. Small Working Group Meeting was convened at MPUAT Udaipur 17-18 June 2022 and draft compilation of syllabus and course content was completed. Large working group meeting with stockholder /farmers' organizations/environmentalist/teachers/ researchers/educationist/ Vice chancellors at CAU Imphal 24th and 25th June 2022 was convened and well in advance draft document was circulated for necessary comments and inputs. At CAU Imphal, detailed discussion was done on the courses proposed along with the content. The Hon'ble DDG (Education) was also present during the deliberations. The suggestions were noted, Similar meeting of stakeholders was held at MPUAT, Udaipur in which scientists, state Govt. officials, students and farmers from Punjab, Haryana and Rajasthan participated. The suggestions received from all the stakeholders were duly considered and addressed while giving a final shape to this Syllabus

Component of Natural Farming

1. Natural Farming System
2. Crop/breed/strain improvement
3. Soil Health Management
4. Livestock Management
5. Plant Protection

6. Weather Forecasting
7. Biodiversity
8. Agronomic practices
9. Bio Inputs
10. Crop Management
11. Water Management
12. Farm Machinery
13. Renewable Energy Sources (Wind, Water, Solar)
14. Post Harvest Management
15. Bio Waste Resource Management
16. Nutrition and Health
17. Certification
18. Community Mobilization
19. Marketing
20. Economics
21. Agro Eco Tourism

Sub Components:

1. Natural Farming System
   - Livestock based Natural Farming
   - Aqua Based Natural Farming
   - Horti based Natural Farming
   - Agro Forestry Based Natural Farming
   - Apiculture
   - Agri Silviculture
   - Pastoral System
   - Shifting Cultivation
   - Traditional Knowledge base
2. Crop/breed/strain improvement
   - Breeding techniques
   - Collection, Conservation and Characterisation of Indigenous Germplasm
   - DUS testing
3. Soil Health Management
   - **Physical Properties**: Texture, Structure, Porosity, Hydraulic Conductivity; Bulk Density,
   - **Chemical Properties**: Nutrient content, pH, EC, Soil Organic carbon, Soil Organic Matter,
   - **Biological Properties:** Soil Biota, Rhizosphere effect, Soil Enzymes,
   - Traditional Knowledge
4. Livestock Management
   a. Cow based
   b. Other Ruminants based
   c. Birds and Fowls based
   d. Traditional Knowledge base
5. Plant Protection

a. Entomology: Insects and Pest; Natural enemies, Trap crops, Pest repellent plants, Pollinators; Beneficial insects
b. Pathology: Diseases management
c. Nematology: Nematode Management
d. Microbiology: PGPR (Plant Growth Promoting Rhizobacteria)
e. Cultural methods
f. Traditional Knowledge base

6. Weather Forecasting
    a. Astronomy based
    b. Traditional Knowledge based
    c. Smart techniques
7. Agronomic practices
    a. Conservation agriculture
    b. Crops and cropping systems
    c. Sowing window
    d. Green manuring
    e. Mulching
    f. Weed management
    g. Wind breaks and shelter belts
    h. Traditional knowledge base
8. Bio Inputs
    a. Jeevamrit
    b. Ghanjeevamrit
    c. Beejamrit
    d. Neemastra, Brahmastra, Dasparni ark, agniastraetc
    e. ITK based microbial formulations
9. Crop Management
    - Selection of crops and varieties
    - Micro climate management
    - Crop geometry
    - Land configurations
    - Seed treatment
    - Sowing
    - Mid term corrections
    - Soil and foliar nutrition
    - Trees for biomass and birds
    - Crop residue management
    - Contingent crop planning
    - Traditional knowledge base
10. Water Management (Per drop more crop)
    a. In-situ and ex-situ moisture conservation
    b. Rain water harvesting and recycling
    c. Micro irrigation
    d. Drainage in-situ and ex-situ
    e. Water budgeting
    f. Traditional knowledge base
11. Farm Machinery

a. Energy efficient Improved tools and equipment
b. Use of renewable energy in farm machinery
c. Artificial intelligence and machine learning,
d. Application of space technology and Drone Technology
e. Tools and equipment for input production
f. Energy budgeting
g. Traditional knowledge base

12. Renewable Energy Resources (Wind, Water, Solar etc)
    a. Solar based
    b. Wind based
    c. Water based
    d. Biomass based
13. Post Harvest Management
    a. Primary processing
    b. Secondary processing
    c. Storage techniques
    d. Storage pest management
    e. Eco friendly handling and packaging
    f. Value chain management
    g. ITK based
14. Bio Waste Resource Management
    a. Waste collection and, grading
    b. Waste processing and decomposition
    c. Value addition of bio waste
15. Nutrition and Health
    a. Anthropometric
    b. Biological
    c. Clinical
    d. Dietary
    e. Zebra line
    f. Selection of Nutrition rich crops and varieties
16. Certification
    a. Standards and certification protocol
        i. Standards and protocols for crop husbandry
        ii. Standards and protocols for animal husbandry
        iii. Standards and protocols for aqua resources
17. Standards for accreditation process
    a. Minimum requirements for natural narming programs
18. Community Mobilization
    a. Motivation
    b. SWOT analysis
    c. Program planning
    d. Organizational structure
    e. Diffusion and adoption process
    f. Process for group formation (SHG, FPO, FBO etc)
    g. Capacity building and Institutionalizing mechanism
    h. Monitoring and Evaluation

19. Economics and Marketing
    a. Agri-business magnagement
    b. Eco-system economic analysis
    c. Bio-economics
20. Marketing
    a. Domestic and global market scenario
    b. Market intelligence
    c. Premium product quality parameters
    d. Database management
    e. Digital platform for price
    f. Natural farming stake holder database
    g. Pricing
    h. E-marketing

21. Agro Eco Tourism
    a. Landscaping and designing natural farms
    b. Location specific economic models and components
    c. Eco tourism and management
    d. Event management

As an outcome of the different meetings, the following courses with detailed contents have emerged which are being presented here.

1. Indian Heritage of Natural Farming **Credits: 3 (3+0)**

Theory:

The chapter addresses the history and heritage of natural farming. Pioneers and scholars of Natural Farming, and their contribution to the heritage of Natural Farming describe historical methods of livestock management, health, nutrition, soil fertility and plant protection. They describe several methods of rainfall prediction, and emphasise the importance of seed and their collection, storage after thorough drying, removal of weed seeds and seed uniformity. The information on agriculture given in this important document is contemporary.

- **Krishi-Parashar**, Systematically wrote the first textbook on agriculture in the world. It deals with prediction of rainfall models on the basis of movement and position of planets, rainfall and its distribution, indicators of drought, management of farming and cattle, nutrient management, seed collection and preservation, agriculture tools and plough mechanics, other agronomic practices useful in modern agriculture (Nalini, 1999).
- **Sitadhyaksha chapter in Kautilya Arthashastra** by Acharya Kautilya (321 BC). It addresses the importance of animal husbandry, particularly of cows, measuring rainfall, seed treatment and seed procurement ,cropping pattern and method and timings of harvesting the crop, etc. (Shamasastry, 1915).
- **Kashyapiya Krishi Sukti** by sage Kashyap (c. 800 CE) deals excellent text on agriculture with details of rice production in irrigated areas of India, cattle management, soil quality, growing pulses on high land as well as vegetables, fruits, spice crops, ornamental plants. The emphasis was given on growing trees, preparing gardens, marketing and mining (Ayachit, 2002).
- **Vrikshayurveda** by Vaidya Surapala is a repository of agricultural knowledge which includes information on garden construction, importance of plants, details of plantation near buildings, procurement of seeds and plantation material, testing, treatment, preparation of pits for planting, selection of land, methods of irrigation, nutrition, manures, etc. Surapala has described a unique fermented liquid fertiliser-cum-plant protection material called Kunapajala, which happens to be the first fermented natural liquid manure in the world. Further, important information is given about plant nutrition, plant diseases, plant protection with natural products/formulations, construction of gardens, miracles related to agriculture and horticulture, use of plant species as an indicator of crops and animal production and description of religious plants (Nalini. 1996).
- **Upavanavinod** have information on benefits and losses from trees near the house, soil, planting of trees, sowing of seeds, pits, distance between trees, auspicious and inauspicious plants, irrigation (watering), garden construction, digging wells, *kunap* (liquid manure), miracle of plants (amazing plants), natural signs for growth of cereal crops, natural signs of animals and signs of reproduction of animals, etc. (Nalini, 2011).
- **Vishwavallabha** by Chakrapani Mishra (1577 CE)**,** an eminent manuscript describing various aspects of agriculture keeping in mind the Asian Agri History Foundation(AAHF) Classic Bulletin deals, Mewar region includes information on groundwater detection, soil testing, plantation, water management, nutrition, disease and treatment, miracles of plant and seeds etc. in dry, semi-arid and moist areas and hills (Nalini, 2004).
- **Brihat Samhita** by Varahamihir(600 AD), deals with widely ranging subjects as astronomy, physics, geology, horticulture, archaeology, etc including Vrikshayurveda as one of the major subjects (Bhat, 1992)
- **Lokopakara** 1000-year-old manuscript which deals with methods and criteria for water divining, Vrikshayurveda and methods for insect control, Perfumery, Veterinary medicine (Sreenivasa, 2006)
- **Nuskha Dar Fanni-Falahat (The Art of Agriculture) by Prince Dara Shikoh (1650 CE)**[9] AAHF Classic Bulletin, A text on synthesis of farm technologies of West Asia and India,grafting unrelated

trees,introduced water-dripping system of irrigation, useful in modern agriculture (Akbar, 2000).

- **Krishi Gita (Agricultural Versus),** (15^{th} century by Vidwan C Govinda Warriar), includes useful crops on the coasts of India, large numbers of rice varieties (124) for different areas described, and many other crops with their varieties are described (Kumar, 2008).

It is well documented in literature that Indian agricultural history was rich, diverse and high yielding before the advent of the Green Revolution, through the ages. Examples of these are -

- 10th-13th Century - Inscriptions in Chola Temple in Ramnad (Tamil Nadu) indicate rice yields of 6.6 MT/Ha (Scott, 2016). Great biodiversity in cultivation from millets, paddy, lentils, vegetables and fruits have been reported (Srinivasan, 2016).
- 16th Century - Abul Fazl mentions in Ain-i-Akbari that the yield of non irrigated wheat was 1.28 MT/Ha (Dharampal, 1999).
- 19th century - Edinburgh review reported land productivity in India was 3 times that of England (George , 1889).
- 1807 - Revenue records of Madras Presidency Coimbatore report rice yields of 6 MT/Ha. Bengal gram production was recorded at 1104 kg/ha in Gujarat (George , 1889).
- 1890 - Dictionary of Economic Product of India (British India) reported the native variety cotton yield to be substantially higher in various parts of India as compared to the national average in 2017-18 as 505 Kg/Ha (George , 1889).

Additional references to the knowledge on plant-human interface is evidenced in the various texts over the millenia and recent history are -

- In Rigveda (c. 8000 BC) there is a reference of the profession of farming, farming operations.
- Lord Rama (c. 5000 BC) enquired from Bharat that all those engaged in agriculture, animal husbandry receive special care.
- Tiruvallur (70 BC) author of the Tamil classic, Thirukural or the Maxima of Tiruvalluvar in which there is evidence that Indian civilization considered farming to be the most noble profession to which even royalty bowed.
- Kautilya's Arthasastra describes the technique for measuring rainfall and method of seed treatment.
- From ancient times till pre-British era farming as a community was a special tradition and enjoyed a respected and dignified status in society. Wealth was measured in natural resources. '*Gau-dhan*' (Cows), *'Ashwa-dhan*' (Horses), '*Gaj-dhan*' (Elephants) etc. were all different forms of wealth. '*Vidya-dhan*' was also a wealth as was raw material of the artisans. Among all these popular wealth forms, the most important one was 'dhanya' or rice/crops. Most of the transactions in the society were done through '*dhanya* (Gupta and Gupta, 2019).
- There is also a broad tradition of 'natural farming', propounded by advocates such as Narayana Reddy (in Karnataka), Shripad Dabholkar (Maharashtra), G Nammalvar (Tamil Nadu), Partap C Aggarwal (Madhya Pradesh) and Bhaskar save (popularly referred to as the 'Gandhi of Natural Farming', working in Gujarat) (Bharucha *et. al*., 2020).
- Natural farming is a system developed in the 1980s by Indian farmer, agricultural scientist and extension agent Subhash Palekar who established Zero budget natural farming (ZBNF) after a period of self- study of vedas, organic farming and conventional agricultural science, testing methods on his own farm (Khadse *et al*., 2017)
- The credit of the Shaping 'natural farming' movement in the country goes to former Governor of Himachal Pradesh Shri Acharya Devvrat, who is presently the Governor of Gujarat. It is the result of his sheer efforts that natural farming has reached all the Panchayats and villages of the state in a small span of three years.
- Evolution of ZBNF as a grassroots social movement and evolving into a major policy initiative in Andhra Pradesh.

- Himachal Pradesh under *Prakritik Kheti Khushal Kisan Yojna* started Natural Farming under the nomenclature *Subhash Palekar* Natural Farming (SPNF) in 2018 and now it is implemented at large scale.
- Govt. of India coined the terminology for natural farming 'Bhartiya Prakritik Krishi Paddhati' (BPKP), though the roots of all kinds of terminologies exists in Vrikshayurveda, a broad based knowledge of natural farming, which is completely in harmony with nature.
- Hon'ble Finance Minister Nirmala Sitharaman mentioned Natural Farming in her speech on the occasion of union budget in the year 2019- 20 and invoked the need to replicate this innovative model.
- Hon'ble Prime Minister of India Sh. Narendra Modi while addressing a conference on Natural Farming on 16th December 2021 emphasised to go for adoption of Natural Farming in India.
- Prakrutik Krishi Vikas board was established in 2021-22 in Gujarat by the Government of Gujarat.
- Hon'ble Finance Minister Nirmala Sitharaman made announcements in her budget speech 2022, about promotion of chemical free natural farming throughout the country, with focus on farmers' land in 5 km wide corridors along the river Ganga in the first stage. Budget also mentions that states will be encouraged to revise the syllabus of agriculture universities to meet the needs of natural, zero- budget and organic farming farming, modern day agriculture, value addition and management.

These indicate the agricultural strength of various parts of India at a time when all the farming was based on Natural Farming Systems before the advent of Agro-chemicals. In addition, in recent history there is clear evidence of India leading with the advent of Agroecology by enabling policy and programme support all over the country.

Heritage of plant protection in natural farming

Rich Heritage of plant protection in natural farming addresses to plant protection found in Vedas, Buddhist literature, Kautilya's Artha-sastra, Krishi-Parashara, Sangam literature of Tamils, Agni Purana, Brhat Samhita of Varahamihira, Surapala's Vrikshayurveda, Viswavallabha of Chakrapani Misra, and some documents of the mediaeval and pre-modern period (Nene, 2012A). Mainly cover the plant protection and treatment practices recommended in Vrikshayurveda, involving methods of applications that are followed even today, but with more efficacious appliances viz balanced nutrition using spraying of kunapajala, seed dressing (dry/ wet), root-dipping, wound dressing, soil drenching, fumigation (smoking), crude spraying (sprinkling), and dusting (Beniwal , *et. al.*, 2020).

- **Identification of disorders**

Surapala's Vrikshayurveda describes various plant diseases based on Tridosha (Vata, Pitta, Kapha) Siddhanta of Ayurveda along with symptoms and remedial measures.

- **Plant protection practices**

Knowledge of plant protection generated by our ancient and mediaeval scholars are applicable to the crop production in modern India, especially at the small farmers level. The use of natural materials available with farmers to control crop disorders has been mentioned since Kautilya's Artha-sastra (c. 300 BC) viz. Cut ends of sugarcane setts meant for planting were plastered with a mixture of honey, ghee, fat of hogs, and cow dung. Plant protection practices verified by Surapala (c. 1000 AD) viz sprinkling a decoction made out of panchamula [roots of *Clerodendrum phlomidis* L. f., *Aegle marmelos* (L.) *Corr., Stereospermum suaveolens* DC., *Gmelina arborea* L., and *Oroxylum indicum* (L.) Vent.]; (b) drenching tree base by decoction of milk, honey, licorice (*Glycyrrhiza glabra*), and *Madhuca indica*; (c) drenching tree base with decoction of triphala (dried fruits of *Terminalia chebula* Retz., *Terminalia bellirica* (Gaertn.) Roxb., and *Emblica officinalis Gaertn*.), ghee, and honey; (d) dressing tree wounds with a paste made from the barks of banyan and cluster fig trees, cow dung, honey, mustard, and ghee; the same treatment for trees that are oozing, (e) applying paste of vidanga (*Embelia ribes* Burm.

f.) and thick mud. Most of these recommendations and use of materials such as botanicals, cow dung, honey, animal fat, cow horn, etc. will be discussed. Varahamihira suggested using milk, ghee, and cow dung for dressing seeds and smoking them by burning animal flesh or turmeric before sowing, sprinkling seeds with a mixture of flour of cereals, legumes, and sesame have also been covered.

Biocidal properties of plant materials, antimicrobial properties of honey, mustard, and licorice, will be addressed. Antiseptic and biological control properties of milk, and cow dung, which usually gets mixed with urine will also be covered (Nene, 2012B).

Kunapajala

First fermented liquid natural manure of the world (Nene, 2006). This covers original form of kunap jal, a fermented liquid natural manure, as mentioned in Vrikshayurveda, written by a physician Surapala about one thousand years ago, in verses 101 to 105 by Sarangadhara (1283–1301 AD) a scholar in the court of King Hammira of the present-day Bundelkhand in the verses 171–174 of Sarangadhara's Upvan Vinoda and by Chakrapani Mishra (1577 AD) in "Vishwavallabha'' and by Chavundaraya a poet in Karnataka in southern India in 1025 AD in Lokopakara (Ayangarya and Sreenivasa, 2004a). It also addresses mainly the variants of natural fermented concoctions used for plant nutrition viz herbal kunao jal; Panchagavya, Sasyagavya, Dhanyagavya and Indsafari. Etc (Ayangarya and Sreenivasa, 2004b).

Bibliography of References

1. Nalini S. 1999. *Krishi-Parashara (Agriculture by Parashara) by Parashara*. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
2. Shamasastry R. 1915. *Kautilya's Arthashastra*.
3. Ayachit SM. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation **4**: 205..
4. Nalini S. 1996. Vrikshayurveda (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 94pp.
5. Nalini S. 2011. Upavana Vinoda (Woodland Garden for Enjoyment) by Sarangdhara (13th century CE): AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 64pp.
6. Nalini S. 2004. Vishvavallabha (Dear to the World: The Science of Plant Life) by Chakrapani Mishra (1577 CE): AAHF Classic Bulletin 5. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 134pp.
7. Bhat M and Ramakrishna. 1992. Varahmihira's Brihat Samhita. Motilal Banarasidas, Delhi India 561pp.
8. Sreenivasa AV. 2006. Lokopakara (For the Benefit of People) by Chavundaraya II (1015 – 1042 CE): AAHF Classic Bulletin 6. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 130pp.
9. Akbar R. 2000. Nuskha Dar Fanni-Falahat (The Art of Agriculture) by Prince Dara Shikoh (1650 CE): AAHF Classic Bulletin 3. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 88pp.
10. Kumar B Mohan. 2008. Krishi Gita (Agricultural Versus) by Vidwan C Govinda Warriar (Ed.): AAHF Classic Bulletin 7. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), India. 134pp.
11. Nene YL. 2006. Kunapajala – A Liquid Organic Manure of Antiquity; Asian Agri History **4**: 315-21.
12. Sreenivasa AV. 2004a. Herbal kunapa. Asian Agri-History **8**:315–17.

13. Sreenivasa AV. 2004b. Manujala: A liquid manure. Asian Agri-History **8**: 319–21.
14. Sreenivasa AV. 2005. INDSAFARI – An organic pesticide for tea. Asian Agri-History **9**:317–19.
15. Bharucha ZP, Mitjans BS and Pretty Jules. 2020. Toward re-designing at scale through zero budget natural farming in Andhra Pradesh, India, International Journal of Agricultural Sustainability, **18**:, 1-20p.
16. Khadse, Rosset, Morales, and Ferguson. 2017. Taking agroecology to scale: the Zero Budget Natural Farming peasant movement in Karnataka, *The Journal of Peasant Studies*, India. 0306-6150.
17. Saxena RC, Choudhary SL and Nene YL. 2009. A Textbook on Ancient History of Indian Agriculture. AAHF Text Book. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telangana), and Rajasthan Chapter of Asian Agri-History Foundation, Udaipur, India. 139pp.
18. Nene YL. 2012A. Potential of some methods described in Vrikshayurveda in crop yield increase and disease management. *Asian Agri-History* **1**: 45-54p.
19. Nene YL. 2012B. Crop Disease Management Practices in Ancient, Medieval, and Pre-modern India. *Asian Agri-History* **3**: 185-201p.
20. Gupta PK and Gupta AK ed. 2019. Smriti jaagran ke harkaare, Jeevika livelihoods support organization, Jabalpur, MP, India.
21. Beniwal SPS and Pandey ST. 2022. Soil nourishment and conservation according to soil agriculture heritage of India, Bhumi Suposhan Commemorative Publication 43-56p
22. Beniwal SPS, Nene YL, and Pandey ST. 2020. Relevance of *Vrikshayurveda* and Traditional Knowledge for Eco-friendly Sustainable Agriculture to Meet SDGs in India. *Asian Agri-History* **1**:3-22.
23. Watt G. 1889. A dictionary of the economic products of India, *Central Secretariat Library*. https://indianculture.gov.in/rarebooks/dictionary-economic-products-india-vol-iv

Note:

1. This course has no practical exercise.
2. Referances need to be reduced to maximum of 10.

2. NATURAL FARMING: PRINCIPLES AND PRACTICES **Credits: 3 (2+1)**

Theory

Origin of concept of natural farming, History of development in agro-ecology & natural farming, principles of agro-ecology, Basic concept, philosophy, definition, principles and components of natural farming. Merits and demerits of natural farming. Principles of Fukuoka and other methods of natural farming, Natural farming including relay cropping, multi-variate cropping, recycling and food chain. Types of natural farming systems and practices (Bio-dynamic, homa farming, natueco farming, rishi Krishi, panchagavvya Krishi, Yogic farming etc). Modern agriculture and need for new strategies, Scope of natural farming in modern time, Law of nature, Indian philosophy /Bhartiya Chintan of panchamahabhut and their role in human life and development. Important management practices for crop, fruit, vegetables and animals in natural farming, comparing conventional, organic production systems. Scientific aspects of ecological and natural farming for supporting food, nutritional and livelihood security- Food sovereignty, Livelihood of farmers and rural communities, sustainable food production and yields, biodiversity and diverse seed systems, sustainable soil health and clean water, ecological pest protection, climate resilient food production. Natural farming in India: Key policies, programmes and coverage, Challenges in growth of natural farming in India, Interventions for driving change, Case studies on natural farming in India, Farmers perspectives in natural farming, Research in natural farming in the World and India, Impact of natural farming (Yield, cost of production, manual labour, price of farm produce, net income, soil health, water use efficiency, resilience to adverse climatic conditions, pest and disease problems, nutrition of family members).

Practical

- Visit of natural farms to study the various components, design and management practices.
- Preparation of on-farm inputs for nutrient, pest and disease management.

- Documentation of indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management in rural area.
- Budgeting of natural farming system.
- Post-harvest management and practices in natural farming
- Quality aspect, grading, packaging and handling in natural farming
- Study of biodiversity at natural farm
- Management practices for water at natural farm
- Documentation of natural farming practices in major crops of different agro-climatic zones
- Computation of cost of production of natural farming and conventionally grown crops

Suggested Readings

1. Ashlesha Khadse& Peter M. Rosset. Zero Budget Natural Farming in India – from inception to institutionalization. 43(7-8), 848-871.
2. Boeringa R. (ed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
3. Ecological Farming, The Seven principles of a food system that has people at its heart. May 2015, Greenpeace.
4. Fukuoka M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp.
5. Fukuoka M. 1985. The Natural Way of Farming: the Theory and Practice of Green Philosophy. Japan Publications, Tokyo, 280 pp.
6. Hill S.B. and Ott P. (eds.). 1982. Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
7. INFRC. 1988. Guidelines for Nature Farming Techniques. Atami, Japan. 38 pp.
8. Khurana, A. and Kumar, V. 2020. State of Organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
9. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, OtthoHeldringstraat.
10. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016)

11. Plenty For All: Natural Farming A To Z PRAYOG PARIWAR METHODOLOGY by Prof. Shripad A. Dabholkar and Prayog Pariwar Prayog Pariwar (2021)
12. Natural Farming Techniques: Farming without tilling by PrathapanParamu (2021)
13. Natural Asset Farming: Creating Productive and Biodiverse Farms by David B. Lindenmayer, Suzannah M. Macbeth, et al. (2022)
14. □□ □□□□ □□□□□□□□□□ □□□□: □□□□□□□□□□□□□□□, pp 1-166.
15. **Malhotra R.** and S.D. Babaji. 2020. Sanskrit Non Translatables- The importance of Sanskritizing English. Amaryllis, New Delhi India.

3. Bhumi Suposhan **Credit: 3 (2+1)**

Theory:

Holistic view on soil in the Indian context. Status and management of soil degradation in India. Characteristics of a healthy soil, soil quality and health. Soil genesis and classification. Physical, chemical, and biological properties of soil. Essential and beneficial nutrients. Classification, functions and deficiency symptoms. Critical limits of nutrients in soil, nutrient movement and uptake, factors affecting nutrient availability. Carbon and nitrogen cycles. Methods of soil fertility evaluation. Soil testing. Plant analysis- rapid tissue test, critical levels of nutrients in plants. Biological methods- field experimentation tests, use of indicator plants, microbiological tests. Different sources of nutrients, naturally occurring minerals, organic (plant and animal based), biofertilizers, crop residue incorporation, green manuring. Formation, characteristics, and management. Acidic, saline, and alkali soils. Sources of contamination, bioremediation. Livestock dung preparations for management of healthy soils. Biogas slurry. Farmyard manure, importance and role in soil health. Compost, Composting methods, its significance for soil health. Vermicompost, Vermiwash, NADEP. Conservation agriculture practices for soil health. Role of organic matter in sustaining production. Soil organic carbon and sequestration. Role of soil microbes in nutrient supplementation. Enrichment of soil microbes by various methods. Microbial associations with plants, microbes & soil structure. Nutrient storage in soil. Best practices for promoting soil health (Low tillage, cover crops, crop rotation, conducive environment for beneficial microbes, mixed cropping, crop rotation, intercropping, mulching, green manuring, biochar, jeevamrut, Panchagavya, Ghanajeevamrut, Beejamrut, Sing Khad, Kunap Jal, Samadhi Khada etc.). Ancient practices for soil enrichment. Traditional festivals of the region in respect to soil health.

Soil carbon and nitrogen indices, nitrogen management index, carbon management index, Importance of carbon and nitrogen in natural farming.

Practical

- Soil sampling methods, processing, and storage.

- Determination of soil texture (feel method, hydrometer method and international pipette method).
- Determination of soil bulk density, particle density, porosity, and water holding capacity.
- Determination of soil pH and EC.
- Determination of soil organic carbon.
- Determination of available nitrogen.
- Determination of available phosphorus
- Determination of available potassium
- Determination of available secondary plant nutrients (Ca, Mg, S,).
- Determination of available micronutrients (Zn, Fe, Cu, Mn, B, Mo).
- Plant sample digestion procedure
- Analysis of important nutrient elements in plant
- Studies on important ITKs for selection of Soil.

Suggested reading

1. Akshay Krishi Parivar.2022. Bhumi Suposhan- Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication No.11.pp212.
2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
3. Inventory of Indigenous Technical Knowledge in Agriculture.Thematic area: Soil and water management. Document 1(2002); Document 2 (2003); Document 2- Supplement 1(2003); Document 2- Supplement 2(2004); Document 3 (2004); Document 4 (2004); Published by ICAR, New Delhi.
4. Gaur A.C. (1999). Microbial Technology for Composting residues by improved methods. Published by ICAR, New Delhi.
5. D.K. Das. Introduction of Soil Science.
6. Indian Society of Soil Science (ISSS). Fundamental of Soil Science.
7. T.D. Biswas and Mukherjee. A text book of soil Science
8. N.C. Brady. The nature and properties of soil.
9. K.S. Yawalkar. Manure and fertilizer.
10. Lal Singh Nirankari. Plant Nutrition Manures and fertilizers.

4. Weather forecasting **Credits 3(2+1)**

Theory

Ancient wisdom on Weather Forecasting: Rainfall prediction, analysis and forecast of winter monsoon based on ancient literature and simulated models, Rain forecasting in India Almanacs (Panchangs), Measurement of Rainfall, Testing of Traditional Methods of weather forecast. Ancient Astronomers, Indian Almanac (Nakshatras, Rashi, Months, Paksha, Seasons, Tithi, Var, Yog, karn, nadi,); Krishi Panchang; Effect of Planets on Weather; Ancients Methods of Weather Forecast (Analytical Methods, Observational Methods). Principles of Astro-Meteorology. Rainfall predictions techniques 1. Parashara Technique, 2. Varahamihira techniques, 3. Predictions based on Planets, 4. Bio-Indicators, 5. Other ancient Rainfall Predictions, Sudden Rainfall, Indications of Famine, The Method of ascertaining the type of cloud of the year. Folklore regarding Weather Forecasting (Ghagh and his wife Bhaddri). 6ITKs with its description and the practitioner for Weather Forecasting. Meaning and scope of agricultura lmeteorology; Earth atmosphere-its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Nature and properties of solar radiation, solar constant, depletion of solar radiation, shortwave, longwave and the norma lradiation, netradiation, albedo. Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations oftemperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet and hail, cloud formation and classification; Artificial rain making. Wind, causes and types of wind, cyclone, anticyclone, land breeze and sea breeze, General circulation; Indian Monsoon - mechanism and importance in Indian agriculture; Weather forecasting - types of weather forecast and their uses, ITK in weather forecasting; Weather hazards- High winds, drought, floods, tornado, frost, tropical cyclones, thunderstorms, duststorm, lightning and hailstorms and extreme weather conditions such as heat-wave andcold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normal's for crop and livestock production. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture, Types of Climate Models – GCM and RCM.

Practicals

- Visit of Agrometeorological Observatory, siteselection, layout, exposure to instruments and data acquisition techniques
- Study and use of different instruments for measuring air temperature, rainfall.
- Estimation of net short-wave radiation, net long wave radiation, total global and netradiation
- Measurement of albedo and sunshine duration, wind speed & direction,
- Measurement of evaporation rate using USWB Class Aopenpan Evaporimeter
- Determination of relative humidity and vapour pressure
- Study and use of Duvdevani Dew Gauge for measurement of Dew
- Computation of climatic normal using historical weather data
- Study of ancient methods of weather forecast
- Preparation of Krishi Panchang.
- Testing local folklore for weather forecasting

Suggested Readings:

1. Sharma BD. 2007. Ancient Indian Wisdom on Agriculture and Weather Forecasting.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 323-325.
2. Varshneya MC. 2007. Ancient and Recent Methods of Rainfall Prediction.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 326-343.
3. Murugan M, Miniraj N, Josephrajkumar A, Pradeep K P and Yusuf L. 2007. Analysis and Forecast of Winter Monsoon Based on Pre-Vedic Literature and Simulated Model.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 344-353.
4. Mishra SK, Dubey VK and Pandey RC. 2007. Rain Forecasting in Indian Almanacs (Panchangs): A Case for Making Krishi – Panchang.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 354-364.
5. Balkundi HV. 2007. Measurement of Rainfall in Ancient India.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 365-372.

6. Kanani PR. 2007. Testing of Traditional Methods for Weather Forecast in Gujarat.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 373-388.
7. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
8. Ram Niwas, Surinder Singh, Diwan Singh, M.L. Khichar and Raj Singh. 2006. A Text Book on Agricultural Meteorology. CSS HAU, Hisar.
9. Chandrasekaran, B., K. Annadurai and E. Somasundaram. 2010. A Textbook of Agronomy. Publ: New Age International (P) Limited Publishers. pp856.
10. Inventory of Indigenous Technical Knowledge in Agriculture. Thematic area: Weather Forecasting. Document 1(2002); Document 2 (2003); Document 2- Supplement 1(2003); Document 2- Supplement 2(2004); Document 3 (2004); Document 4 (2004); Published by ICAR, New Delhi.
11. Pt. Umashankar Dubey. Prachin Varsha Vigyan. Publishar Shri HanumatJyotish Mandir, Kanpur.
12. वराहमिहिर संहिता

5. AGRONOMIC PRACTICES Credit: 3(2+1)

Theory

Classification of crops- Field crops – Origin, distribution, economic importance, soil and climatic requirements, varieties, cropping systems: definition, principles and its importance; physical resources, soil and water management in cropping systems; Importance of mixed cropping in natural farming, multiple cropping, alley cropping, sequential cropping and intercropping, cropping system indices -mechanism of yield advantage in intercropping systems. Complementary and competition relations; multi storied cropping and yield stability in intercropping, Types of crops - trap, cover, catch and restorative crops. ITK related to crops and cropping systems. Seeds- Traditional and recent varieties, classification of seeds, seed dormancy, nursery management, main field preparation, types of tillage, Seasons of India, Pre-monsoon sowing, sowing techniques, Optimum time of sowing for different crops-ITK for seed treatment and seed selection, Methods of planting of crops, Time of planting of different crops & intercrops, Row spacing for different crops. Irrigation – Definition, irrigation types, water saving techniques and management. ITKs in irrigation and water management. Green manures and green leaf manures **–** Types of green manures, Ideal plant types for green manures, Nutrient content and biomass contribution, time and method of incorporation, decomposition pattern. Advantages & limitations. Weeds- Classification, habitat management of weeds, crop weed interaction, critical periods of weed competition, non-chemical weed management, weed mulch, trap crop, biological and herbal measures. Mulching – Types, cover crops – advantages and disadvantages, Soil moisture conservation approaches and Water Harvesting, ITKs on soil and water conservation. Alternate land use system – Definations and types.

Practical

Identification crops in different growth stages, manures and seeds, agriculture tools and implements, nursery and main field preparation, animal drawn, seed treatment and seed dormancy, methods of sowing, input requirement, water requirement and WUE, Weeds in wetland, irrigated up land, dryland system, low cost technology, indices for cropping systems, mulching practices , green manureing practices - alternate land use system - wind break and shelter belt - – ITKs in crops and agronomic practices.

Suggested Readings:

1. Agronomy Principles and Practices, E Somasundaram and M Mohamed Amanullah, 2017, New India Publishing Agency, New Delhi.
2. A Text book of Agronomy, B. Chandrasekaran and E. Somasundram, 2018, New Age International Publication, New Delhi.
3. Principles of Agronomy, S. R. Reddy, 2020, Kalyani publications. New Delhi
4. Principles of Agronomy, T. Yellamanda Reddy and G. H. Shankara Reddy, 2016, Kalyani Publications, New Delhi.
5. Agroforestry principles and Practices, A. P. Dwivedi, 2019. Oxford & IBH Publication.
6. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
7. Crops and Cropping Systems/ Soil and Water Management/ Rain water management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publ: ICAR New Delhi.

Note: Similar pattern of referances need to be adopted.

6. BIODIVERSITY CONSERVATION Credit: 3 (2+1)

Definition, Genetic diversity, Species diversity, Ecosystem diversity: Structural and functional aspects. Agro ecological zones in India with a brief understanding of diversity in soil types, temperature, rainfall, watershed atlas of India, seasons and season cycle in India, festivals and seasons, Importance of local biodiversity, Bio-geographic classification of India. the value of biodiversity and conservation. India as a Mega Diversity Nation. Hotspots of Biodiversity: Criteria for determining hot spots. Threats to Biodiversity- Habitat loss, pollution, species introduction, global climate change, overexploitation, poaching of wildlife. Rare species. Extinction: mass extinction, extinction process, Human factors: social factors, economics, politics and action. Endangered and endemic species of India, common plant species, common animal species. Conservation of Biodiversity- Strategies for conservation: In-situ and ex-situ conservation. Conservation Practices in India and World- Organizations involved in resource conservation IUCN, WWF, UNEP, UNESCO, Biodiversity International, IPGRI, FAO, BSI, ZSI. General account on activities of DBT, BSI, NBPGR, ZSI, FSI, NBFGR and NBAGR NFPTCR, Sacred groves, Biodiversity register. Conservation of biodiversity. Salient Provisions of Biological Diversity Act, 2002. Role of Gramsabha in biodiversity conservation. Ancient Indian culture in biodiversity conservation.

Practical

1. Field Survey for studying plant species diversity in a village/region.
2. Study of the morphology and reproductive structures of the types of micro-flora and micro-fauna.
3. Staining of fungal filaments by Cotton Blue, Methylene Blue
4. Practical involving preparation of sterilization, media, principles of isolation, pure culturing.
5. Collection, identification and submission of non-wood forest products
6. Visit to forest to study genus/species distribution.
7. Notes on pest and diseases of forest plants (any four)
8. Study of ITKs on biodiversity conservation
9. Orientation aboutnbiodiversitybregister and its activities

Suggested Readings

1. Gadgil, M., &Seshagiri Rao, P. R. (1998). *Nurturing biodiversity an Indian agenda*. Ahmedabad: Centre for Environment Education.

2. Sayan Bhattacharya (2014) (19). Forest and biodiversity conservation in ancient Indian culture: A review based on old texts and archaeological evidences. *International Letters of Social and Humanistic Sciences*. pp35-46.
3. Krishnamoorthy, K.V (2004) An Advanced text book on Biodiversity- Principles and Practice: Oxford and IBH publishing company Pvt. Ltd. New Delhi. 10
4. Krishnamurthy, K.V. (2003). Text book on Biodiversity, Science Publishers, New Hampshare.
5. Negi, S.S. (1993) Biodiversity and its Conservation in India.
6. Shahid N., Daniel E. Bunker, A.H., Michel L. and Charles Perrings (2009). Biodiversity, Ecosystem Functioning, and Human Wellbeing: An Ecological and Economic Perspective, Oxford University Press, New York.
7. Sharma P.D. (2003). Ecology and Environmental Sciences, Rastogi Publications, Meerut, India
8. Trivedi, P. C. 2007 Global Biodiversity status and conservation. Pointer publishers Jaipur India.
9. Bilgarmi, K. S and Saha, L. C. (2010). A Textbook of Algae. CBS Publishers, New Delhi.
10. Dubey, R. C. and Maheswari, D.K. (2010). A Text book of Microbiology, S. Chand & Company, New Delhi.
11. Puri, GS, Gupta RK, Meher-Homji VM, Puri S. (1989). Forest ecology. Volume 2. Plant form, diversity, communities and succession. Oxford& IBH Publishing Co. Pvt. Ltd., New Delhi

7. NATURAL FARMING SYSTEMS: ELEMENTS, CHARACTERISTICS AND DESIGN **Credits: 4 (3 + 1)**

Theory

Ecosystems: Definition, concept and components, The water cycle, nutrient cycle and energy cycle, Types of ecosystems: Natural ecosystems and Agri-ecosystems, Concept and classification of ecosystem services, Concept and elements of natural systems, Classification of farming types (Based on geographical condition, levels of technology & external input use, labour demand of produce etc.), Subsistence farming: Intensive subsistence and primitive subsistence, Traditional farming, intensive conventional farming, sound farming, integrated farming, conservation agriculture, eco-agriculture, ecologically intensive agriculture, organic farming, biodynamic farming, permaculture, cow based farming, Yogic kheti, natural farming, System approach in farming (Natural ecosystem mimicry and use of ecological concepts in agriculture), Natural system models at the basis of mimicry (The rain forest model, The dry forest model, Concept of ecosystem based integration of crops, livestock, horticulture and fish farming as complimentary activities, Traditional integrated farming system models based on natural farming principles, Important agri-based, horti-based, animal based, agro forestry, aqua farming system, The prairie model), Comparison of natural ecosystems, traditional farming system and modern agriculture, Production syndrome in natural farming, Hypotheses and concepts in designing the natural farming system models (Biodiversity and the mimicry hypothesis, productivity, resilience, equilibrium and stability, Levels of organization for nature mimicry in agro-ecosystems), Principles for cropping system design based on natural ecosystem mimicry, Steps for development of agricultural systems based on mimicking natural ecosystems, Strength and weakness of natural farming systems. Economic evaluation and comparative analysis of different farming systems and natural systems.

Practical

- Identification and characterization of different natural &agri-ecosystems in the rainfed and irrigated regions
- Study of characterisation of natural eco-systems and farming system
- Study of water cycle in natural ecosystem and farming system
- Study of nutrient cycle in natural ecosystem and farming system
- Study of energy cycle in natural farming

- Study of carbon cycle in natural farming
- Preparation of cropping schemes for natural farming systems
- Study of biodiversity in natural and conventional farming systems
- Recycling of organic waste and nutrient budgeting in farming system
- Farm records and farm book keeping in natural farming system
- Designing of natural farming systems/ models in rainfed and irrigated ecosystem
- Quantification of ecosystem services in different ecosystems
- Cost and profit analysis in natural and conventional farming systems

Suggested Readings

1. Harwood R.R. 1990. A history of sustainable agriculture. pp. 3-19. In: Edwards C.A., Lal R., Madden P., Miller R.H. and House G. (eds.) Sustainable Agricultural Systems, Soil Water Conserv, Soc., Iowa.
2. James W. Jones, John M. Antle, Bruno Basso, Kenneth J. Bootea, Richard T. Conantd, Ian Foster, H. Charles, J. Godfray, Mario Herrerog, Richard E Howitth, Sander Janssen, Brian A. Keating, Rafael Munoz-Carpena, Cheryl H. Porter, Cynthia Rosenzweig, Tim R. Wheeler. 2016. Brief history of agricultural systems modelling. *Agricultural Systems,* 155: 40-254.
3. Kumar, S., Bhatt, B. P. and Dey, A. 2018. Integrated Farming System in India: Current Status, Scope and Future Prospects in Changing Agricultural Scenario. *Indian Journal of Agricultural Science.* 88:1661-1675.
4. Manna, M. C., Rahman, M. M., Naidu, R., Fazle Bari, A.S.M., Singh, A. B., Thakur, J. K., Ghosh, A., Patra, A. K., Chaudhari, S. K. and Subbarao, A. 2021. Organic farming: A prospect for food, environment and livelihood security in Indian agriculture. *Advances in Agronomy,* 170: 101-153.
5. Minamino Y. 1994. Manifesto of Nature Farming. In the Front of Organic Agriculture. Fumin-Kyokai, Tokyo, 195pp.
6. Nelson EJ, Daily GC (2010) Modelling ecosystem services in terrestrial systems. F1000 Biol Rep 2:.https://doi.org/10.3410/B2-53.
7. Singh SP (2002) Balancing the approaches of environmental conservation by considering ecosystem services as well as biodiversity. *Curr Sci,* 82:1331–1335.

8. Edwards, P. (1983). The future potential of integrated farming systems in Asia. Proc. V WCAP 1, 273– 281.
9. Natural Farming: a Practical Guide by Pat Coleby (2004) Compendium of Success Stories of Natural Farming Publishing Agency: NITI Aayog (2022) ISBN: 978-81-953811-4-2
10. Agroforestry Principles and Practices, A. P. Dwivedi, 2019. Oxford & IBH Publication.

8. COMPREHENSION AND COMMUNICATION SKILL IN ENGLISH Non-Credit

Theory

War Minus Shooting- The sporting Spirit. A Dilemma- A layman looks at science Raymond B. Fosdick. You and Your English – Spoken English and broken English G.B. Shaw. Reading Comprehension, Vocabulary- Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to Help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations. Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Written Skills: Paragraph writing, Precise writing, Report writing and Proposal writing. The Style: Importance of professional writing. Preparation of Curriculum Vitae and Job applications. Synopsis Writing. Interviews: kinds, Importance and process.

Practical

Listening Comprehension: Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and listening, politeness &Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectual ability. Group Discussions.

Suggested Readings:

9. CROP MANAGEMENT Credits: 3(2+1)

Theory

Selection of crop and variety– Criteria for selection of crops in natural farming, Traditional and indigenous variety - Advantages and disadvantages -Classification of crops - factors affecting selection of crops and variety. Weather management- Concept of weather and climate - Factors affecting crop production – Climatic factors, Edaphic, Biotic, Physiographic; Micro-climate management techniques, Windbreaks and shelter belts, Management of weather in natural farms. Seed, sowing and Irrigation– Importance and concept of seed selection, seed treatment, Seed rate- Factors affecting seed rate and seed germination; Sowing- time, method and depth, indigenous methods and animal drawn techniques, Time and method of irrigation, management of irrigation, ITKs in seed, sowing and water management. Crop Geometry- Definition of crop geometry and crop density, types of crop geometry, importance of crop geometry, thinning, gap filling, optimum plant population, factor affecting plant population, relation of crop geometry and growth, relation of crop geometry and yield. Weed management: Classification of weeds and their importance, Different methods of weed management, practices of weed management in natural farming. Nutrient management: Sources of nutrient application & their management in traditional and modern agriculture, maintenance of soil health and plant health.

Practical:

- Selection of crops and cropping systems for natural farming,
- To study functions of different agro-met observatory,
- Calculation of seed rate and sowing,
- Plant geometry and population calculation
- Traditional seed treatment
- Preparation of traditional nutrient supply concoctions and their use
- Traditional knowledge techniques in crop management
- Study of methods of crop residue management
- Study of important methods of plant protection
- Irrigation efficiency

- Preparation of crop calendarfor different sowing seasons under various micro-climates
- Preparation of contingency crop plan for natural farming
- Yield estimation in naturally grown crops.
- Field visit to natural farm

Suggested Readings:

1 Agronomy Principles and Practices, E Somasundaram and M Mohamed Amanullah, 2017, New India Publishing Agency, New Delhi.

2 A Text book of Agronomy, B. Chandrasekaran and E. Somasundram, 2018, New Age International Publication, New Delhi.

3 Principles of Agronomy, S. R. Reddy, 2020, Kalyani publications. New Delhi

4 Principles of Agronomy, T. Yellamanda Reddy and G. H. Shankara Reddy, 2016, Kalyani Publications, New Delhi.

5 Fundamentals of Agronomy, Gopal Chandra De, 2017, Oxford & IBH publication.

6 The One-Straw Revolution: An Introduction to Natural Farming (New York Review Books Classics)

7 Natural Farming: a Practical Guide by Pat Coleby (2004) Compendium of Success Stories of Natural Farming Publishing Agency: NITI Aayog (2022) ISBN: 978-81-953811-4-2

8 The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides) by Nicole Faires (2016)

9 Spiritual Farming: Faith In The Natural Farming Cycle By Michael Gondo (2020)

10 Vrikshayurvedic Farming: The Traditional Indian Agriculture by C &Mujh R Nandhakumar Swaminathan (2017)

11 100 Herbs for making JADAM Natural Pesticide: The way to Ultra-Low-Cost agriculture (JADAM Organic Farming) by Geol Yu, Youngsang Cho, et al. (2016)

12 Natural, Organic, Biological, Ecological and Biodyanamic Farming by V. N. Tivari (2010)

13 Crops and Cropping systems.2004. In Inventory of Indigenous Technical Knowledge in Agriculture Document 2 (Supplement 1) pp 9-26. Publ: ICAR New Delhi.

14 Crops and Cropping Systems/ Soil and Water Management/ Rain water management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

10. NATURAL FARMING AND HUMAN HEALTH Credit: 3(2+1)

Theory

Food situation in India and in the world, Need of healthy food, Concept of healthy food, safe food, organic food, green food, pesticide free food, fast food, slow food, concept of nutrition and health per acre; Interrelationship between natural farming and human health. Health and nutrition disconnect in the Agriculture Policy of India. Effect of Natural farming on Animal reproduction, Nutrients, taste, Safety, immune system, Antibiotic resistance, Antioxidant value and protection of environment. Recommended Dietary Allowances (RDA), food exchange list, food composition database, food composition and food groups, Criteria for classification of quality food safe food. Human health – definition and philosophy, concept of health- biomedical, ecological, psychological and holistic, Criteria & qualities of organic and natural food. Comparsion of natural and conventionally grown foods: Nutritional and non-nutritional components, bioactive components, their impact on human health, effect of processing on nutritional components, conservation of nutrients in processed foods. Food standards, food laws and labelling of natural foods. Concept of Nutritional Garden, Homestead kitchen garden and Nutri smart village. ITKs in human food and nutrition and Health.

Practicals

- Physical examination of foods, determination of gluten, bulk density, hydration capacity and index, oil absorption capacity, 1000 kernel weight in conventional and natural farming produce/foods.
- Sensory evaluation and organoleptic evaluation of natural and conventional foods
- Analysis of proximate composition in conventional foods and natural farming produce/foods based on available secondary data.
- Determination of pesticide residues and heavy metal contamination in foods.
- Market survey and listing of natural farming foods available in the market. Preparation of nutrithali

Suggested Readings

1. Lamuela-Raventós (2019) Organic food and the impact on human health, Critical Reviews in Food Science and Nutrition, 59:4, 704-714, DOI: 10.1080/10408398.2017.1394815

2. Shiva V and Singh V (2011). Health per Acre- Organic Solutions to Hunger and Malnutrition. Navdanya/Research Foundation for Science, Technology & Ecology.
3. Shiva V, Shiva M and Singh V (2013). Poisons in Our Food- Links between Pesticides and Diseases, Natraj Publishers, Dehradun
4. Sawhney SK and Singh R (2000) Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
5. Kalia M (2002) Food Analysis and Quality Control. Kalyani Publishers, New Delhi.
6. AOAC International (2016) AOAC Official Methods of Analysis. 20th Edition, Association of Official Analytical Chemists. Washington DC.
7. Agarwal, A and Udipi, S. (2014). Text Book of Human Nutrition. Jaypee Medical Publication, Delhi.
8. Bamji, S.M., Rao, P.N., and Reddy, V. (2003). Textbook of Human Nutrition. Oxford and IBH Publishing Co Pvt Ltd.
9. Late Dutta Sarat Chandra.2007. History of Soma and Other Spirituous Liquors. *In.*
10. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 871-881.

11. Mathematics and Statistical Methods **Credits: 3(2+ 1)**

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Discrete and continuous distribution, normal distribution, sampling distribution, t, F and chi square, Analysis of two-way classification, CRD, RBD and LSD.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling. Excercise on CRD, RBD and LSD.

Suggested Readings:

1. R. Rangaswamy. 2020. A Textbook of Agricultural Statistics. Publ: New Age International Pvt. Ltd.
2. G. Nageshwar Rao. Statistics for Agricultural Sciences. 2018. Publ: B.S. Publications.
3. S.R.S. Chandel. A Handbook of Agricultural Statistics. Publ: Impect Publishers.

12. SOIL BIOLOGY IN NATURAL FARMING **Credit: 3 (2+1)**

Theory

Soil as a habitat for Life, Concept of soil biome & its components, Soil organic matter: Definition, characterisation of soil humus and decomposition processes. SOM as carbon source for soil biota. Soil biodiversity, Soil microbiota: Metabolism and physiology, Soil fauna (arthopods, springtails, earthworm, etc.): Distribution, abundance, diversity and interactions, Factors affecting soil biodiversity, Significance of biota in soil development, Soil biological interactions: Functions and processes. Above-ground and below-ground biotic linkages, plant-microbe interactions: Rhizosphere, spermosphere, phyllosphere. Habitat adaptive fitness benefits to host crops in terms of tolerance to abiotic and biotic stresses, Biological nitrogen fixation: Symbiotic (Rhizobium-legume, Actinorhizal, Azolla-anabaena), Associative (Azotobacter, *Azospirillum*, *Gluconacetobacter*, etc.), Free-living (BGA, Klebsiella, etc.), Mechanisms of BNF, factor affecting BNF. Microbial mediated nutrient availability and exchange in soil, Nutrient mobilization: Arbuscular mycorrhizal symbiosis: its types, biochemical basis of interactions and benefits to host crops. Soil enzymes -characterization and mode of action, Soil health, soil sickness, soil resistance concept, indicators and evaluation criteria. ITKs on soil health management through enriching soil microbiome.

Practical:

- Hands on Microscopy and examination of microbes.
- Microbiological media and methods of sterilization.
- Methods of isolation and purification of microbial cultures.
- Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
- Isolation of *Azospirillum*, *Azotobacter*, BGA, *Rhizobium.*
- Determination of microbial biomass C and N.
- Assay for soil enzyme activities.
- Assay for carbon substrate utilization.
- Determination of earthworm population and biomass.
- Estimation of soil carbon active pool (CO_2 evolution, SMBC).
- Estimation of different carbon fractions of soil

- Estimation of soil carbon stock

Suggested Readings

1. Hillel D. 2003. Introduction to Environmental Soil Physics. Academic 88 Press.
2. Indian Society of Soil Science. 2015. Introduction to Soil Science. ISSS, New Delhi.
3. Lal R & Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
4. Kannaiyan S, Kumar K & Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
5. Mengel K &Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland. Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
6. Pierzinsky GM, Sims TJ & Vance JF. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press. Stevenson FJ & Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.
7. Tisdale SL, Nelson SL, Beaton JD &Havlin JL. 1999. Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.
8. Soil Microbiology and Biochemistry...by E.A. Paul and F.E. Clark
9. Soil Biotechnology...by J.M. Lynch
10. Prescott's Microbiology....by J.M. Willey, Linda M. Sherwood and C.J. Woolverton.
11. Crops and Cropping Systems/ Soil and Water Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

13.WATER MANAGEMENT Credit : 3(2 + 1)

Theory:

History of water management in ancient and medieval India. Water Management: Definition, scope and importance. Water resources: Use and over- utilization of surface and ground water, floods, drought, dams-benefits and problems. Region specific traditional water harvesting and management systems. Rainwater conservation technologies - in-situ and ex-situ storage, water harvesting and recycling, Rain water harvesting, Farm ponds, Groundwater recharge, Contour and graded bunding, Chalkhal. Water budgeting, Irrigation water requirement. Micro irrigation: Sprinkler, Drip irrigation systems, gravity fed drip irrigation system. pitcher irrigation system, maintenance of micro irrigation system, fertigation, advantages and limitations of fertigation, IOT based smart irrigation. Drainage, water logging, familiarization with the drainage problems of the state; types of drainage. quality of irrigation water, conjunctive use of fresh and saline water. Watershed concept in natural farming-watershed deterioration, components of watershed management, conservation measures for natural resource management, impact of climate change, Fundamentals of RS and GIS, development of climate smart watershed. Reservoirs, Ground Water Harvesting and Conservation (Tanka, Talai, Nadi, Nada, Talab, Khadin). Indian Traditional Knowledge in Rain water management, soil and water conservation and waste water management.

Practical

1. Measurement of soil moisture by different soil moisture measuring instruments.
2. Measurement of irrigation water requirement.
3. Determination of bulk density, field capacity and wilting point.
4. Case study on water budgeting.
5. Estimation of Farm Pond storage capacity.
6. Testing of irrigation water quality, EC, pH, TDS.
7. Study of different components of sprinkler irrigation system
8. Study of different components of drip irrigation.
9. Field visit to micro irrigation system.
10. Maintenance of different components of micro irrigation systems
11. Survey of watershed resources.

12. Watershed planning and use of RS and GIS.
13. Field visit to watershed.
14. Field visit to water harvesting structure.

Suggested Readings

- Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.
- Elangovan, K., (2006) GIS: Fundamentals, Applications and Implementations, New India Publishing Agency, New Delhi-l10088
- Lillesand, T.M. and Kiefer, RW. (2000) Remote Sensing and Image Interpretation. John Wiley & Sons, Inc. New York.
- Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
- Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
- Mishra Anupam, 2021. AajBhiKhara Hai Talab.
- Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
- Rajasthan ki Rajat Bunde.
- Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
- Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.
- Sadhale Nalini. 2007. Water Harvesting and Conservation in Ancient Agricultural Texts.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 414-424.
- Singh Harpal and Kavia ZD. 2007.Traditional Rainwater Harvesting Methods of Indian Thar Desert.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 432-440.

14.FARM POWER AND MACHINERY Credit: 3(2+1)

Theory

Mechanization in Agriculture: its potential and prospectus. Energy efficient improved tools and equipment's in natural farming. Draught animal power and its relevance to Indian Agriculture. Versatile age-old agricultural implements and its relevance in natural farming. Introduction to primary and secondary tillage equipment. Energy efficient improved tools and equipment's in natural farming: Introduction to rotavator, planter, vegetable transplanter, bed former, disk harrow, mulch laying equipment, ergonomically improved hand tools for intercultural operation: wheel hoe, long handle hoe, garden tools, labour saving/drudgery reducing tools. Plant protection equipment: knapsack sprayer, power sprayer. threshing and shelling machinery, Broad understanding of performance and efficiency of engines. Use of Renewable energy in farm machinery: Introduction to Renewable energy, use of biogas, solar dryer, solar photovoltaic system, operation of small farm equipment with solar PV such as solar thresher, winnower, sprayers, Use of bio-diesel /bio-ethanol as alternative fuel for engines., Animal drawn farm equipment/tools: Animal drawn bund former, Seed drill, Planters, cultivator. Tools and equipment for input production: tools and equipment for Manures mixing, vermi-compost pelleting machines, screening, crop residue management, shredding, etc., Energy budgeting of important tools, Introduction of energy budget/audit concept in agriculture. Use of Energy coefficients and conversion of physical units into their energy equivalents. Estimation of operation-wise and source-wise energy consumption for agricultural activities, ITK in farm machinery. ITKs on farm tools.

Practical:

- Familiarization with energy efficient improved tools and equipment for tillage, sowing, intercultural, plant protection and harvesting equipment.
- Visit to nearest renewable energy sources to know their working and their parts of operation.
- Familiarization with tools and equipments for input production in field.
- Numerical related to energy budgeting of some important tools.
- Study of the different components of IC engines

- Study of different engine systems

Suggested Readings:

1. Elements of Agricultural Engineering, J Sahay, Standard Publishing Distributer
2. Pimental D 1980, Hand book of Energy Utilization in Agriculture, CRC
3. Digital Technologies for Agriculture, N S Rathore, Sunil Joshi, Naveen Choudary, NIPA Genx Electronic, Resourses and Solutions P Ltd.
4. Rai, GD (2013). Non-Conventional Energy Sources, Khanna Publishers, Delhi. 2013.
5. Rahudkar WB. 2007. Ancient Agricultural Implements.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 389-396.
6. Akshay Krishi Parivar.2022. Bhumi Suposhan- Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan. AKP Publication No.11.pp212.
7. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
8. Sangwan Satpal. 2007.Level of Agricultural Technology in India (1757-1857). *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 397-413.
9. Tillage and Interculture Management / Farm Implements. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.
10. Dakshinkar N.P. and M. Singh 2022. Draught Animal Power and its relevance to Indian Agriculture. In Bhumi Suposhan, Akshay Krishi Parivar.pp 80-87.
11. Peshwe D.R., Ram Kumar Sing, K.A. Deshmukh and S. Chopra. 2018. Advances and Research in Agricultural Tools. Publ: MME Pulishing House Nagpur.

15.RESEARCH METHODOLOGY AND ETHICS Credits: 3(2 + 1)

Theory

Research Ethics = Introduction, ethical ethos- researcher's obligations & participants rights, Research Ethics: Researcher-Participant, General Ethics, Ethical Issues in India, Ethics Committees. Experimental techniques: Research design, sampling, data collection, On-station experimentation, On-Farm experimentation, tabulation, Statistical tools and analysis techniques for interpretation of data. Geo-referenced characterization: Questionnaire design principles, Questionnaire design for consumers of organic products, Questionnaire design for farmers and producers of organic products, Questionnaire design for processors/traders/exporters, Geo-spatial analysis and mapping of natural farms/producers/traders/consumers. Meta data analysis: Concepts, statistical methods, clustering research results, Holism, Positivism, Objectivism, Reductionism, Constructivism, Subjectivism, data source, Variable coding and analysis, interpretation. Niche area and crops for natural farming: Parameters for niche area and crop, Different scales of niche area, Tools and steps in Niche area and crop identification, Parameterization and classification based on macro, regional and micro level. Climate resilience of natural farming: Methodology for identification of climate resilient production systems, GHG's estimation using IPCC, GHG's measurement using instrumentation, Global Warming Potential, Energy & Carbon budgeting. Breeding for natural production system: Conventional breeding strategies for organic production, participatory plant breeding, Marker aided selection, Stability analysis, Molecular characterization of indigenous natural inputs, Bio-chemical and molecular signature of natural produces. Commercial Project Formulation on natural Farming: Internal rate of return, Pay Back period, B:C ratio, Net Present Value, Model project formulation for organic farming, Impact analysis tools and methods. Farming System model development: Synthesis of IFS models using primary and secondary data, classification, validation of farming systems.

Practical

1. Synthesis of farming system model
2. Estimation of GHG emission from IPCC tool
3. Meta data analysis using published papers
4. Identification and niche area and crops for a district or block
5. Identification of Climate resilient production system using long term meteorological data

6. Commercial project formulation
7. Geo-spatial analysis using GIS platform
8. Carbon and energy budgeting of an organic and natural farm

Suggested Readings

1. Kamat,P.V. (n.d.). Research Ethics. Retrieved from https://www3.nd.edu/~pkamat/pdf/ethics.pdf.
2. Parveen, Huma &Showkat, Nayeem. (2017). Research Ethics.https://www.researchgate.net/publication.

16. Fundamentals of Economics in Natural Farming Credit: 3(2+1)

Theory

Scope and purpose of Economic analyses, Economic valuation of natural resources for farming, Ecosystem services-based approach, types of ecosystem services. Demand and supply, elasticity of demand and supply. Economic Analysis Frameworks: Cost Benefit analysis: Benefit Cost Ratio (BCR), Incremental Cost Benefit Ratio, Net Present Value (NPV), Payback PeriodCost-effectiveness analysis (CEA) and Economic-impact analysis (EIA). Farm planning under natural farming, Linear Programming.Bio economics, Knowledge-Based Bio-Economy (KBBE), bio-economy and the green economy, policies for trigger India's bio-economy. Finance and Risk Management – Types of credit, credit inclusiveness, Formal and informal financial institutions and Insurance.Factors efficiency measures, Depreciation, return to scale, factor share. Input-output relationship. Lessons from Kautilya'sartha shastra on economic policies on Agriculture.A brief understanding of the Bharatiya concept of Economics.

Practical

Determination of demand and supply curves, computation of demand and supply Elasticities, cost benefit analysis in certified natural products, computation of cost of production and cost of cultivation in natural farming, different cost concept and input output relationships. Computation of economic analysis framework: Benefit Cost Ratio (BCR), Incremental Cost Benefit Ratio, Net Present Value (NPV), Payback Period, Farm efficiency measures, factor share.

Suggested Readings

1. H.L. Ahuja. Principles of Microeconomics. (2011).18th revised edition. ISBN 81-219-0335-1. S. Chand &Company Ltd, Ram Nagar, New Delhi-110055.
2. Shenoy. G.V. (1989). Linear programming methods and applications. Wiley, New Delhi.
3. Simister, N., James, D. and Scholz, V. (2017). Cost-benefit analysis. M&E training consultancy, Intrac for civil society. intrac.org/wpcms/wp-content/uploads/2017/01/Cost-benefit-analysis.pdf.
4. BIRAC. (2020). India Bio-Economy Report 2020. Biotechnology Industry Research Assistance Council, Lodhi Road, New Delhi, India.
5. Hall, R. and Zacune, J. (2012). Bio-economies: The EU's real 'Green Economy' agenda? World Development Movement and the Transnational Institute.

6. Levidow, L., Birch, K. and Papaioannou, T. (2012). EU agri-innovation policy: Two contending visions of the bio-economy. Critical Policy Studies, 6(1), 40-65.
7. Mills, E. (2015). The Bio-economy: A primer. The Transnational Institute (TNI) and Hands on the Land, European Commission.
8. National Academies of Sciences, Engineering, and Medicine. (1999). Perspectives on Biodiversity: Valuing Its Role in an Everchanging World. Washington, DC: The National Academies Press. https://doi.org/10.17226/9589
9. Queensland Government (2017). Economic Impact Assessment Guideline. The Department of State Development, Queensland 4002, 100 George Street Brisbane Qld 4000 (Australia). https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0012/33420/economic-impact-assessment-guideline.pdf.
10. Singh, R., Naik, D. and Feroze. S.M. (2014). Agri-Business potentials in India: Experiences from Hill states. EBH Publishers India136, M.L. Nehru Road, Pan Bazaar, Guwahati-781001.
11. Singh, R., Yumnam, A., Roy, A. and Choudhury, A. (2018). Agriculture development: Technical and policy options. Biotech books 4762-63/23 Ansari Road, Darya Ganj, New Delhi, 110002.
12. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
13. Pandey, O.P. (2020). Bharat Vaibhav (Hindi) [India's Prosperity]. New Delhi, India: National Book Trust.

17.INTELLECTUAL PROPERTY RIGHTS Credit: 1(1 +0)

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc; Types of Intellectual Property and legislations covering IPR in India: -Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database; Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing. Understanding Intellectual Property rights in ancient India.

References

1. Deepak Verma and Madhu Bala. 2020. National Intellectual Property Rights Policy of India - A Review. In book: Sensitizing and Imparting Awareness about Intellectual Property Rights among Students (pp.125-132). Publisher: National Press Associates.
2. Prabha Sridevan.2015. Intellectual Property in the Ancient Indian Texts. In book: Diversity in Intellectual Property.pp.232-246. Publ: Cambridge University Press.
3. H.S. Chawla. 2020.Introduction to Intellectual Property Rights. Publ: Oxford and IBH Publ. pp312.
4. P.C. Sinha. 2007. Encyclopaedia of Intellectual Property Rights. Publ: Anmol Publications Pvt. Ltd.

18.Nature-based Fish Seed Production Credit: 2(1+1)

Theory

Perception of fish and pisciculture in ancient India; Natural Fish seed resources of India like freshwater, brackish water, sea water and cold water. Types of seed and their identification; Natural fish breeding and natural seed production of different species like common carp, puntius, catfishes (singhi, magur), koi and other self-recruiting species; Riverine seed collection sites, gears used and methods of collection. Embryonic development of various cultivable species. Methods of breeding; Brood stock raising from natural water bodies and their rearing in captivity for quality seed production. Selective breeding, Sympathetic breeding. Evolution of fish hatchery system; Breeding techniques for major fish's carps, minor carps, mahaseers, trouts, tilapias, catfishes, mullets, milk fish, pearl spot, sea bass, for off-season and multiple breeding of carps and others. Preparation of feed by using natural resources at farm level; Rearing techniques of fish seed production, Certification of hatchery and fish seed. Act and rules for protection of natural seed resources and seed.

Practical

Types of different fish seed and Identification of eggs, spawn, fry and fingerlings of different species. Study of maturity stages in fishes and Gonado somatic Index. Histological studies of ovary and testes and study of different reproductive stages. Collection and preservation of fish pituitary gland, preparation of PG extract, Calculation of fecundity. Brood-stock maintenance and selection male and female for injection. Simulation techniques for breeding of fishes. Breeding of prawns, shrimps and crabs etc. Study of fish, prawns, shrimps and crabs eggs and embryonic developmental stages. Preparation and management of nursery and rearing ponds. Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries.

Suggested Readings

1. James, P. Mcvey, 1983. Handbook of Mariculture, CRC press, Florida
2. Thomas. P. C *et al.*, 2003 on "Breeding and seed production of finfish and shellfish" Daya publishing house, New delhi),
3. Jhingran. V. G., 1991, Fish and Fisheries of India, Hindustan Publishers

4. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.

19. **NSS/NCC/Yoga** Non Credit

Theory

Introduction and basic components of NSS: Orientation NSS programmes and activities Understanding youth, Community mobilisation, Social harmony and national integration Volunteerism and shramdan, Citizenship, constitution and human rights Family and society Importance and role of youth leadership, Life competencies, Youth development programmes, Health, hygiene and sanitation, Youth health, lifestyle, HIV AIDS and first aid youth and yoga Vocational skill development, Issues related environment Disaster management, Entrepreneurship development Formulation of production oriented project, Documentation and data reporting, Resource mobilization, Additional life skills, Activities directed by the Central and State Government. All the activities related to the National Service Scheme course is distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load. The entire four courses should be offered continuously for two years. A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two year. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

20. Fundamentals of Entomology Credits: 3 (2 +1)

Theory:

Entomology in ancient India. Historical classics of Modern Entomology . Major points related to dominance of Insecta in Animal kingdom.**General account on nature and type of damage by different arthropods pests**. Classification of phylum Arthropoda up to classes; Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation; Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus; Insect Ecology - Introduction, Environment and its components; Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance; Categories of pests. Stored grain pests.

Solutions for insect pest control in Natural Farming:

Surveillance, Perimeter weeding, Conventional land preparation, Organic manure, plant resistance, Interaction of plant resistance traits and biocontrol agents, crop rotation and planting practices (date of sowing and seed rate), Intercropping/ mixed cropping , trap crops, border crops, Sanitation ,Conserving natural enemies via habitat manipulation, Physical control strategies to reduce pest incidence (exclusion , Pheromone traps, sticky traps, light traps). Physical Control (Temperature, Heat, Pressure, UV trap etc.) , Mechanical Control, Behavioral Control (repellents, anti feedants, Insect Pheromones), Biological Control (Importation, Conservation, Augmentation ; parasitoids predators & pathogens) , Microbial Control (Bt, Beauveria, Metarhizium etc.),. Factors affecting success of biological control :**Narrow host range/ Climatic adaptability/ Synchrony with host life cycle /High reproductive potential / Efficient search ability,/ Short handling time / Survival at low host density**. Botanicals (Plant extracts & Essential oils). Plant bioformulations: agniastra, brahmastra, neemastra, dasparni ark etc. Management of stored grain pests by non-chemical methods. Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of economic importance and their distinguishing characters.

History and economic importance of nematodes: General characters of plant parasitic nematodes, their morphology, symptomatology and control of important plant parasitic nematodes of field and fruits by non chemical methods. Use of various plant bioformulations like agniastra, brahmastra, neemastra, dasparni ark etc. for nematodes management. Metamorphosis, Type of larvae, Type of pupa, Insect integument.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Preparation of agniaster, brahmaster,neemaster, dasparni ark and their application. Sampling techniques for estimation of insect population and damage.

Suggested Readings

1. Ahmad, Salman & Khan, Nadeem &Basri, Rabia & Siddiqui, Saba & Abu Nayyer, Md & Srivastava, Deepti. (2019). Botanicals and Their Application in Control of Insect Pests. In Biofertilizers and Biopesticides in Sustainable Agriculture. Research Gate Publication.
2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
3. Pest and Disease Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.
4. Biological control of Insect pests and Weeds. Chapman and Hall, New York
5. Honey bee Diseases and their Management. Abrol D.P. W Sharma D. Kalyani publishers; New Delhi.
6. Pollination Biology: Biodiversity Conservation and Agricultural Production, Springer :Abrol DP.
7. Honey Bees and their management in India ICAR. N. Delhi India,- Mishra R.C.
8. Agricultural Insect pests of Crops & their management: V.S. Pawan.
9. Textbook of introductory plant nematology: Bajaj and Walia (1st and 2nd Edition)

Note: Add MPUAT referances/ papers

21.Insect Ecology, nematodes and pest Management Credit hours (2+1)

Insect Ecology - Introduction, Environment and its components; Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance; Categories of pests. Stored grain pests.

Solutions for insect pest control in Natural Farming:

Surveillance, Perimeter weeding, Conventional land preparation, Organic manure, plant resistance, Interaction of plant resistance traits and biocontrol agents, crop rotation and planting practices (date of sowing), Intercropping/ mixed cropping , trap crops, border crops, Sanitation ,Conserving natural enemies via habitat manipulation, Physical control strategies to reduce pest incidence (exclusion , Pheromone traps, sticky traps, light traps). Physical Control (Temperature, Heat, Pressure, UV trap etc.) , Mechanical Control, Behavioral Control (repellents, anti feedants, Insect Pheromones), Biological Control (Importation, Conservation, Augmentation ; parasitoids predators & pathogens) , Microbial Control (Bt, Beauveria, Metarhizium etc.),. Factors affecting success of biological control : Narrow host range/ Climatic adaptability/ Synchrony with host life cycle / High reproductive potential / Efficient search ability,/ Short handling time / Survival at low host density. Botanicals (Plant extracts & Essential oils). Plant bioformulations: agniastra, brahmastra, neemastra, dasparni ark etc. Management of stored grain pests by non-chemical methods.

History and economic importance of nematodes: General characters of plant parasitic nematodes, their morphology, symptomatology and control of important plant parasitic nematodes of field and fruits by non chemical methods. Use of various plant bioformulations like agniastra, brahmastra, neemastra, dasparni ark etc. for nematodes management.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Preparation of agniaster, brahmaster,neemaster, dasparni ark and their application. Sampling techniques for estimation of insect population and damage.

Suggested Readings

1. Ahmad, Salman & Khan, Nadeem & Basri, Rabia & Siddiqui, Saba & Abu Nayyer, Md & Srivastava, Deepti. (2019). Botanicals and Their Application in Control of Insect Pests. In Biofertilizers and Biopesticides in Sustainable Agriculture. Research Gate Publication.

2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.

3. Pest and Disease Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

4. Biological control of Insect pests and Weeds. Chapman and Hall, New York

5. Honey bee Diseases and their Management. Abrol D.P. W Sharma D. Kalyani publishers; New Delhi.

6. Pollination Biology: Biodiversity Conservation and Agricultural Production, Springer : Abrol DP.

7. Honey Bees and their management in India ICAR. N. Delhi India,- Mishra R.C.

8. Agricultural Insect pests of Crops & their management: V.S. Pawan.

9. Textbook of introductory plant nematology: Bajaj and Walia (1st and 2nd Edition)

10. Dhaliwal GS, Singh R, and Jindal V.A .2013. Text book of Integrated Pest Management . Kalyani Publishers .

11. South Wood TRE. Henderson PA..2000.Ecplogical Methods. Black well Science

22.BIOINPUTS FOR CROP GROWTH AND PRODUCTION Credits: 4 (2 + 2)

Theory

Defination and types of bioinputs, Importance of bioinputs, Biofertilizers: Definition, history of biofertilizers research in India, types of biofertilizers and their functions, advantages of biofertilizer, potential of biofertilizers for natural farming, Mechanism of action of bioinputs, Multifunctional biofertilizers in consortium mode, solid and liquid biofertilizer formulations, Methods of production application and doses of biofertilizers. Vermicompost: Types of earthworms, ecological groups and identification, Importance of earthworms as ecosystem engineers. Vermicomposting, vermiculture and different products from use of earthworms and their composition & methods. Organic manures, Farm yard manure, Compost, Green manures, Herbal and cow-based bioproducts for nutrient, pest & disease management, Areated & non-areated bioinputs: Methods of production, factors affecting production & use of bioinputs, characterstics of bioinputs, composition of bioinputs, economic of production of bioinputs. Oil cakes, Biochar, Bioformulants, Jeevamrut, Beejamrut and Ghanjeevamrut and Waste decomposer.

Practical

1. Preparation of Panchagavya and study of their use
2. Preparation of Sanjivak and study of their use
3. Preparation of Bramhastra and study of their use
4. Preparation of Agniastra and study of their use
5. Preparation of Neemastra and study of their use
6. Preparation Dasagavya and study of their use
7. Preparation of Dashparni ark and study of their use
8. Preparation of Ginger- Garlic- Chilli extract and study of their use
9. Preparation of Fermented butter milk and study of their use
10. Preparation of Beejamrut, Jeevamrut, Ghanajeevamrut and study of their use
11. Study of physical, chemical and biological characterstics of important bioinputs
12. Project formulation for bioinput production

Suggested Readings

1. Ayangarya Valmiki Sreenivasa. 2006. Organic Tea – A Vrikshayurveda Experience. Agri-History Report No. 1. Asian Agri-History Foundation. pp. 36.

2. Nene YL.2003. Crop Disease Management Practices in Ancient, Medieval, and Pre-modern India. Asian Agri-History. Vol. 7(3):185-201.
3. Nene YL. 2007.Plant Pathology in India Prior to Twentieth Century. *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
4. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
5. Arun Sharma. Biofertilizers. Agrotech Publishing Academy, Udaipur
6. A.C. Gaur. Microbial Technology for Composting of Agricultural residues by improved methods. ICAR.
7. Pest and Disease Management / Soil and Water conservation/ Soil fertility Management/ Garbage disposal and Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

Note: Add reference from MPUAT
Add books on organic farming

23.MARKETING OF NATURAL FARMING PRODUCE Credits: 3(2+1)

Theory

Concepts and definition of market, agricultural marketing, marketing of natural farming products, market structure, marketing mix and market segmentation, Demand, supply and producer's surplus of agricultural commodities marketable and marketed surplus, Pricing consideration and approaches cost based and competition based pricing, market promotion and publicity, Marketing management- segmentation, targeting & positioning, marketing function- physical function, facilitating functions, market functionaries and marketing channels, marketing efficiency, marketing costs, market margin and price spread, Role of government in marketing of natural farming products, public sector institution involved – CWC, SWC, FCI, CACP, APEDA, Risk in marketing-types of risks involved speculation and hedging, forward markets and future markets.

Practical

Study of relationship between market arrival and prices, demand and supply curves, calculation of marketable and marketed surplus, identification of market channels for selected commodities computation of market margin, price spread visit to marketing institutions to study their organization and functioning.

Suggested readings

1. Acharya, S.S. and Agarwal, N.L. 1994. Agricultural Price Analysis and Policy, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Acharya, S.S. and Agarwal, N.L. 2000. Agricultural Marketing in India, Oxford and IBH Publishing Co. New Delhi.
3. G.L. Meena, S.S. Burak, D.C. Pant and Rajesh Sharma. 2017. Fundamentals of Agribusiness Management, Agrotech Publishing Academy, Udaipur, ISBN: 978-81-8321-418-6. First edition.
4. Kahlon, A.S. and George, M.V. 1985. Agricultural Marketing and Price Policy, Allied Publication Pvt. Ltd. New Delhi.
5. Kohls, Richard L. and Uhl, Joseph, N. 1980. Marketing of Agricultural Products, Macmillan Publishing Co. Inc. New York.

6. Mamoria, C.B. and Joshi, R.L. 1971. Principles and practices of Marketing in India, Kitabmahal, Prayagraj.

24. AGRO-ECO-TOURISM Credits: 3 (2+1)

Theory

Basic principles of Agro-Tourism. Scope of Agro-Tourism in India. Components of Agro-eco-tourism. Developing a conceptual framework for Agro–Eco-Tourism. Eco-Tourism as a business. Eco-Certification. Eco-tourism and community development. Importance of local festivals, epics and mythology. Eco-tourism and community development. History, definitions, Scope and importance of landscaping, Principles and Elements of Landscaping, Garden components and adornments, Plants for landscaping. Challenges of eco-tourism in natural farms. Eco-tourism policy in India, Types of eco-tourism, impact on environment, local communities and economy, Development of Agro-ecotourism model. Steps in agro-ecotourism development, Conceptual framework for sustainable events, Basic phases of event management, marketing strategies, Location specific events and festivals, rural games. Ancient healing system of India. Naturopathy as an alternative for holistic lifestyle.

Practical

Visit nearby agro-ecotourism site and understand the management of the site. Preparation of model of latest landscaping designs in Agro–Eco-Tourism. Visit to naturopathy centre and understand the socio-physical benefits of naturopathy. Use of softwares, Apps and mass media tools for promotion of Agro–Eco-Tourism. Hands on experience of community-based management of Agro–Eco-Tourism site. Comparative study of ecotourism policies of different states. Design a sustainable Agro-Eco-Tourism model for a selected natural farm. Graphic symbols and notations in landscape designing, Strategic analysis of event management.

Suggested Reading

1. David Weaver (2008). Eco-Tourism. John Wiley $Sons Australia, Milton. Pp.1-348.
2. G. Poyyamoli (2018). Eco-Tourism Policy in India: Rhetoric and Reality. *Grassroots Journal of Natural Resources*. **1(1)**:46-61.
3. Kreg Lindberg and Donald E. Hawkins (1999). Eco-Tourism A guide for planners and Managers Vol 1 & 2. Natraj Publication, Dehradun.
4. Razaq Raj and James Musgrave (2009) Event Management and Sustainability. CABI publishing house. Cambridge, USA
5. Sara J. Scherr and Jeffrey A. McNeely (2007). Farming with Nature: The Science and Practice of Ecoagriculture. Island Press, Washington.

6. Sarah Ellis Collins (2012). Landscape agriculture: landscape design lessons learned from the farming communities of rural appalachia. a thesis submitted to the graduate faculty of the university of Georgia.
7. Seema Bhatt and Syed Liyakat (2005). Eco-Tourism Development in India: Communities, Conservation and conservation. Center for Environment Education, Ahmedabad
8. Rajput, R. K. 2015. Agrotourism and the Rural Environment. Random Publications, ISBN- 978-9351115410, pp.
9. Rai, U. 2014. Agro tourism as an Alternative form of tourism in Bali Indonesia. Scholars' Press, ISBN- 978-3639667127, pp. 108
10. Tanja A., Petkova, S., Dzordzevic M. and Cvetanka R. 2018. The development of agro-tourism in the North eastern Macedonia. LAP Lambert Academic Publishing, ISBN- 978-6139850044, pp. 56
11. S.G Walke, Atul Kumar Yadav and Vinaydeep Brar. 2020. Agrotourism Management. LAP Lambert Academic Publishing, ISBN- 978-6202518604, pp. 212
12. Andreas Papandreou. 2018. The Management in the Modern Agro-Tourism Sector in Greece. Scholars' Press, ISBN- 978-6202318730, pp. 56
13. Abbas ShahdiKumleh and Maryam Foroughi. 2018. Agro-Eco-Tourism in Central-West Asia. LAP LAMBERT Academic Publishing, ISBN: 9786138234425, pp. 124.
14. A.K. Tiwari and R. Kumar. 2012. Fundamentals of ornamental horticulture and landscape gardening. New India.
15. Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P. 2004. Floriculture and Landscaping Nayaprakash, Calcutta.
16. Bimal Das Chowdhury and Balai Lal Jana. 2014. Flowering Garden trees. Pointer publishers, Jaipur. India.
17. Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
18. Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.

25. ORCHARD MANAGEMENT UNDER NATURAL FARMING Credits 1+1=2

Theory

Orchard management – defined. Principles of orchard management. Importance and scope of orchard management. Orchard soil management in relation to nutrient and water uptake and their effect on soil environment. Clean cultivation and sod culture .Intercrops - types and its role in nutrient management. Biological efficiency of cropping systems in horticulture. Orchard establishment – principles and strategies. Types of planting system for fruit plants in natural farming. Competitive and complimentary effect of root and shoot systems. Type of mulches - sod mulch and organic mulches for soil moisture and nutrients management. Irrigation – defined. Systems of irrigation for natural farming in fruit crops. Soil microbes and their role for sustainable horticultural crop production system. Training and pruning defined. Methods of training and training of important fruit trees. High density planting (HDP) and meadow orchards and its management. Rejuvenation of old orchards - top working and frame working. Integrated pest and disease management (IPDM). Integrated nutrient management (INM). Crop regulation in relation in fruit crops. Management of resources constraints in existing systems. Climate aberrations and mitigation measures of horticultural crops. Orchard management of important tropical, sub-tropical and temperate fruit crops. ITK for management of Orchards.

Practical: Selection of site for orchard establishment. Different planting systems and its layout – triangular system, contour lines, double row system, rectangular and square. Preparation of pit and procedures for filling. Soil depth and slope for fruit tree plantation. Irrigation methods and application of water to fruit crops. Growing of intercrops ginger, turmeric, colocasia, cowpea, cabbage and green manuring. Filler crops – defined and their use in young orchard. Training and pruning methods of important tropical, sub-tropical and temperate fruit crops. Weed management in orchard. Use of plant based products and microbes for plant protection of tropical, sub-tropical and temperate fruit crops. Mulching of fruit crops. Use of bio-fertilizer in horticultural crops.

Suggested Reading

1. Horticultural crops. 2004. Inventory of Indigenous Technical Knowledge in Agriculture. ICAR. Document 2, Supplement 1. 84-100 pp.
2. Horticultural crops. 2004. Inventory of Indigenous Technical Knowledge in Agriculture. ICAR. Document 2, Supplement 2. 111-136 pp.
3. K. K. Sharma and N.P. Singh. (2021). Soil and Orchard Management. Daya Publishing House.
4. Horticultural Crops/ Pest and Disease Management / Soil and Water conservation/ Soil fertility Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

26.AQUA-BASED NATURAL FARMING Credits:3 (2+1)

THEORY

Physical, Biological and Components of aquatic ecosystem, Ecological structure and function of Aquatic ecosystem, Organic matter recycling and nutrient cycles, food web and food chain, Heterotrophic activities, energy and matter flow in the ecosystem, eutrophication and pollution. Definition and scope of aquaculture. Global and national scenario, Trends and constraints, Different aquaculture systems and utilization of natural food, pond, pen, enhanced fisheries, Pre-stocking, stocking and post-stocking interventions for primary Fish survival and growth, Aquaculture and climate change, Natural productivity and carrying capacity, Secondary and tertiary production, Carrying capacity of aquaculture system and associated factors, Natural food and feeding behavior of fishes and shellfishes: Concept of ecosystem-based aquaculture, Integration of crop, live-stock, horticulture and fish farming as complimentary activities, Comparative nutritional value and decomposition of different types of organic wastes on organic productivity, Nutrient values of common animal waste and agro-residues as potential manures, Biofertilizer. Definition of reservoirs in India; nature and extent of reservoirs, pen and cage culture in reservoir. Health managment in Aquaculture, Traditional techniques for curing fish diseases and pond management, Probiotics and bioremediation. Renewable and eco-friendlybio-inputs in aquaculture, Management and conservation natural aquatic ecosystems

Practical

Identification of important cultivable species. Estimation of carrying capacity. Practices on pre-stocking, stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH_3, Organic matter, CO_2). Analysis of certified manure/natural aquaculture inputs. Measurement of important soil and water quality parameters and their correction measures with certified standard materials/inputs. Preparation of artificial feeds using locally available permitted feed ingredients. Identification of different live food organisms and their rearing/culture with standard methods. Case studies on cage and pen culture.

Suggested Readings

1. Midlen and Redding T. A., 1998. Environmental Management for Aquaculture. Kluwer.
2. Pillay T. V. R., 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambrige University Press, Cambridge.
3. Bardach. J. E., 1997. Sustainable Aquaculture. John Willey and Sons.
4. Bardach, J. E., Rhyther, J. H. and Mc. Larney, W. O., 1972. Aquaculture Farming and Husbandry of Freshwater and Marine Organisms. John Wiley and Sons.
5. Chavin, W. (Ed.)., 1973. Responses of Fish to Environmental Changes. Charles C Thomas Publ
6. Rankin, J. C, and Jensen, F. B., 1996. Fish Ecophysiology. Chapman and Hall.
7. Zaman, A. Integrated farming system and agricultural sustainability. New India Publishing Agency- Nipa.
8. Adhikari, S. and Chatterjee, D. K., 2008. Management of Tropical Freshwater Ponds. Daya Publishing House.
9. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
10. Boyd, C. E., 1979. Water Quality in Warm Water Fish Ponds. Auburn University.
11. Fisheries. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

27.CROP IMPROVEMENT **Credits 4 (3+1)**

Theory

Genetic basis of crop Improvement: Laws of inheritance; qualitative and quantitative traits; multiple factor hypothesis; pureline theory; components of phenotypic variance; GXE interaction; heritability; breeder's equation; populations/ landraces/ varieties/ cultivars; Hardy Weinberg equilibrium and factors effecting it. Assortative and dissortative mating; Difference between self-pollinated, cross pollinated and clonal populations. Important physiological parameters for crop improvement- photosynthesis, transpiration, water and mineral regulation. Breeding objectives under natural farming systems- Nutrient Use Efficiency; Tolerance to micronutrient, mineral deficiencies and toxicities; Weed competitiveness; Enhanced Interaction with Rhizospheric microorganisms; Multiple Disease and Insect Resistance; Quality; Earliness/ crop duration to suit multiple cropping system and agroecologies; Wider adaptability and stability; Broad genetic base / population heterogeneity; High yield; Multipurpose crops- stay green, food, feed, fiber and fuel. Plant breeding techniques: Domestication, introduction, Selection, hybridization; Breeding self-pollinated crops- Pureline selection, mass selection, pedigree selection, mass selection, SSD, backcross breeding; Breeding cross pollinated crops- Population improvement, recurrent selection, composite and synthetic varieties; Improving clonally propagated crops- clonal selection. Farmer participatory plant breeding. Molecular markers; Marker Assisted Selection (MAS); comparison of MAS vs. Phenotypic selection.

Practical

1. Study of floral biology of different crops
2. Hybridization techniques
3. DUS characterization important land races and traditional varieties of crops
4. Breeding methods for natural farming
5. Study of root characteristics of crops grown under natural and other production systems
6. Learning of techniques of participatory plant breeding
7. Techniques of conservation of plant genetic resources
8. PRA for mapping indigenous crops & their characteristics

9. Seed identification & collection for natural farming systems
10. Identification of important land races and traditional varieties of crops
11. Identification of important land races and traditional varieties of fruit crops

Suggested Readings

1. Chahal, G.S. and S.S. Ghosal. 2019. Principles and Procedures of Plant Breeding,
2. Chopra, V.L. 2004. Plant Breeding. Oxford & IBH Publishing Co Pvt Ltd, New Delhi
3. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participa- tory approaches in plant breeding for low-input systems. *Euphytica*. 2008; 160:143–54.
4. Fess TL, Kotcon JB, Benedito AV. Crop breeding for low input agriculture: a sustainable response to feed a growing world population. *Sustainability*. 2011; 3:1742–72.
5. Lammerts van Bueren ET, 2002. Organic plant breeding and propagation: concepts and strategies. Ph. D. Thesis, Wageningen University, the Netherlands
6. Lammerts van Bueren, E.T., Jones, S. S., Tamm, L., Murphy, K.M., Myers, J.R., Leifert, C. and Messmer, M.M. (2011). The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review. NJAS - Wageningen, Journal of Life Sciences 580: 193-205.
7. Phillips SL, Wolfe MS. Evolutionary plant breeding for low input systems. *J Agric Sci.* 2005; 143:245.
8. Singh A K. 2007. Plant Biodiversity and Agriculture in India: A Historical Perspective. *In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 493-505.
9. Ranganathan Nithya. 2018. *Drumavichitrikaranam* - The Ancient Approach to Plant Mutagenesis, Asian Agri-History, Vol. 22(3): 218-225.
10. Geographical Indications of Plant Species. In Inventory of Indigenous Technical Knowledge in Agriculture Document 5; Publ: ICAR New Delhi.

28.RENEWABLE ENERGY SOURCES **Credits: 3 (2+1)**

Theory

Introduction to energy, Forms of energy, Conservation of Energy, Sources of energy and their classification, Energy consumption patterns in India, Concept of renewable energy sources, Potential of renewable energy sources, classification of renewable energy sources, ecological footprint, carbon footprint. Role of renewable energy in natural farming and its impact on food system, environment and economy, Solar Energy: Introduction of solar energy, solar radiation, Solar collector and its types, Solar thermal energy systems: solar cooker, solar distillation, solar water heater, solar dryer, Fundamental of Solar PV cells, types of solar cells, Solar photovoltaic systems and their different types & uses, soil solarization. Biomass Energy: Introduction of biomass, characterisation of biomass, value addition to biomass, biogas - types of biogas plants, How to construct & maintenance of Gobar gas plants. biogas generation and its application, usage of biogas spent slurry, Pyrolysis of Biomass, Biomass Gasification- types of gasifiers, producer gas production and utilization, Introduction to ethanol biodiesel and hydrogen production process. Wind Energy: Introduction, Principle of wind energy conversion, Windmill, Components of windmill, Types of windmill rotors, Applications of windmill. Hydro Energy: Introduction of hydro energy, Hydropower Plants and Classification, applications of hydro energy. Role of renewable energy in carbon mitigation. Energy balance in natural farming, Programmes and policies for promotion of renewable energy in India.

Practical

1. Visit of a farm to study different source of energy and their consumption
2. Study of solar cooker
3. Study of solar dryer
4. Study of solar water heater
5. Study of solar distillation
6. Study of solar photovoltaic system
7. Study of biogas plant
8. Study of biomass gasifier
9. Study of improved biomass cookstove
10. Study of wind energy system

11. Study of hydro energy system
12. Determination of energy balance in natural farming

Suggested Readings

1. Rai, GD (2013). Non-Conventional Energy Sources, Khanna Publishers, Delhi. 2013.
2. Rai, GD (2013). Solar Energy Utilization, Khanna Publishers, New Delhi
3. Kothari DP, Singal KC and Ranjan R (2008) Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., New Delhi
4. Rathore NS and Panwar NL (2021). Fundamentals of Renewable Energy, New India Publishing Agency, New Delhi
5. Seveda MS, Narale P and Kharpude SN (2021). Advances in Renewable Energy Engineering, Narendra Publishing House, New Delhi
6. Solanki CS (2008). Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
7. Rathore NS, Panwar NL (2021). Biomass Production and Efficient Utilization for Energy Generation" New India Publishing Agency, New Delhi

29.COMMUNITY MOBILIZATION FOR NATURAL FARMING Credits:3 (2 + 1)

Theory

Motivation–Definition, meaning, theories of motivation, importance, motivation cycle, classification of motives, types of motivation, techniques of motivation, role/importance/factors of motivation. Conflict- Meaning, management techniques. Community mobilization- Importance, requirements, strategies, steps, benefits. Yoga for community mobilization- History, purpose, concepts, importance, types, benefits. SWOT Analysis- Meaning, advantages, case study. Social core value systems- Ethical principles, purpose, benefits. Development of understanding about rural society, Behavioural change and attitude. Programme Planning- Introduction, need and interest, concept, objectives and principles, process. Organizational structure- Define, key elements, types, span of control, centralization and decentralization, formalization. Diffusion and Adoption Process- Define, meaning and Stages. Process for group formation (SHG, FPO/FPC, FBO etc.)- Define, group formation, modes of group development, stages of SHG development, FPO- benefits, activities to be undertaken by FPO, implementing agencies to form and promote FPOs, application procedure, loan to FPO. Capacity building and institutionalizing mechanism- Counseling and Mentoring- Meaning, define, process, Philosophy. Training methodology for capacity building in natural farming. Monitoring and Evaluation- Define, objectives, types, concept, difference, importance. Impact analysis on social, economic and environmental effects of natural farming. Case studies in community mobilization. Uses of traditional media in agricultural information communication.

Practical

Studies of motivation techniques. Exercise on Yoga. SWOT analysis of organization/institution/company. Visit of organization in volved in community mobilization. Study of the social core value systems. Study of procedure and formation of SHG, FPO, FBO and methods of working. Organize training on capacity building programme.

Suggested Reading

1. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
2. R.R. Prasad. Community Mobilization – Methods and Models. Publ : Discovery Publishing House Pvt. Ltd.

30.Entrepreneurship Development and Business Communication Credits 2(1+1)

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of Entrepreneurs; SWOT analysis and achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneural Development process, Business Leadership skills, Developing organizational skills (controlling, supervising, problem solving, monitoring and evaluation), Developing Managerial skills, Business Leadership skills (Communication, direction and motivation skills), Problem solving skill, supply chain management and Total quality management, Project planning formulation and report preparation; Financing of enterprise, opportunities for agri-entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement, motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Suggested reading

1. Vasant Desai and Urmila Rai .2010. Entrepreneurship Development And Business Communication.Publ: Low Price Publication.
2. N. Chavda. Entrepreneurship Development and Communication Skill.Publ: AgriMoon.
3. Sagar Mondal.2021. Entrepreneurship Development and Business Communication. Publ: Kalyani Publishers.
4. S.B. Das, S.B.R. Nahatkar and Dhirendra Khare. 2022. Agri entrepreneurship oppurtunities. Publ: Scientific Publisher, Jodhpur.

31. ICT APPLICATIONS FOR NATURAL FARMING/AGRI- INFORMATICS Credit: 2(1+1)

Theory

ICT and its importance – Computer Fundamentals - Basic anatomy of the computer system: Input devices, CPU, Output devices, Memory: Primary and secondary - Software – Types: System software, Application software and Utility software – Software terminologies: Firmware, Liveware, Freeware, Shareware, Commercial software, Proprietary software, Semi-free software, Open Source. Internet - World Wide Web – URL – Domain names - Protocols: HTTP, HTTPS - Internet Applications: Email, File sharing web apps, Social Networks, Online shopping, Video Conferencing – HTML: Introduction, Editor, HTML Documents – Tags: Website development. Convergence technologies - Internet of Things (IoT) – Definition and characteristics – Wireless Sensor Network (WSN) – IoT based automation in agriculture – Precision Agriculture. Cloud computing – Big data Analytics – Block chain technology – Cyber physical systems. Imaging Technologies: Drone, Image Processing and Augmented reality, Virtual reality and Extended reality (AR, VR and XR). Communications Protocols: Barcodes, Quick Response/QR Codes, RFID, Near Field Communication/NFC and Bluetooth.

Practical

Innards of computer – Boot and shutdown – Windows apps: Sticky Notes, Steps Recorder, Snipping Tool – Pin and unpin the programs – System tray customization – Shortcut keys - Software practices. Installation / Uninstallation – Practice of DOS commands: dir, cd, mkdir, rmdir, del, cls, attrib, ren, copy, move, ipconfig, ping. Microsoft Excel - Entering a formula in a cell, Built-in functions: SUM, AVERAGE, MIN, MAX, COUNT, COUNTIF, IF – Import and export data - Charts - Create Bar and Pie charts – PIVOT table. MS-ACCESS: Creating agriculture database – Entering, editing, deleting data – Creating Forms - Query wizard: select, update, delete – Reports. Internet Applications: Email, File sharing web apps: Dropbox, Google drive - Social Networks, Online shopping, Video Conferencing – Creating a web page. Case study on machine learning applications in agriculture - Case study on Deep learning applications in agriculture - Agricultural Internet of Things (Ag - IoT).

Suggested Readings

32.SEED PRODUCTION TECHNOLOGY Credits 3 (2 + 1)

Theory

Seed quality: definition and concept of seed quality. Classification of seed, Use of biodiversity for seed production, Formal and informal seed production systems. Principles of seed production of important cereals, pulses, oilseeds, fodder crops vegetables. Seed Physiology: Seed Germination, viability, seed dormancy, types and requirements of seed germination, Seed health Quality seed collection from natural farming. Seed Legislation, Seed testing, Varietal identification through Grow Out Test and Electrophoresis, Biochemical tests and Molecular tools. Minimum Seed Certification standards, field standards and seed standards. Seed drying and processing, Orthodox seed and recalcitrant seeds. General principles, stages and factors affecting seed longevity during storage and handling. Seed Village Concepts (seed self reliance), types and significance of indigenous seed conservation, community seed banks. Seed marketing, Role of WTO and OECD in seed marketing. Seed production, collection, storage and quality control in context with Natural farming. Technology of Seed Health during ancient time, Materials recommended (plant based, animal based) in ancient time for seed treatments. Sample case study of a few Farmers initiative on conservation of seed in different states of India. PPVFR act (2001) and Suo generis plant variety law approach, ITKs in seed storage and seed health as compiled by ICAR.

Practical

Seed production in major self-pollinated crops. Seed production in major cross-pollinated crops. Seed production in select vegetable crops. Seed sampling procedures. Seed testing: Steps, Physical purity, moisture test, varietal purity. RPL, germination, viability, Grow out test and electrophoresis, etc. Seedling vigour tests, Seed health tests. Genetic purity test: moisture tests, heterogeneity. Seed certification: Procedure, Field inspection, Taking of field counts, Preparation of field inspection and seed testing reports, Seed collection and rural improved storages. Visits to seed production farms, seed testing laboratories and seed processing plants.

Suggested Readings

1. Andersen MM, Landes X, Xiang W, Anyshchenko A, Falhof J, Osterberg JT, et al. Feasibility of new breeding techniques for organic farming. *Trends Plant Sci.* 2015; 20:426–434.

2. Borgen A. (2009). Present and future system organization of organic plant breeding, in: 1 IFOAM Int. Conference on Organic Animal and Plant Breeding Ed. A Zschoke pp 253-255. IFOAM, Santa Fe, New Mexico, USA.
3. Chahal, G.S. and S.S. Ghosal. 2019. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishing House Pvt. Ltd. New Delhi
4. Dawson JC, Murphy KM, Jones SS. Decentralized selection and participatory approaches in plant breeding for low-input systems. *Euphytica*. 2008; 160:143–54.
5. Fess TL, Kotcon JB, Benedito AV. Crop breeding for low input agriculture: a sustainable response to feed a growing world population. *Sustainability*. 2011; 3:1742–72.
6. Phillips SL, Wolfe MS. Evolutionary plant breeding for low input systems. *J Agric Sci.* 2005; 143:245.
7. Singh, B.D. 2018. Plant Breeding-Principles and Methods. Kalyani. Publishers, Ludhiana.
8. Nene YL. 2007. Seed Health in Ancient and Medieval History and its Relevance to Present-day Agriculture.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 533-553.
9. R.M/ Chauhan. 2022. Indigenous seeds and Bhumisuposhan. In Bhumi Suposhan-Commemorative Publication of the Nationwide Bhumi Suposhan and Samrakshan Abhiyan, Akshay Krishi Paravar, Publication No.11. pp112-117.
10. Mone, S. (2016). A source book on India's organic seeds. The Organic Farming Association of India. pp 104.

33. BENEFICIAL INSECTS **Credits: 3(2+1)**

Theory

Ecological understanding of insects in natural farming, Study of their life cycle, population dynamics and interaction with other abiotic and biotic components in a natural farming ecosystem, Decomposers (insects) in natural farming system, Pollinators in natural farming systems, their kinds, types, diversity, conservation and profitable use for enhancing productivity in terms of quality and quantity, Natural enemies of poriferous insect's generalist predators, specific predators, parasitoids (egg, larval, pupal & intermediary) and entomopathogens to manage pests below economic threshold levels, Insects in ecological communities, Insects as food , soil builders and insects of aesthetic value, Promotion of required habitat for friendly insects, Pollinators: Pollinators, bee biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease; Bee pasturage, bee foraging and communication; Insect pests and diseases of honey bee. Role of pollinators in cross pollinated plants, Indigenous technical knowledge on management of insect pests, Knowledge and importance of beneficial insects in ancient India.

Practicals

Rearing dung beetles for decomposing organic wastes as manure, Pollinators-diversity, species richness and their use in enhancing productivity of crops, Natural enemies- diversity, species richness, their conservation in in situ and wherever possible, artificial rearing for using pest management. Collection of beneficial insects, study of life cycle & habitats of beneficial insects, crop wise applications of beneficial insects for pest control.

Suggested Readings

1. Beneficial insects: By- David V. Alford
2. Choudhary, S.L., G.S. Sharma and Y.L. Nene (eds). 2000. Ancient and Medieval History of Indian Agriculture and its relevance to Sustainable Agriculture in the 21st Century. Proceedings of the summer school held from 28th May to 17th June 1999, Rajasthan College of Agriculture, Udaipur, India pp363.
3. Handbook of Entomology (4th Edition) By: - T.V. Prasad
4. The Insects: Beneficial and Harmful Aspects, By: - Danstan P. Ambrose
5. Beneficial Insects: Arthropods- insects General: By Barnes & Noble
6. Getanjaly, Vijay Laxmi Rai, Preeti Sharma and Ranjit Kushwaha, 2015. Beneficial Insects and their Value to Agriculture. Res. J. Agriculture and Forestry Sci. Vol. 3(5), 25-30.

7. Reddy, A, Anusha, C., Ramprasad, B., Kumar, R & V. Daravath. (2022). Importance of Beneficial Insects in Agriculture. In Research Trends in Multidisciplinary Research and Development (pp.7-24) Publisher: Wiser publications, Germany

34. BIO-INPUTS FOR PEST MANAGEMENT Credit: 4(2 +2)

Theory

Defination and concept of bioinputs, Phytochemicals: Definition and types of Ryania, Rotenone, Pyrethrin/ Pyrethrum, Nicotine, Azadirachtin, Sabadilla, Avermectins, Spinosads, Side effects of chemical insecticide & herbicides, Botanical herbicides for pest management: Natural plant products for weed management, botanicals for pest management, bioherbicides; Plant extracts (raw/aqueous/methanolic etc). Preparation of raw extract- Parthenium, Mellilotus, Physalis, Jasminum, Ocimum, Calotropis, Ageratum, Eichinichloa, Cyperus, Blumeala, Tephrosea, Carica papaya, Hibiscus, Tagetus, Cannabis, Karanga, Acoraus calamus, Eupatorium, Mikania, Mimosa. Trichoderma: *Trichoderma* species: Description and identification, as an antagonistic biocontrol agent for plant diseases management, as a plant growth promoter, as a natural decomposer, as a bioremediation, solid and liquid fermentation technology for mass production of Trichoderma- Materials required, methodology, inoculation method, shelf-life study, quality parameters, precautions. Entomopathogenic fungi: *Beauveriabassiana, Metarhiziumanisopliae., Nomorearileyii, Leacinicilliumlecani*- History of entomopathogenic fungi, Entomopathogenicity, role environmental factors, uses as a bioagents, Solid substrate and liquid fermentation technology. Biological management: Diseases caused by phytopathogenic bacteria, fungi, viruses and nematode. Mode of action: Competition, antibiosis, plant regulators, coiling, lysis, SAR, ISR, enhancement of nutrient uptake. Microbial biopesticides: Bacteria, fungi and viruses for insect and weed control. Nematodes for insect control. Pheromones, plant essential oils, sticky traps, bird perches, light traps. Botanical insecticides: Repellents, antifeedants, toxicants, natural grain protectants, reproduction inhibitors, insect growth & development inhibitors, NSKE (Neem seed kernel extract). Preparations of raw extract of commonly available plants with herbicidal activity (*Parthenium*, *Mellilotus*, *Jasminum*, *Ocimum*etc) and testing its herbicidal activity in field. Ancient heritage and ITKs in plant protection. Various inputs and raw materials used in plant protection

Practicals

Evaluation of antagonistic organisms against plant pathogents, Enumeration of Trichoderma population in soil, Bio-efficacy study of entomopathogenic fungi, Field evaluation of Sticky

traps and Light traps, Preparation and evaluation of NSKE, Preparation of different ITK based formulations for pest management in crops

Suggested Readings

1. Principles of organic farming: S.R. Reddy. Kalyani Publisher
2. Burges HD and Hussey NW. (Eds.). 1971. Microbial Control of Insects and Mites. Academic Press, London.
3. Chapman and Hall, New York. Huffakar CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
4. Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. Laboratory Exercises in Plant Pathology: An Instructional Kit. Scientific Publ., Jodhpur.
5. Dhingra OD & Sinclair JB. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo. Fox RTV. 1993. Principles of Diagnostic Techniques in Plant Pathology, CABI Wallington.
6. Nene YL.2003. Crop Disease Management Practices in Ancient, Medieval, and Pre-modern India. Asian Agri-History. Vol. 7(3):185-201.
7. Choudhary SL and Saxena RC. 2007. Plant Protection in Medieval and Modern Indian Agriculture.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
8. Arun Sharma. Biofertilizers. Agrotech Publishing Academy, Udaipur
9. A.C. Gaur. Microbial Technology for Composting of Agricultural residues by improved methods. ICAR.
10. Pest and Disease Management / Soil and Water conservation/ Soil fertility Management/ Garbage disposal and Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1& 2); Document 3; Publ: ICAR New Delhi.

35. Bio-Resources and Agricultural Crop Residue Management Credits: 3(2+1)

Theory

Introduction to bio-resources and agricultural waste, Classification and characterization of agricultural waste including animal wastes, Principles of agricultural waste management: RRR approach, Potential of recyclable crop residues and its management, In-situ management of agricultural waste, Role of soil and plants in waste management, Impact of agro-waste on soil and plant quality and the environment. Pre-treatment of agricultural wastes, Need of bio waste pre-treatment, Pre-treatment methods: physical, chemical and biological treatment, Biological processes of waste management, Composting and vermicomposting for bio conservation of biodegradable waste, Manure management during pre-spreading and spreading phase, Methods of preparation of different organic liquid manures from bio-resources. Bio-conversion technology: organic manure, composting, vermicomposting, biogas generation, operation and management of biogas plants, utilization of biogas and spent slurry, landfill Thermo-conversion technology: combustion, incineration, Production of natural source of dietary fiber; antioxidants; pectin; enzymes; organic acids such as acetic acid, ferulic acid, lactic acid and citric acid, Farm waste management machinery, Environmental benefit of waste management, Standards to bio- wastes and manures. ITK information on waste management as compiled by ICAR.

Practical

Visit to various agri-farms and industries using waste and food by-products, Collection and preparation of agricultural waste sample, Characterization of agricultural waste, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Determination of pH, EC and CEC, Determination of BOD and COD, Nutrient status (N, P, K, and micronutrients) analysis of agricultural waste, Survey of different agri waste from livestock, dairy, food processing, fruit & vegetable and agri-chemicals, Study of different types of composting and Vermicomposting, Study of biogas production process and Study briquetting of agricultural residues.

Suggested Readings

1. Agricultural Waste Diversity and Sustainability Issues.2021. Ed(s): Peter Onu, Charles Mbohwa. Academic Press.pp 187.

2. ZainulAkmar Zakaria. 2019.Sustainable Technologies for the Management of Agricultural Wastes (Applied Environmental Science and Engineering for a Sustainable Future)

3. Deepthi Reddy M. Devender, RojaMandapati. 2018.Agricultural Waste Management ICAR

4. D.C. Joshi and S.R. Choudhary B.N. Swami. 2006.Agricultural Organic Waste-Ii (Management for Crop Production).
5. M.S. Shaktawat, N.C. Aery, M.K. Katewa Mohan Singh, B.N. Swami .2004. Phosphate Rich Organic Manure (Prom).
6. Waste water Management/ Garbage disposal and Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

36. STANDARDS AND CERTIFICATION FOR NATURAL FARMING Credit: 3(2+1)

Theory

Fundamentals of certification, types and process of certification in agriculture, Certification program, standards, compliance assessment procedures, documentation, verification and grant of certification, International and national regulations on quality assurance and certification for Non-chemical farming systems, ISO systems based third party certification, Participatory Guarantee Systems, Natural farming certification, Other types of certification systems, On-field management of standard compliance and documentation, Individual and grower group certification management, Certification of crop, livestock, aquaculture and other systems, Certification of processing, handling, trading and management of traceability.

Practicals

Documentation of certification procedures, acquaintance with record keeping, handling, labeling and preparation of farmers IDs for developing ICS/ groups. Visit to certification bodies, certified farms, certified processing and handling operations. Development of organic system plan for specific production system. Development of inspection format and checklists for specific production system. Development of operating procedures on specific aspects. Risk assessment on organic farms and possible mitigating measures. Running of audit trails in certified operations. Mock inspections of different production systems. Exercise on inspection report/ peer evaluation checklist review and certification decision. Exercise on methods of yield assessment.

Suggested Readings:

1. APEDA, 2018. National Programme for Organic Production- A Training Manual. Pub: Agricultural and Processed Food Products Export Development Authority (APEDA), Ministry of Commerce and Industry, Govt. of India, NCUI Complex, August Kranti Marg, New Delhi. (https://apeda.gov.in/apedawebsite/Announcements/NPOP_Training_Manual_English_E_Book.pdf)
2. Coleby, P., 2010. Natural Cattle Care, 1st edition. Pub: Acres U.S.A.; ISBN-10: 0911311688, ISBN-13: 978-0911311686. pp. 214.
3. https://agritech.tnau.ac.in/org_farm/orgfarm_index.html.
4. https://www.agrifarming.in/home-fish-farming-in-india-a-full-guide
5. https://www.agrifarming.in/organic-aquaculture-in-india-organic-fish-farming
6. https://www.fao.org/3/i2734e/i2734e04c.pdf:Proceedings of the Global Conference on Aquaculture 2010- Farming. Expert Panel Review 4.3: Organic aquaculture: the future of expanding niche markets.

7. https://www.iucn.org/sites/dev/files/import/downloads/annexes_iucn_poyang_lake_report_8_17_10.pdf: CBD Guidelines – The Ecosystem Approach.
8. National Standards for Organic Production, 2005. National Programme for Organic Production., Department of Commerce. Ministry of Commerce and Industry, 21-36.
9. Paajane, T., 2011. The Complete Guide to Livestock Farming: Everything You Need to Know About Natural Farming on a Small Scale (Back to Basics Farming), Pub: Atlantic Publishing Group Inc., ISBN-10: 1601383819, ISBN-13: 978-1601383815.
10. Reddy, S. R., 2017. Principles of Organic Farming (As per ICAR New Syllabus). Pub: KALYANI Publishers. ISBN: 9789327274479, 9327274474.

37.VALUE CHAIN MANAGEMENT IN NATURAL FARMING Credit: 3(2+1)

Theory

Concept of agriculture value chain, peculiar characteristics of value chain management in natural farming, types of value chains, role and importance of value chains. Dynamics of renewable and non-renewable resources, resource scarcity, pricing and valuation of natural resources. Good agriculture practices, good manufacturing and good processing practices. Value chain models- Producer driven, buyer driven, facilitated model's role of farmer producer organization in value chains of natural farming products. Market initiation and strategies, organization of value chains, roles and responsibilities of stake holders of value chain, transportation, logistics and infrastructure, cold chain components, dispute resolutions and arbitration, physical asset collateralization. Quality certification like HACCP and FSSAI standards. Postharvest, quality, and value-added aspects for domestic and export market special economic zones. Theory of storage and Warehouses – Types, Classification, Advantages and disadvantages.

Practical

Case studies and success stories on natural farming value chains in India and abroad, environmental resource accounting techniques, visit of special economic zones, identification of value chains for commodities, identification of niche markets for natural farming produces. Post Harvest loss assessment.

Suggested Readings:

1. Gulati, A., Ganguly, K. &Harshwardhan. 2022. Agriculture value chains in India. Springer Open Access Book, India Studies in Business & Economics.
2. Faires, Nicole. 2022. The Ultimate Guide to Natural Farming and Sustainable Living, Skyhorse Publishing, ISBN- 9781634502818.
3. Carlson G.A., Miranowski J., & Zilberman D. 1998. Agricultural and Environmental Resource Economics. Oxford Univ. Press.
4. Conrad J.M. & Clark C.W. 1997. Natural Resource Economics: Notes and Problems, Cambridge University Press.

5. Prato T. 1998. Natural Resource and Environmental Economics. Iowa State Univ. Press.
6. Sterner T. 2003. Policy Instruments for Environmental and Natural Resource management. Resources for the Future, Washington DC.
7. Singh, R., Naik, D. and Feroze. S.M. (2014). Agri-Business potentials in India: Experiences from Hill states. EBH Publishers India136, M.L. Nehru Road, Pan Bazaar, Guwahati-781001.
8. Singh, R., Yumnam, A., Roy, A. and Choudhury, A. (2018). Agriculture development: Technical and policy options. Biotech books 4762-63/23 Ansari Road, Darya Ganj, New Delhi, 110002.

38.COW BASED NATURAL FARMING Credits: 3 (2+1)

Theory

Sociology of natural farming, Indian Livestock scenario, Indigenous livestock breeds of cattle, Differentiating features of indigenous, crossbred and exotic cattle, Traditional livestock farming practices, Draft animal power in natural farming, Feeding cattle at various phases, Forage production, Hay making, Preventive health care practices, Bio efficacy of cow urine on crop production, Effect of different organic inputs on yield, quality and soil properties, Effects of cow urine and its major constituents on pasture properties, Cow based rearing systems: Land, feed and water requirement of traditional farming method, Advantage of cow based natural farming methods, Economics of cultivation and comparison with currently adopted practices, Role of cow based faring system in utilising the available cattle (Desi cow) as valuable resource, Cost of cultivation having cow based natural farming, Composition and constituents of desi cow milk vs cross breeds; role of tryptophan precursor of serotonin helps in relaxing human mind and better sleep, role of A2 Milk helps in controlling blood sugar level,Sustainable agriculture and fodder business, Natural farming business and Entrepreneurship development. Supply chain management, Application of bio gas in agriculture, Traditional therapies for various aliments. ITKs in cow based natural farming.

Practical

Assessment of feed and fodder requirement of desi cow, Chemical composition of various locally available feed stuffs, Chemical composition of desi cow milk and its important constituent with regards to human health, Production and use of Panchgavya in natural farming, Composition of Natural pesticides & fungicides from cow dung and milk products, Neemastram (prepared with Neem extract, cow urine, cow dung and water), Fermented buttermilk from desi cow, Decoctions prepared with Aegle marmelos, and Asafoetida and fermented buttermilk, Jeevamrut, Beejamrut, Ghanjeevamrut, Preparations and use of cow based products in agriculture operations, Physio-biochemical analysis of cow urine, Visit to biogas plant

Suggested Reading

1. Banerjee GC. 1989. Text Book of Animal Husbandry. Oxford and IBH.
2. ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.

3. Sastry NSR & Thomas CK. 1991. Dairy Bovine Production. Kalyani Publishers.
4. Thomas CK & Sastry NSR. 2013. Livestock Production Management. Kalyani Publishers.
5. Nivsarkar A E, Vij P K and Tantia M S. 2000. Animal genetic Resources of India: Cattle and Buffalo, by ICAR- KAB, New Delhi- 110012, pp 382.
6. Taparia AL.2007.A Historical Overview of Animal Husbandry in Ancient and Medieval India. In. Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp.151-156.
7. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

39. Livestock and Poultry production Credit: 4(3+1)

Theory

Heritage perspective and General Livestock Management: Historical account of livestock in India Vedic, medieval and modern era. Farming and characteristics of farming in India. Classification of farming and systems. Demographic distribution of livestock and role in Indian economy. Livestock production systems. Organic livestock production. Culling of animals. Selection and purchase of livestock. Major pastoral systems in India. Fodder production and conservation: Importance of grasslands and fodder in livestock production. Agronomical Practices for fodder production. Important leguminous and non-leguminous fodders in different seasons. Soil and Water conservation and drainage of water for fodder production. Fodder production for small livestock units. Structures for storage of feeds and fodders. Scarcity fodders and preservation of green fodder. Recycling of animal washings and wastes in fodder production and use of recycle waste. Livestock production management: Housing systems, layout and design of different buildings for animals. Selection of site. General principles affecting the design and construction of building for housing for various livestock species. Breeds of cattle and buffalo and descriptions of important breeds. Economic traits of cattle and buffaloes. General management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals. Draught ability of cattle and buffaloes. Routine animal farm operations and labour management. Animal farm accounts and records. Indigenous technical knowledge related to livestock rearing and veterinary practices. Indigenous technical knowledge pertaining to health and management of livestock. Poultry Production Management: Classification of poultry with respect to production characters, age and standards. Description of indigenous fowls and their value in rural farming. Specific strains developed for rural poultry production; their acceptability and importance in rural eco-system Brooding management – Types of brooders – preparation of shed – Importance of environmental factors. Housing – Types of poultry, houses – space requirements. Scavenging system of management – Low input technology – Backyard and semi-intensive units; their management and economic achievements. Deep litter management and recycling of litter. Management of growers and layers. Stress

management. Feeding management–Classification of nutrients, Nutrient requirements and feed formulations. Feeding systems. Water management. Breeding systems and methods of mating. Selection and culling. Principles of disease prevention management. General principles of poultry medication. Diversified poultry production and hatchery management: Principles of incubation and hatchery management practices. Factors affecting fertility and hatchability, selection and care of hatching eggs and hatchery hygiene. Candling, sexing, grading, packing and disposal of hatchery waste. Troubleshooting hatchery failures. Poultry waste management, pollution and environmental issues. Organic and hill farming. Mixed and integrated poultry farming, Vertical & horizontal integration in poultry production, Management of ducks, turkeys, Japanese quails and guinea fowls. Rabbit production: Scope of rabbit farming in the country, breeds and their distributions in India. Prospectus and limitation of rabbit production, Selection, care and management of breeding stock for commercial purpose. Identification, care and management of kindling animals. Care of new born, growing stock. Breeding and selection techniques for optimal production of rabbit. Feeds and feeding for rabbit production. Hygienic care and Housing for rabbit production. Disposal, utilization and recycling of waste *etc.* Swine production management: Introduction and scope of swine farming in the country. Demography of swine population. Selection and breeding techniques in swine. Important breeds (exotic and indigenous) & their characteristics. Housing and feeding of swine. Management of different categories of swine for optimal production: breeding and pregnant sows; sows at farrowing and after farrowing: piglets, growing stock, lactating sows, feedlot stock.

Practical

General livestock management: Identification of common tools used on animal farm. Familiarization with body points of animals. Methods of identification. Use of rope for knot and halter making. Dentition and ageing of animals. Preparation of animals for show. Selection and culling of animals. Livestock waste utilization and recycling. Fodder production and conservation: Visit to the fodder farm. Familiarization with various types of fodders in the state and India. Familiarization with various fertilizers and manures. Collection, preservation and storage of feed and fodder. Livestock production management: Layout plans for different livestock houses. Visit to different animal farms and Identification animals. Humane handling and restraining. Spraying and spotting sick

animals. Determination of body weight using different measurements. Familiarization with routine farm operations. Detection of heat. Body condition score in different species of animals. Record of body temperature and restraining of different animals. Poultry production management: Identification of common breeds of poultry, different classes, Indian chickens and other avian species breeds. Housing and design of a poultry farm. Poultry farm equipments. Brooding arrangement in broiler farms. Poultry feed ingredients and its quality assessment. Poultry feed preparations. Vaccination, Deworming and Medication of birds. Records and maintenance. Festivals related to animals: Participation and documentation of the region specific festivals related to animals. ITKs related to livestock management.

Suggested Readings

1. Ghotge, N.S. (2004). Livestock and Livelihoods, the Indian Context. Foundation Books, New Delhi.
2. Dakshinkar, N.P. & Singh, M. (2022). Draught Animal Power and its Relevance to Indian Agriculture. In: Akshay Krishi Parivar, *Bhumi suposhan: commemorative publication of the nationwide bhumisuposhan and samrakshanjanabhiyan.* Akshay Krishi Parivar Publication Number 11. pp. 80-87.
3. Uprit, S. (2022). Livestock Dung Based Model Sustainable Agriculture through Healthy and Enriched Soil. In: Akshay Krishi Parivar, *Bhumi suposhan: commemorative publication of the nationwide bhumisuposhan and samrakshanjanabhiyan.* Akshay Krishi Parivar Publication Number 11. pp. 88-96.
4. Chatterjee, B.N. and Das and P.K. Forage Crop Production.
5. I.C.A.R Grasses and Legumes
6. I.C.A.R. Handbook of Agriculture
7. I.C.A.R. Handbook of Animal Husbandry
8. Lebas, F; Coudert, P; Rouvier, R and Rochambean, H. (1986). The Rabbit – Husbandry, Health and Production
9. Leeson, S and Summers, J.D. (1993) Commercial Poultry Production
10. Merkel, J. Managing Livestock Wastes
11. North, M.O and Bell, D.D. (1990) Commercial Chicken Production Manual, 4th Ed.
12. Pathak, N.N. and Jakhmola, R.C. Forages and Livestock Production
13. Sastry, N.S.R. and Thomas, C.K. (2005) Livestock Production Management 4th Ed.

14. Scanes, C.G.; Brant, G and Ensminger, M.E. (2004) Poultry Science, 4th Ed.
15. Sharda, D.P.(2005) Swine Production
16. Sreenivasaiah, P.V. (2006) Scientific Poultry Production – a unique encyclopedia, 3rd Ed.
17. Taylor, R.E. and Field, T.G. (1977) Scientific Farm Animal Production
18. Thomas, C.K. and Sastry, N.S.R (1991)Dairy Bovine Production
19. ICAR,AICRP-UAE (2018)Research Highlights pp.1-6.
20. Watson, J.A.S. and Mills, W.J. (2005) Farm Animals and their Management
21. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

40.Goat and Sheep Based Natural Farming Credit: 3(2+1)

Theory

Historical account of goat and sheep rearing, Distribution of goats and sheep in different agro climatic zones, Benefits of rearing small ruminants, Local breeds available across the country and their importance, Adaptability of indigenous breeds and their role in natural farming; genetic improvement and conservation programme of Indigenous small ruminant breeds, Prevalent Small Ruminant production system in the country, Importance of small ruminant rearing system in natural farming as 5 star animals, Introduction to traditional housing models, Concept of loose housing system and its application/modification required to rear ruminants under natural farming system, CPR based production system, Role of common property resources under natural grazing on rangelands and pastures in small ruminant rearing system, Low cost feeding and use of available feed resources for balanced diet, Importance of silvipature in small ruminants sector growth, Fodder tree plantation, Importance and drinking water requirement of small ruminants, Selection of goats, Breeding systems and management, Different management practices, Role of sheep and goat rearing in rural economy, Role of sheep and goat dropping in maintaining soil health and manure utilization on farmland, Flock health management, Introduction to traditional therapies and preventive strategies . Observations on related ITK compiled by ICAR.

Practical

Identification and characteristics of various local breeds of goat and sheep, Assessment of feed and fodder requirement of goats and sheep, Chemical composition of various locally available feed stuffs being consumed by goats and sheep, Chemical composition of goat and sheep milk and its important constituent with regards to human health, Chemical composition of goat and sheep manure and its carbon content, Chemical composition of waste sheep wool and its use for water holding capacity, Role of waste wool in soil fertility enhancement as nitrogen source, Study of various equipments employed in small ruminant production system, Clipping, Shearing, Dipping, Spraying and spotting of sick animals.

Suggested Readings

1. R. M. Acharya, Sheep and Goat Breeds of India, Food and Agriculture Organization of the United Nations

2. Harvey David Blackburn, Small Ruminant Production: Systems for Sustainability : Proceedings from a Workshop for the PVO and University Communities, June 20-21, 1991, University of Maryland, College Park, Maryland
3. Range Research and Range Problems: Papers Presented at the Annual Meeting of the Crop Science Society of America in Tucson, Arizona, Crop Science Society of America August 1970
4. S. K. Jindal, 2012 Goat Production Kalyani publication
5. Satish Kumar Jindal 2013 Goat Production and Health Management, New India Pub. Agency,
6. Veterinary and Animal Husbandry. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement1& 2); Document 3; Publ: ICAR New Delhi.

41.MANAGEMENT OF PLANT DISEASES Credit: 3(2+1)

Theory

Plant disease management under natural farming; Causes / factors affecting disease development: disease triangle and tetrahedron and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Pathogenesis. Koch's postulates. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants. Epidemiology: Factors affecting disease development. Survey, surveillance and vigilance, crop loss assessment and models. Principles and pre-requisites of forecasting of diseases. Principles and methods of plant disease management. Symptoms, etiology, disease cycle and management of major diseases of field Crops and horticulture crops. Methods of Plant Disease control: Host plant resistance, cultural, mechanical, physical, legislative, biological control. Ecological management of crop environment. Role of soil microbiome in disease management. Suppressive soils, concepts and potentialities for managing soil borne pathogens. Application of Khattilassi, Jungle ki Kandi, Sontha aster for the management of various types of diseases. Plant growth promoting rhizobacteria (PGPR) and their use in plant protection Heritage perspective of Plant Protection (Drumraksha). Plant Protection through Botanicals. ITKs related to management of plant diseases.

Practical

Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Preparation of extracts of natural plant products as fungicides. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium; Preparation of pressed and well mounted specimens. Preparation and methods of application of Khattilassi, Jungle ki Kandi, Sontha aster for their Management. Biosurfactants and their use

Suggested Readings

1. Saharan, B. S., and V. Nehra. "Plant growth promoting rhizobacteria: a critical review." *Life Sci Med Res* 21. 1 (2011): 30.
2. Saharan, B. S., R. K. Sahu, and D. Sharma. "A review on biosurfactants: fermentation, current developments and perspectives." *Genetic Engineering and Biotechnology Journal* 2011.1 (2011): 1-14.
3. Nene YL. 2007.Plant Pathology in India Prior to Twentieth Century.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 441-454.
4. Choudhary SL and Saxena RC.2007. Plant Protection in Medieval and Modern Indian Agriculture.*In.* Nene YL. ed. Glimpses of the Agricultural Heritage of India. Asian Agri-History Foundation. pp. 455-480.
5. Pest and Disease Management. In Inventory of Indigenous Technical Knowledge in Agriculture Document 1; Document 2; Document 2 (Supplement 1 & 2); Document 3; Publ: ICAR New Delhi.

42. POST HARVEST MANAGEMENT I **Credit: 3(2+1)**

Theory

Post-harvest management: Importance of fruits and vegetables; introduction to postharvest physiology of fruits and vegetables; Post-harvest losses, maturity indices, harvesting methods and collection devices, unit operations in packaging with emphasis on use of natural products like bee wax, gum Arabic, shellac, xantham gum etc. environment friendly and safe ripening methods, post-harvest diseases, disorders and their management. Storage techniques: Traditional and modern storage structures, on farm and off farm storage, refrigerated storage, evaporative cool chambers, refrigerated vehicles, Storage techniques for local cultivars seeds. Value addition: Principles and methods of preservation, natural preservatives, indigenous and traditional preservation techniques, phytochemicals for preservation, FSSAI, BIS, and Codex standards for major processed products from fruits and vegetables; value addition in fruits and vegetables through drying, pickling, jam, jelly, marmalade, preserve (murabba), candy, juice, ready-to-serve, squash, nectar, crystallized products, etc.; minimal processing. Eco-friendly handling and packaging: Use of essentials oils and ecofriendly phytochemicals in postharvest handling; Edible films and coating, eco or bio-based polymeric films used for packaging. Modified atmosphere packaging, Vacuum Packaging, Smart packaging, Active Packaging using natural or bio-colours, ITKs for handling and packaging; neem-based products for fruit and vegetable handling.

Practical

Demonstration and use of different harvesting tools, Practical demonstration on packhouse operations, Study of different preservation methods for fruits, and vegetable, Study of weight loss of produce in eco-friendly packaging, Determination of TSS and acidity in fresh and processed products, Determination of ascorbic acid, Determination of sugars, Study of different types of dryers, Study of evaporative cooling system, Preparation of traditional value-added products from fruits and vegetables, Preparation of jam, Preparation of jelly, Preparation of fruit-based beverages, Preparation of pickels, Study of different packaging materials. Visit to industry/processing unit.

Suggested Readings

1. Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of Davis, USA.

2. Wills, R. and Golding, J. 2016. Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables. 6th Edition, CABI.
3. Yahia, E.M. 2019. Postharvest Technology of Perishable Horticultural Commodities. United Kingdom: Elsevier.
4. Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
5. Srivastava, R.P. and Kumar, S. 2002. Fruit & Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.
6. Pareek, S. 2016. Postharvest Ripening Physiology of Crops. CRC Press, US.
7. Pareek, S. 2016. Fresh-Cut Fruits and Vegetables: Technology, Physiology, and Safety. CRC Press, US.
8. Pareek, S. 2017. Novel Postharvest Treatments of Fruits and Vegetables. CRC Press, US.
9. De Freitas, S.T., and Pareek, S. 2019. Postharvest Physiological Disorders in Fruits and Disorders. CRC Press, US.

43.POST-HARVEST MANAGEMENT II Credit: 3(2+1)

Theory

Post-harvest management: Physic-chemical and nutritive properties of cereals, pulses and oilseeds, causes of postharvest losses, traditional and modern storage structures, on farm and off farm storage, bulk and bag storage (especially eco/bio-based bags), Primary processing of cereals, pulses and oilseeds: Cleaning, grading, curing/tempering/conditioning, pre-treatments including parboiling, Secondary processing: Drying, size reduction (milling), Oil seed milling: Ghanis, hydraulic presses, expellers, extrusion processing and different types of extruded products (snack, breakfast cereals and weaning foods), bakery and confectionary products. Traditional value-added products (regional products like nuggets/wadi/badi, papad, vermicelli/sevai, etc.), Storage Pest Management: Use of ITKs like oil treatment, ash treatment, bio-control practices for storage pest control of cereals, pulses and oilseeds. Primary processing operations in poultry: Preslaughter operations and slaughtering operations for poultry, Stunning, icing, Grading, blanching, Washing, Evisceration, Beheading, Scaling, cutting off fins and belly flaps, Steaking, Filleting, Skinning, Deboning (meat-bone separator), Mincing of skinned fillets, Peeling, Deveining, Shucking, Knobbing. Preservation methods for fish: Preservation of meat and fish by canning, chilling, freezing, marination (pickling), curing, cooking and smoking, dehydration, and biological preservatives (fermentation), etc. Different value-added products from fish and meat. Hygienic handling and storage of fish: chilling or icing, refrigeration, Pest infestations in stored fishery products, means to control pest infestation, Food-grade coatings as processing aids, Integrated pest management.

Practical

Study of physicochemical properties of cereals, pulses and oils seeds, Determination of gluten content in wheat flour. Study of Conditioning of wheat. Milling of wheat and rice by laboratory mill. Study of pre-treatment and milling of pulses. Study of oil expression equipment. Manufacture of value- added products; millets, guar gum and other minor crops, Study of primary processing of fish or meat, Study of preservation methods for fish/meat, Preparation of traditional value-added products from fish/meat, Preservation of meat/fish by freezing, Preservation of meat/fish by curing and pickling, Preservation of meat/fish by dehydration,

Preparation of value-added poultry meat products, Quality evaluation and grading of eggs, Visit to processing facilities

Suggested Readings

1. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida
2. Chakraverty, A.K., 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
4. Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd Ed. Springer Science + Business Media, NY, USA.
5. AmalenduChakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
6. B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi
7. Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman & Hall, London.
8. William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th Ed. Food Products Press, NY, USA.
9. Cutting, C. L. 2002 Processing and Preservation of Fish. Agro Bios, New Delhi.
10. Mishra, R. (2022). Handbook on Fish Processing and Preservation. Taylor & Francis.

44. Environmental Studies and Disaster Management Credit: 3(2+1)

Theory

Multidisciplinary nature of environmental studies. Definition, scope and importance. Natural resources: Renewable and non renewable resources, Natural resources and associated problems. Forest resources, Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, Biodiversity and its conservation, Endangered and endemic species of India. Conservation of biodiversity: In= situ and ex- situ conservation of biodiversity. Environmental pollution: definition, causes and types, effects and control measures, Thermal pollution, nuclear hazards. Social issues and the Environment, Wasteland reclaimation. Wildlife Protection act. Forest conservation act, Issues involved in enforcement of environmental legislation. Human population and the environment. Natural disasters: Meaning and nature of natual disasters, their types and effects. Man made disasters, Concept of disaster management, National disaster management framework, financial arrangements; Role of NGO's, community-based organizationsand media. Central, State, District and local administration. Armed Forces in disaster response: Disaster response; Policies and other organizations.

Practicals

Pollution case studies. Case studies- Field work: Visit to local area to document environmental assets river/ forest / grassland / hill / mountain, visit to local polluted site- Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems- pond, river, hill slopes etc.

Suggested Readings:

45.Communication Skills and Personality Development Credit: 2(1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication, listening and note taking, writing skills, oral presentation skills, field diary and lab. Record; indexing, foot note and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group Discussion, Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills, field diary and lab. Record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

Suggested Readings:

46.AGRO-ECO SYSTEM ANALYSIS FOR NATURAL FARMING Credit: 2(1+1)

Theory

Definition of system, system hyerarchy, Introduction, definition, meaning and concept of agro eco system, Properties of agro eco system, Types of agro eco system analysis, Tools and techniques used in agro eco system analysis, Agro eco system analysis and sustainable agriculture, Steps involved in agro eco system analysis, Methodology of agro eco system analysis, Energy flow of agro eco system analysis, Participatory rural appraisal related terms – RRA, PRA, PLA, PLAM, and Philosophy of PRM, Participatory planning frame work, Importance of participation, Principles of participatory extension, Participatory technology development process.

Practical

Simulated exercise on space related methods, Time related methods, Flow related methods, Documentation of participatory technology development process**,** conducting agro eco system analysis using PRA tools and techniques in village situation**,** Learn the techniques of action plan development

Suggested Readings

1. Adhikary. 2006. Participatory Planning and Project Management in Extension Science. Agrotech Publ. Academy.
2. Singh BK.2008. PRA/PLA and Participatory training. Adhyayan Publ. & Distr.
3. Agroecosystem Analysis for Research and Development Gordon R. Conway
4. Handbook and agro eco stystem analysis and agro ecological zoning: a tool for district land use planning- NAFR Lao-Swedish Upland Agriculture and Forestry Research Programme

47. INDIAN TRADITIONAL KNOWLEDGE Credit: 2(2+0)

Theory

Introduction and importance of Indian Traditional Knowledge. Definition. Difference between Traditional Knowledge System and Western Science System. Protection of Traditional Knowledge. IPR and other provisions. Indian Traditional Knowledge in Agriculture covering Veterinary and Animal Husbandry; Pest and Disease Management; Grain/ Seed storage; Horticultural Crops; Crops and Cropping system; Farm implements; Weather forecasting; Soil and water conservation; Soil fertility Management; Rain water management; Tillage practices; Fisheries; Post Harvest Technology; Garbage disposal and Management; Wind erosion; Waste water management. Some case studies on validation of ITK's; Need to revive traditional technologies relevant to the contemporary agricultural scenario. Geographical indications of plant species involved in various ITK's (Pest and Disease Management, Grain/ Seed Storage, Veterinary and Animal Husbandry and Weather forecasting).

Suggested Readings

1. Indigenous Technical Knowledge in Agriculture- Geographical Indications of Plant Species. Document 5. 2004. Published by ICAR New Delhi. Pp 284.
2. Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture Document 4. 2004. Published by ICAR New Delhi. Pp 230.
3. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1. 2002. Published by ICAR New Delhi. Pp 411.
4. Inventory of Indigenous Technical Knowledge in Agriculture. Document 2. 2003. Published by ICAR New Delhi. Pp 680.
5. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement 1). 2002. Published by ICAR New Delhi. Pp 226.
6. Inventory of Indigenous Technical Knowledge in Agriculture. Document 1 (Supplement 2). 2004. Published by ICAR New Delhi. Pp 321.
7. Validation of Indigenous Technical Knowledge in Agriculture. Document 3. 2004. Published by ICAR New Delhi. Pp 505.

48. MEDICINAL PLANTS Credit: 3(2+1)

Theory

General aspects of Medicinal Plants. Definition, history, present and future needs. Introduction of plant parts (fruit, leaves, roots, stem, seeds and their modification). Cultivation and harvesting practices. Processing and storage practices. Marketing of medicinal products. Important Indian Medicinal Plants. Plant parts used as powder: Identification and utilization of Amla (Embelica officinalis), Behra (Terminalia bellerica), Harad (Terminalia chebula), Turmeric (Curcuma longa), Garlic (Allium sativum), Bitter guard (Momordica charantia), Black plum (Syzygiumcumini), Fenugreek (Trigonella foenumgraecum), Cinnamon (Cinnamomum verum), Sarpgandha (Raulfia serpentina), Black pepper (Piper nigrum), Ashwagandha (Withaniasomnifera), Psyllium husk (Plantego ovata) . Plant parts used as juice/ decoction: Identification and utilization of Amla (Embelica officinalis), Ginger (Gingiber officinalis), Onion (Alium cepa), Bottle guard (Lagenaria siceraria), Basil (Oscimumsantum), Arjun (Terminalia arjuna), Neem (Azadirecta indica), Gwarpatha (Aloe vera), Brahmi (Bacopa monnieri), Giloy (Tinospora cordifolia), Shankhpushpi (Convolvulus prostrate), Bael (Aegle marmelos). Plant Parts Used as Lotion and Ointments: Identificationand utilization of Gwarpatha (Aloe vera), Fenugreek (Trigonella foenumgraecum), Pot marigold (Calendula officinalis), Neem (Azadirecta indica) Plant Parts Used as Oil: Clove (Syzygiumaromaticum), Neem (Azadirecta indica), Coconut (Coccus nucifera), Nilgiri (Eucalyptus sp.). Plant Parts Used as Surgical Fibres, Sutures and Dressings: Identification and utilization of cotton (Gossipium sp.), Jute (Corchorus capsularis), Bana (Musa sp.). Plant Parts Used as Poultice: Identification and utilization of Turmeric (Curcuma longa), Nilgiri (Eucalyptus sp.), Ginger (Gingiber officinalis), Garlic (Allium sativum), Onion (Alium cepa), Dhatura (Dhatura sp.), Aak (Calotropis sp.), Arandi (Ricinus communis).

Practical

Identification of locally available common medicinal plants, Basic preparation of herbal products as kadha, powder (Ex. Neem leaf, moringa leaf, tulsi leaf, giloy, arandana), Juice (Ex. Amla, Aloe vera), Trifala, Chyavanprash, Amla candy, herbal tea, etc. Study and documentation of commercial production of at least five medicinal plants. (Using website/ You Tube). Submission of digital photo album of at least ten medicinal plants with brief

description. Cultivation maintenance and reporting of at least five medicinal plants within college campus.

Suggested Readings

1. Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi
2. CSIR – Cultivation and Utilization of Medicinal Plants
3. Brahmvarchas, Ayurved ka Pran: Vanoshadhivigyan, Vedmata Gayatri Trust, Shaktikunj Haridwar.
4. Chaudhry R. D., Herbal Drug Industry, Eastern Publication
5. Atal and Kapoor, Cultivation and Utilization of Medicinal Plants, RRL Jammu Tavi. 1982
6. Raphael Ikan, Natural Products: A Lab Guide, Academic Press, 1991, 2nd edition
7. Dutt Ashwin. An Introduction to Medicinal Plants, Adhyayan Publishers and distributers, 2009.

49.VALUATION ON ECOSYSTEM SERVICES Credit: 3(2+1)

Theory

Ecosystem Services (ES)- Meaning, concept and its importance, Classification of Ecosystem Services - Provisioning, Regulating, Supporting and Cultural services, Basics of natural capital, Quantification of ecosystem services- Direct and Indirect approaches, Valuation of Ecosystem Services and its need, Ecosystem Valuation Methods-Revealed preference methods: Market pricing, Production function , Hedonic pricing methods, Travel cost method and Random utility models, Stated Preference methods-Contingent valuation method and Choice modelling, Cost based approachesof Ecosystem Valuation- Opportunity cost, Cost of alternatives or substitute goods ,Replacement cost method, Methods for Obtaining Non-economic Values-Focus groups, Citizens' Juries ,Health-based valuation , Q-methodology and Delphi surveys, Payment for ecosystem services (PES), Governance and policy issues in ecosystem services, Challenges in valuation of ecosystem services.

Practical

Ecosystem Valuation methods- direct and indirect method calculation, An Overview-Millennium Ecosystem Services (MEA) Assessment, Case studies on Payment for ecosystem services (PES), Case studies in Ecosystem Services in India and abroad, Study on Environmental Impact Analysis, Visits to the ecosystem areas (Agro ecosystem, Forest Ecosystem and Aquatic Ecosystem.

Suggested Readings

1. Kerr JM, Marothia DK, Singh K, Ramaswamy C and Beritley WR. 1997. Natural Resource Economics: Theory and Applications in India. Oxford and IBH.
2. Tom Totenberg and Lynne Lewis. 2009. Environmental and Natural Resource Economics Pearson – Addision Wesley publication, 9th edition.
3. De Groot, R.S., Wilson, M.A. &Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, 41, 393–408.
4. Norberg, J., 1999. Linking Nature's services to ecosystems: some general ecological concepts. Ecological Economics, 29, 183–202.

Please send feedback to *feedback.edunf@gmail.com*