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SUSTAINABLE ALTERNATIVE FARMING TECHNIQUES - AN INDIAN PERSPECTIVE

Ashima Gakhar*
Department of Botany, KVA DAV College for Women, Karnal – 132001, Haryana, India
*Email: drashimagakhar@gmail.com

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ABSTRACT

Unlike the various socio economic and political issues, food security is the major daunting root challenge every country is to deal with. Food security problems accelerate with increasing population, overexploitation of natural resources, climate change, and resource degradation associated with rapid economic growth. Most of the third world countries are highly affected in terms of food dependency and food production crisis. The absence of a sustainable farming methods and the reduced efficiency of the traditional methods are the main reasons to be blamed on. In India the traditional farming methods like subsistence farming, ley farming, shifting agriculture, crop rotation, intensive farming, mixed agriculture, dryland and rain fed farming, and terrace cultivation are widely followed. These chemical farming methods are not only eventually reducing the land fertility, but also posing greater threat to the environment. A closer attention to these problems is mandatory to avoid the imminent food dependency and insecurity. The greater threat posed by the growing population and the reduction in the arable land escalate the problems. In this context country like India has to look on other alternative farming techniques which can be parallel to the traditional methods at the initial stages and can take over the centre stage at later stages for intelligently handling the intricate agricultural production challenges. In this review article, various alternative farming methods which India can successfully adopt for sustainable food production are discussed. The suitability and the potential drawbacks of each methods are also been analysed to have a better insight for careful selection of each methods.

Keywords: Sustainable, Organic Farming, Alternative farming, Yield, Crop, Environmentally Friendly

INTRODUCTION

India is a country whose economic growth largely depends on agricultural progress. It also produces the livelihood for 50% of the Indian population. As the country's population is increasing with an exponential rate and would reach 1.6 million by 2050 the food requirements should be increase up to 100% (United Nation, 2017). Even though India has experienced prominent increases in agricultural productivity over the last two decades (Chand and Parapurathu, 2012) unfortunately it would not be sufficient to feed the predicted number of population (Hinz *et al.,*2020*).*

During the past 150 years, India has practised significant land utilization and land-cover changes including, cropland changes, deforestation, and urban expansion (Roya *et al*., 2015) Over 50% of the total area is used as cropland, making India one of the largest producing countries of agricultural products globally (Teluguntlaand Thenkabail, 2015). Parallelly, the possible negative impacts on environment due to agricultural intensification cannot be overruled (Ramankutty *et al.,* 2018)

Above all, the traditional farming followed in India widely uses chemicals which are an instrumental to environmental pollution and toxication of the products. This is considered as the major causes of health hazards and rare diseases in humans and animals which is a greater threat to human society. Apart from these the reduction in the nutritional values of the food produced by the traditional farming is also worrisome. These all facts pointing towards the need of a more sustainable alternative farming methods which can resolve most of the existing problems. The greater acceptability of the concept of sustainable food system is because of its potential to limit the work within the countries natural resource constraints, less dependency on the use of chemicals, proposes conservation of water and energy, stresses on local production, minimizes the utilization of resources, promotes biodiversity and ecology. Truly sustainable agricultural techniques are those which can produce safe and nutrient rich food, ensuring profit without harming environment and promoting biodiversity.

Many developed countries shifted their focus from traditional farming methods and widely relay on different alternative farming methods. This review emphasis on the methods, scopes and challenges of different alternative farming methods India can concentrate on, despite of its geographical and climatic vividness to ensure the county's food security.

Sustainable Farming Methods

Unlike rigorous traditional agriculture methods,

sustainable farming has enormous potentials for profiting the environment and safe guarding natural resources. It greatly depends on, following natural cycles, omission of aggressive use of agricultural chemicals recycling water and nutrients. The many advantages of the sustainable agricultural methods are explained in the (Fig.1)

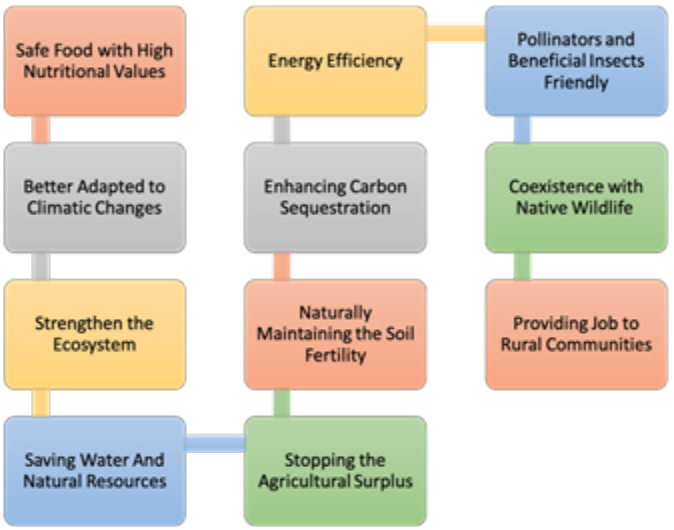

Fig.1: Benefits of sustainable agricultural methods

Environmental sustainability and quality food production unaffected by the seasonal/climatic mayhem are the two main reasons drawing the attention of agriculturalist towards alternative farming methods. The following are the widely accepted alternative farming methods practised worldwide (Fig. 2).

Organic Farming

Organic farming is the method which evades the use of synthetic inputs (such as pesticides, fertilizers, feed additives, hormones, etc.) and relay upon crop rotation cycles, crop lees, biological system of nutrient deployment, mineral grade rock additives, off-farm organic waste, animal manures, vermi compost, animal husbandry and plant protection. The green manure could contribute nearly 40–60 kg nitrogen per hectare per year for the succeeding crops and serve as an economical source of organic fertilizer to develop or maintain soil fertility. The inoculation with vermi composting facilitates the uptake of $H_2PO_4^-$, NO_3^- K^+ and releases various by products such as riboflavin, auxins, cytokines, and vitamins facilitate the higher growth of plants. Crop rotation helps to break the growth cycles of weeds, insects and diseases, thus reduces the need for pesticide usage. The cover crop systems followed in organic farming prevents soil erosion and improves water penetration. The Higher soil biodiversity in organic farms has shown to increase the rate of nutrient cycling, soil aggregation, stability and disease suppression of agricultural soils (Poyyamoli and Padmavathy, 2011; Amanullah *et al*., 2007).

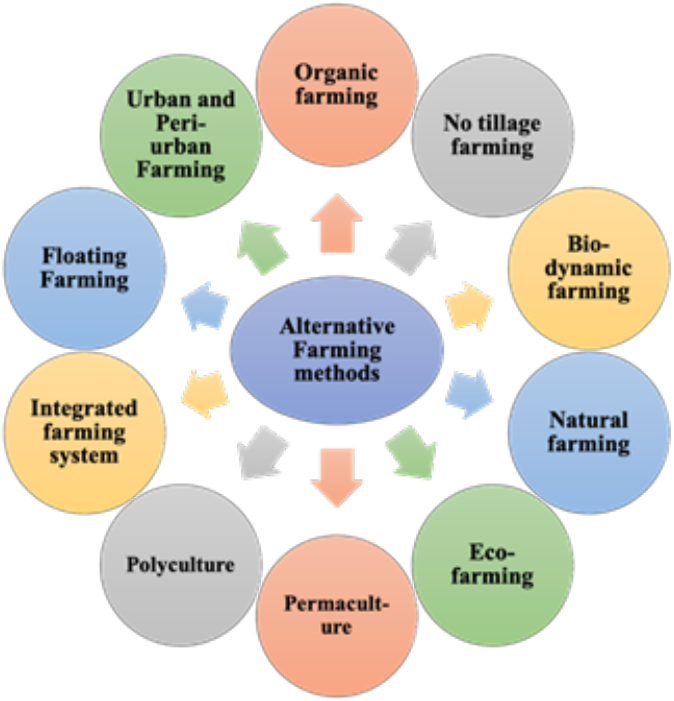

Fig. 2: Different alternative farming methods

Scope and challenges

The economic aspects of the organic farming are welcoming for country like India as it completely avoids chemical fertilizers and pesticides. With low investments, farmers can earn good revenue on investment. Organic farming in India can be very environment friendly; as it does not use fertilizers and chemicals which helps to reduces the soil and water pollution. This method can produce nutritious, healthy, safe and tasty products. The awareness of health hazards of crop grown with chemical farming and pesticide increases the demand of organic and other naturally grown foods. But proceeding with this natural farming is a costly affair and the initial year's uncertainty and low production creates difficulty to farmers. Organic farming in India has very fewer choices, as the off-season crops are limited. The lack of technical skills is also one of the purging issues of organic farming in India.

Non-Tillage Farming

Agricultural processes usually relay on regular tilling which plough the soil in various ways, with the help of tractors and trillers. These vigorous tilling practise affects the loss of organic atmosphere of the soil in terms of soil aggregate degradation and destruction of good microbes in the soil (Hussain *et al.,* 1999). By no tilling method, crop scums or other organic features are retained on the soil plain, sowing and nurturing is done with minimal soil disruption. No-till benefits with relaxed evaporation, ensures better absorption of rainwater and boosts irrigation efficiency, resulting higher yields, especially

during dry and hot weather. No-till practices, when united with other regenerative methods like cover cropping, increases soil organic carbon by up to 21% within six years and can establish truly renewing and climate-buoyant farms.

Scopes and challenges

No tilling method is fully environmentally friendly posing no threat to the ecosystem. It is economical for long run which saves money in labour and fuel. Water retention occurred by the no tilling approach can be a blessing to farmers in drought-stricken areas of our country The retention of water occurring with this method prevents pesticides and herbicides from oozing into nearby water bodies.(Laxmi *et al.,* 2007)This methods is highly efficient and can Increase the crop yield to maximum.

The main drawbacks of this method are that, it can take years to achieve sufficient economic benefits for farmers. Elevated moisture levels in the soil can promote fungal diseases which is difficult to prevent. This can be discouraging for the farmers who greatly depends on agricultural income. Proper upskilling and technical support for the farming are also some of the hurdles to be faced when proceeding with the No-tilling method.

Biodynamic Farming

Biodynamic farming is a holistic, ethical approach to farming and gardening, which is similar to organic farming. It encompasses some kind of natural forces to the organic farming elements which increase the liveliness of the soil. Biodynamic farming applies the indigenous knowledge of rhythmic positions of moon, sun and planets when sowing seeds, transferring, using liquid and solid manures. The principles of biodynamic farming are mainly concentrating on crop rotation, crop diversification, biodynamic compost, life forces, animal husbandry, solutions using homeopathy (Fig. 3). Chemical pesticides are completely avoided in this agricultural method, and it solely depends on biological nutrients produced by fungi, algae, bacteria, actinomycetes, mycorrhiza etc. Pest management is done in a natural way by employing predators, plethora and other parasites. Biodynamic compost is enriched by the use of preparations made from stinging nettle, yarrow, oak bark, chamomile, valerian and dandelion. These medicinal herbs assure the holistic relationship with nature, animals, and the biocycles which indeed helps to boost the healing

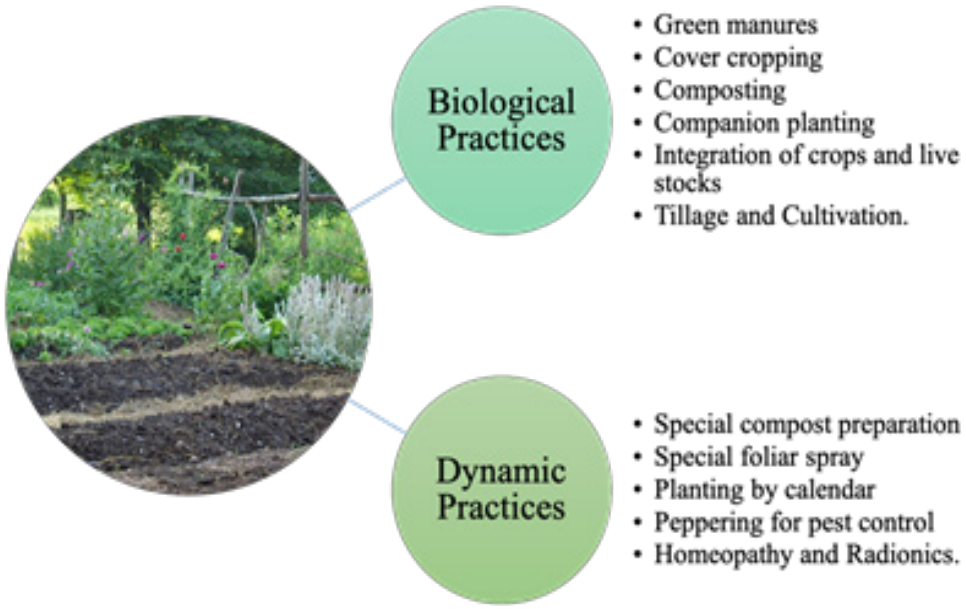

Fig. 3: Different principles of biodynamic farming

properties of the crops and foster the growth (Poyyamoli and Padmavathy, 2011; Laxmi *et al.,* 2007; Government of India, 2001).

Scopes and challenges

India is possibly the only country where the doctrines of biodynamic farming, which began in Germany over 90 years ago, is widely practising. India has nearly 100,000 certified biodynamic farms. This farming method not only integrates many independent elements like plants, animals, soil, people, forest, and spirits but also keen on the harmonizing these elements which is matching with Indian farming ideologies. The sustainability and acceptability of any farming methods in Indian is very much tangled with the Indian ideologies and its spiritual concepts. Apart from this, biodynamic farms are designed to suit the unique biodiversity of natural ecosystems and the exclusivity of each landscape India. Recently the concept of shared farming with biodynamic methods are catching up the momentum in urban populations, where consumers can rent small plots to grow their own food. The yield of fruit and vegetable produced by these methods is of high quality. Unlike chemical farming methods, the altered environment of bio dynamic method naturally prevents the pest, which is a great relief for Indian farmers (Poyyamoli and Padmavathy, 2011; Turinek *et al*., 2009; Reganold**,** 1995; Carpenter-Boggs**,** 2000)

The major constraint of biodiversity methods is that the crops grown by this method are generally spoiled faster because of various reasons. The labour force involved is comparatively larger, as each stages of farming should be monitored and controlled. There is always a need for suitable temperature management for promoting faster

compost preparation, typical flora species.

Eco Farming

Ecology farming is a sustainable agricultural method, parrel to the organic farming. One can find many similarities in both the techniques but they are truly discordant. Moreover, ecological farming includes all methods of organic farming techniques like, regeneration of ecosystem, no tilling, pasture cropping, strip cropping, shelter belts, cover crops, terrace cultivation, etc (Poyyamoli and Padmavathy, 2011). Eco farming is also called as site-specific farming which gives much importance to the selection of agricultural sites depends upon climates, temperature and soil. It also concentrates on restoration of suitable trees and shrubs in agricultural lands, division of farms in to numerous small parts, organic manuring and selective weeding control etc. (Scherr and McNeely, 2003).

Scopes and challenges

Eco farming systems in India, promotes the sustainable land management and biodiversity in food production. It protects soil structure and soil fertility, controls erosion and contamination of water bodies, preserves landscape features, protects various of species, emphasis on safe guarding of nature and preserve livestock husbandry (Scherr and McNeely, 2003). However, the delay in the certification process, absence of integration effort from supporting agencies in India, lack of subsidies for organic inputs, awareness on high-value crops, training capacity, farm research on eco farming are some of the crucial constraints (Xue**,** 2006; Tai-Cheol**,** 2008).

Natural Farming

Natural farming methods follows laws of nature and works along with the natural biodiversity of each agricultural area, promoting the complexity of living organisms. These techniques are an ecological farming approach proposed and established by Masanobu Fukuoka. The crops of natural farming methods never miss the flowering and fruiting season, and produce exceptionally huge quantity of food year after year (Poyyamoli and Padmavathy, 2011). Natural Farming is distinctivein the matter, that it is not meant to be commercialized but moreover practiced by individual farmers with cheap easily available components and microbes particular to each localities or farms. In order to mimic the natural conditions, this method follows minimal irrigation, cover crops, crop rotation, no tillage, and natural prevention of pests. It also avoids the use of weeding, ploughing, manuring or spraying of chemicals.

Scopes and Challenges

The lower cost of natural farming makes it as one of the favourite methods among others. It is a farmer friendly technique, ensures constant flow of income with diversified, nutritious, healthier plants with high yield and better quality. However, the major setback of these methods comes from its higher demand of labour and lack of awareness. Farmers have to take extra effort to manage the sequencing of crop rotation, crop residues and the problems associated with weeds and pests. (Sustainable India Finance Facility, 2018)

Polyculture

Unlike the cultivation of single crop on an area during the vegetation season(monoculture), a polyculture crop production system involves the growing of multiple crops concurrently or in a crop rotation. Usually, after the main crop is harvested it is followed by the planting of the next, and so until the year is over. This type of cropping efficiently utilizes land, water, and fertilizer, which results in exceptional crop production and hence more profitable. It also practises intercropping (agroforestry) where two or more crops simultaneously cultivated in the same field. It allows the farmer to propagate more than one type of crop at a time on the same land. For example, pineapple or bananas are intercropped with coconut trees or date. If crop rotation is followed it assures better growth atmosphere for plants, thus ensuring higher and quality yields (McSorley**,** 2008). The different approaches of polyculture are shown in (Fig. 4)

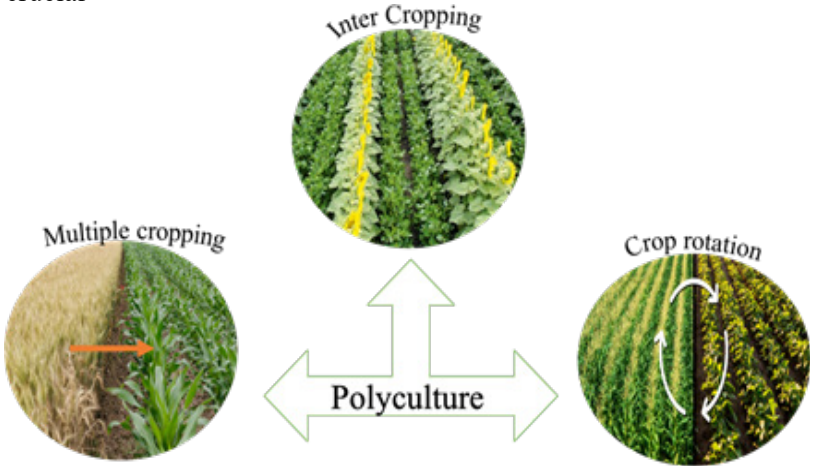

Fig. 3: Different principles of biodynamic farming

Scopes and challenges of polyculture

This technique has wide acceptability in India, as it is economical and generate consistent income from multiple crops every year. The loss due to one or two crops varieties can be compensated with the other crops. This simultaneous farming poses excellent control over pests, plant diseases and weeds. It's been reported that the co

farming improves the yield by 100% of high quality compared to the monoculture methods. High sustainability can be achieved by polyculture as it is environmentally friendly and extremely efficient technique. But sometimes underperformance of one or more crops can creates challenges because of the competition for light, water and nutrients among the crops. Lack of proper guidance and subsidiaries from government can pull back the benefits of polyculture.

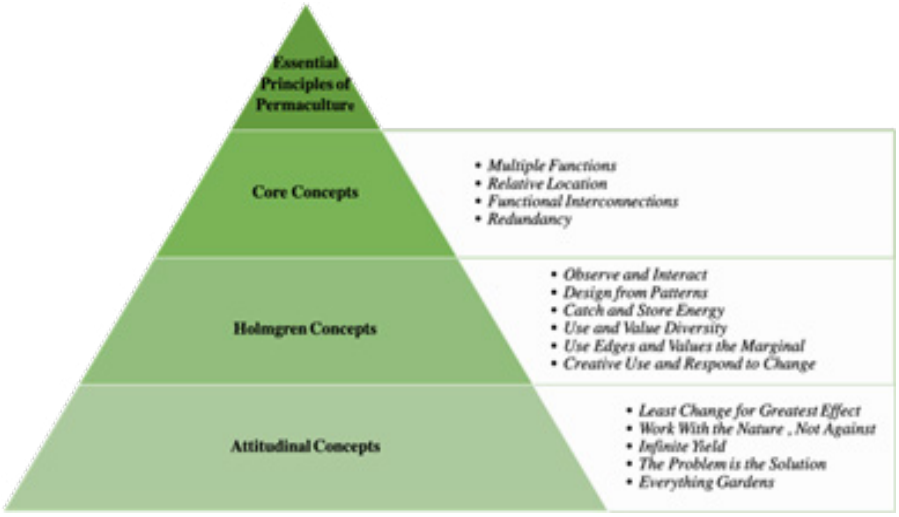

Fig. 5.2 : Various Principles of Permaculture

Permaculture

Permaculture is the agricultural system and settlement that concentrates on sustainability and interrelationships of natural ecosystems. In contrast to intensive

agriculture, which leads the land unsuitable for farming and uninhabitable for human. Permaculture is a way of protecting life and earthby making use of the land in productive manners, allowing for personal existence. (Mancebo and De la Fuente de Val, 2016)The sustainability of permaculture is largely depends upon

Fig. 5.1: A Typical Permaculture Farm

its basic foundation principles like, being observant and responding , creating and storing renewable energy, zero waste, integration no segregation, slow and small solutions, value and respect for the diversity, making use of all available resources wisely, responding to changes etc.(Fig. 5.1 &5.2)

The most distinctive property of permaculture is its concept of dividing land into different zones (Poyyamoli and Padmavathy, 2011; Mollison and Slay, 1991).as discussed below,

- Zone 0: The house other settlements having facilities for solar designs and other electricity generating arrangements
- Zone I: Nearby by area of house mainly consists of vegetable gardens and small work stations
- Zone II: This area is little away from the house mainly having poultry farms and orchards, Semi intensively cultivated
- Zone III: Consist of land area for cropping and planting can have cover of variety of trees.
- Zone IV: This area may not be present in every farm usually have semi-managed areas like hills, can be used for timber production.
- Zone V: Its mainly for inspiration, Meditation aesthetics and wildlife conservation. This area also may not be present in every farm.

Scope and Challenges

Permaculture relay on crop production in natural conditions which has base on care for soil structure, soil fertility, preservation of landscapes, erosion and ecosystem, pollution control, protection of different nature, animal & plant species. The protection of natural element automatically contributes to the quality of food with high output. The farmer friendly approach is easy to establish even with small area of land and different elements of multiple/ inter cropping, organic farming can be integrated successfully.

The major constraint of permaculture is the rules implemented by the government for certification. This

process can be a burden for small scale farmers. (Ferguson and Lovell, 2014) Farmers utilizing complex polycultures and diverse enterprises will likely face significant hurdles to attain economic viability. The availability of subsidiary is very crucial for the development of these farms. The lack public awareness and training facilities are also some of the drawbacks of permaculture.

Floating Farming techniques

Floating farms are those allow growth of vegetables and fruits on floating structures on water. It is a way of utilising areas which are waterlogged for long periods of time in the production of food Uninhabited islands or small to big man-made raised platforms in or near a waterbody can be used for float farming. The roots simply keep growing into the waterbody below, thus ensuring the availability of asmuch fresh water as they need.

Hydroponics and Aeroponics

Hydroponics and aeroponics are modified floating farming techniques which are called as soilless farming (Shavrukov *et al*., 2012). Hydroponics and aquaponics are revolutionary application in urban farming where crops are cultivated in a water with added nutrients. Vertical farming with hydroponics concepts is now becoming popular India as it is a soilless farming method (Fig. 6). These techniques are proposing an intelligent solution to the reduced cultivable lands of the country. These methods give the farmers a greater chance cultivate the crops throughout the year with higher yield.

Scope and challenges

Settling a floating structure on which aquatic vegetation grow can be arranged at low cost. Float farming can be used in areas where crop land is submerged for long time period, especially during the rainy season. This practice helps to prevent land loss through flooding, by allowing cultivation of these areas to continue. In this way, an increase in total arable area can be expected which can assure self- sufficient food production. Crop loss due to flooding can be minimized in flood prone areas as these techniques are unaffected by flooding of the waterbodies. Plants can grow as close as possible space can be utilized properly with maximum yield (Sardare *et al*., 2013)

Hydroponics techniques can be suitable even in the dry lands as the water consumption is low and water can be reused all the time. Only 1/20th of water is consumed during hydroponics when compared with the traditional methods. The season independent continuous flow of production of food with this soilless technique can be a greater solution to almost all the agricultural crisis. The quality, taste and nutritional contents are exceptionally high in crops produced by hydroponics farming.

Compared to the rural floating islands, the urban vertical farming setting can be costly makes it lesser affordable to farmers. It requires deep skills and practical knowledge to grow crops with hydroponics techniques. Another major limitation is that the technology is not extended to grow all crops. Presently hydroponics and aeroponics are limited to cultivation of strawberry, tomato, chilli, Brinjal, beans, bell pepper, Cauliflower, cucumber, melons, radish, onion, lettuce, mint, basil, some ornamental flowers and medicinal plants. (Solanki *et al.,* 2017)

Integrated Farming Systems

Integrated farming imitates nature's dogma, where not only crops but also varied types of plants, animals, birds, fish, and other aquatic flora and fauna are utilized for production (Folnovic**,** 2021). The various elements integrated in the farming are crop land, fodder land, pond, poultry, apiculture, compost, cattle / dairy unit, Goat/ piggy unit, chicken or duck unit and mushroom unit etc. The basic principle of this farming is to enhance the ecological diversity. In ideology, integrated farming has

Fig. 6 : Different Methods Float Farming - **a)** Floating Islands, **b)** Aeroponics, **c)** Hydroponics, **d)** Urban Vertical farming

some crucial concepts of organic as well as intensive farming. In this method, a closely packed inter relation between the elements is practised so that the "waste" from one element becomes an input for another section of the system. This reduces expenses and elevates the production and thereby income. The wise usage of waste as a resource, guarantees lower production cost with maximum outputs.

Scopes and challenges

Integrated farming systems are successful methods that have widely practised by farmers across the world including China, Vietnam, Indonesia and Thailand. India is also one major player in imparting IFS to

achieve sustainability of food production with enhanced biodiversity. India's climatic vividity can be advantageous for integrated farming as farmers can select the suitable units for integration according to the suitability of the region.

But farmers are often confronted with non-availability of fodder plants as crossbreed varieties are prone to climatic atrocities. Integration of various units is comparatively difficult to achieve unless the farmers are trained to handle various independent elements.

Urban and Peri Urban Farming

Urban and peri urban agriculture is the method of cultivating, processing and marketing vegetables and fruits within the urban areas. This is initially practised in the urban communities as a part of relaxation activities but became popular because of the increased awareness on the health benefit of sustaining with a self-made, organic vegetables and fruits. Urban agriculture contributes to food safety and security by increasing the amount of fresh vegetables, fruits and meat products to people living in cities. Rooftops farming, balcony farming, hanging farming, hydroponics and aeroponics are the main techniques followed in unban farming (Wilson**,** 2002).

Scopes and challenges

The wide acceptability of urban and peri urban farming is a greater source of entrepreneurial activities and provides various job opportunities. Waste water and kitchen waste can be successfully utilized for the farming. The green cover in the urban houses can be great tool minimize the atmospheric pollution. Good nutritional content and high yield can be expected because of the personnel care offered to the crops. But the use of waste water in the urban farming without proper pre-treatment causing health concerns.The land constraints, legal restrictions, minimum chances of land expansion options, are some of the other major challenges of urban farming.

CONCLUSION

From decades, many natural, eco- friendly and sustainable alternative methods are practised worldwide along with the traditional intensive farming. India's economic, social and geographical suitability for these methods are exemplary and can be well adopted without rigorous changes. However, these methods are failing to be a front runner for the agricultural production, because of the lack of awareness, lack facilitation and promotion from the higher authorities. If successfully implemented these methods can be a true solution for the impeding population and food crisis and can lead India to a highly secured country in terms of sustainable agricultural food production

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