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Current research needs for sustainable agriculture

Irene F Lalrintluangi[1] Dipti Bisarya[1*], Vinai Kumar[2] and Lalnunsanga[3],

[1]M. Sc. Agronomy, School of Agriculture, Lovely Professional University, Phagwara, Punjab

[1*]Assistant Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab

[2]Assistant Professor, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh

and

[3]M. Sc. Agronomy, School of Agriculture, Lovely Professional University, Phagwara, Punjab

Abstract

Sustainability lies on the principle that we must address the needs of the present without losing the potential of future generations to meet their own needs. Starvation in poor countries, obesity in developed nations, rising food prices, ongoing climate change, rising fuel and transport costs, global market failure, world pesticide contamination, adaptation and resistance to diseases, soil fertility and depletion of organic carbon, soil degradation, biodiversity decrease, desertification and so forth. Despite the extraordinary scientific progress that has allowed subatomic particles, to visit planets and reveal them, serious land problems with food clearly show that conventional agriculture is no longer suitable for feeding human beings and preserving ecosystems. Sustainable agriculture combines the biological, chemical, physical, ecological, economic, and social sciences in a holistic method to create a modern, healthy farming practice that will not degrade our ecosystem, and while conventional farming is directed almost entirely by productivity and profits. The concept of sustainable agriculture has achieved popularity since 1987. However, the concept of sustainable agriculture is undefined and ambiguous, making it particularly difficult to use and apply. This review addresses the constraints and suggests a detailed understanding of the adoption of sustainable farming practices to minimize the adverse effect of agriculture on the environment and the need for research on different practices to increase sustainability.

Keywords: sustainable agriculture; climate change; agronomy for sustainable development; organic farming; nutrient management; pest management

Introduction

The population of the world is rising exponentially and is expected to reach 9.8 million in 2050 and 11.2 million by 2100 according to the latest estimates (**UNDESA, 2017**). The world should be prepared to meet the anticipated rapid population growth in this regard. Sufficient, high-quality food and reliability will be the most critical challenges for humanity in the coming century. Technological developments have led to an intensification of farming to increase productivity while the quality of the produced and its long-term effect has been neglected. This increased impact on the environment leading to a variety of environmental effects with the widespread use of fertilizer, pesticides, water, changes in land use, etc. (**Bockstaller *et al.*,**

2009). Agricultural environmental concerns have attracted the attention of the scientific community, which is now discussing the concept of agricultural sustainability, without reaching consensus (**Binder *et al.*, 2010; Olde *et al.*, 2017**).

There is no question that, as with any other sustainability term, identifying agriculture sustainability is a challenge. However, it is a general agreement that the three main pillars of sustainability should be addressed at least by simultaneously environmental assessments, farming practices, economic and social issues (**Van and Smith, 2014**). In the broader sense, however, the sustainability evaluation of agricultural practices can be a very complex process, since it requires several case-specific variables. As the Food and Agriculture Organization (FAO) proposes, major attributes of sustainable agriculture : (1) conserving resources, (2) environmentally friendly, (3) technically adequate, (4) economically feasible, and (5) socially justified. Sustainable agriculture is characterized as an agricultural system that combines sustainable agriculture practices and avoids or reduces the use of environmentally damaging agricultural practices (**Ansari, 2018**). Alignment with or at least not defying natural force is the first law of sustainability (**Reddy, 2007**).

Since the end of the World War II, agriculture has changed drastically. New technologies, mechanizations, increased chemical use, and state policies favoring maximized production led to the growth of productivity in food and fiber. Although these reforms had many beneficial effects and eliminated many risks in agriculture, considerable costs were incurred. Prominent among these are (1) increasing environmental pollution, (2) depleting groundwater table, (3) shrinkage in net cultivated area, (4) increasing malnutrition, (5) increasing unemployment (6) Increasing cost of production, (7) low farm income, (8) decline in food production, (9) decline in factor of productivity and (10) agriculture growth rate (**Reddy, 2007**).

Figure 1: Key aspects of agricultural sustainability

As a result, the productivity of agriculture has been stagnating in recent years and the output of agriculture at risk will result in migration from rural to the urban and suburban areas. The agricultural sector now faces the challenge of guaranteeing food safety amidst the constraints. According to National

Mission for Sustainable Agriculture (NMSA, 2010), the Department of Agriculture and Cooperation, Ministry of Agriculture New Delhi listed different strategies for the challenges of climate change (**Reddy, 2007) (Figure 1).**

Use of improved crop seeds, livestock, and fish cultures for sustainable agriculture

Seed is an essential input for better cultivation and productivity. Increased quality of the seeds can enhance crop yield potential with substantial folds, thus being one of the most economical and most effective inputs to farm production. Enhanced technology generation and transition are critical conditions for agricultural production, in particular in an agrarian economy. A seed has specific characteristics as a means for the exchange of germplasm between farmers, farmers, and scientists. In simplest terms, a seed is a medium that is transferred to farmers through modern cultivation technologies. It acts as a carrier of genetic messages for a variety of components (**Abebe and Alemu, 2017**). There is a high likelihood of adoption of improved varieties if various seed sources are available and farmers have access to them (**Alene *et al.*, 2000**).

In a risk-prone agricultural environment, an agricultural household's ultimate aim is to achieve seeds with characteristics appropriate for the agro-ecological and socio-economic conditions of farmers. Similarly, improvements in seeds are crucial for improving food safety and the lives of farms**.** Various genetic resources allow for the selection and breeding of plants and animals with desired properties, thereby increasing farm productivity. Decentralization and diversification of seed supply via the promotion of the local seed producers and traders will give access to the resource for the small-scale farmers. Food and seed security in agriculture rehabilitation programs come one after the other. Seed security is, therefore, a prerequisite for increased food production, improved farm incomes, poverty reduction, and food security, both in normal and in disaster years (**Bishaw and Van, 2008**).

Classical breeding the process of selectively breeding the best plants to improve crop varieties can help farmers boost yields and income, fight pesticides and weeds, avoid dryness, adjust to changing climates and improve biodiversity and global food safety. They have more tolerance to disease and pest, adverse climatic conditions, high productivity and profitability, high nutrient-use efficiency, local adaptation, and adaptation to organic and other regenerative systems. Decades of study and experience (**Union of Concerned Scientists, 2015**) demonstrated that the technology in traditional plant breeding is versatile and reliable for achieving the aforementioned targets at a fraction of the cost. The few other classic breeding programs that remain publicly financed are starving for resources. As these initiatives decline, the production of new cultivars (or "cultivars"), which are motivated by large market shares and profit margins, is increasingly determined, often opting for expensive, proprietary genetic engineering technology. This means that the needs of many current farmers, who need various seed varieties adapted to a region that developed the most affordably by traditional breeding, are not currently addressed by large commercial seed companies and this must be changed. Classical breeding is necessary to make farming more profitable, adaptable, and sustainable (**Brodt *et al.*, 2011**).

Diversifying the portfolio of agriculture to livestock is a successful way to speed up farming development and reduce rural poverty. The value of livestock in agricultural production is now greater than that of foodgrains. It also addresses technical and institutional options for exploiting the untapped potential of this sector at a time when demand for animal food produces continues to increase both domestically and globally, driven by a sustainable economic and incoming growth as well as an expanding urban population. Animal food demand, driven by sustainable economic and income growth and increase in urban population continues to speed up (**Delgado *et al.*, 2001; Kumar and Birthal, 2004; Rao and Birthal, 2008**).

Particularly in developing countries, the demand for animal food is also increasing rapidly worldwide (**Delgado *et al.*, 2001**). The expanding demand for animal products is an opportunity for millions of smallholders to boost their income and jobs in the livestock industry, with ample labor and limited land. The growth rates of livestock were 1.6 times higher in the crop sector and 1.3 times higher in total agricultural growth in the animal sector. This shows the importance of livestock for sustainable farming development. In the 1990s the sector accounted for 31% of agriculture growth and rose to 36% in the 2000s (**Birthal and Negi, 2012**). In the agricultural and animal production conditions of India, there is considerable diversity. The economic and development importance of livestock at a disaggregated level is, therefore, necessary to understand. The degree to which the livestock sector offers pro-poor growth prospects depends on how research institutions and policies approach the constraints facing animal husbandry.

The industry of aquaculture is seen as the main source of potential fish production growth with around three-quarters of world fish catches entirely or overfished. There are noticeable variations in the sourcing and consumption of fish protein for feeds between regions. Compound feed derived from target feedstocks in South America and Europe is being used in high-performance countries, although the demand for such resources in Asia is leading, the producers of aquaculture in South America and Europe have progressively substituted fishmeal with plant-based alternative (**Huntington and Hasan, 2009**).

The human population and requirement for marine and more aquatic resources continue to grow, and global aquaculture contributed significantly to bridging the supply-demand gap. Fish meal and fish oil constitute significant ingredients in aquaculture and their sector consumption increased by 2003 to 2.94 and 0.80 million tonnes respectively, which accounted for 53.2 and 86.8% of global production (**Tacon *et al.*, 2006**). Fortunately, aquaculture growth in favor of non-carnivore species which are processed through more comprehensive, conventional aquaculture methods is skewed (i.e. with little or no fishmeal in the diet). This is largely why the balance is for aquaculture's benefit (**Roth *et al.*, 2002**). Nevertheless, the largest consumer of fish meal, using over 53 percent of the total global supply, is estimated to be aquaculture (**Tacon *et al.*, 2006**).

Demand for fish meals is still rising, but global supplies of fish meal and fish oil are relatively fixed (**SEAFEEDS, 2003**). This means that the fish supplying these goods will be increased if alternatives are available and commonly accepted in the future. Fish meal is utilized in animal diets as a feed supplement for most domestic animal species to increase the protein content of the diet and provide important minerals and vitamins. Fishmeal is generally regarded as an excellent source of protein, they are rich in amino acids, notably lysine, cysteine, methionine, and tryptophan, which are key limiting amino acids in large farmed species for growth and productivity (**Huntington and Hasan, 2009**).

Nutrient management for sustainable agriculture

When discussing the issue of enhanced crop production, the rising food requirement of the growing population and the need for an environmentally friendly approach to sustainable agricultural growth is of great concern. Maintaining soil and crop production is the most important challenge in agriculture. The uncontrolled use of synthetic agricultural methods such as inorganic fertilizers, pesticides, herbicides, etc. has a significant influence on human and environmental health. Chemical fertilization has certainly increased crop production but has contributed more to soil degradation. The fertility of the soil is severely decreased and the crops' yields are also affected. Excessive and unattended use of pesticides results in gradual immunization of pests. (**Rao, 2007**)

The use of organic nutrients or integration with inorganic nutrients is the best alternative for high input conventional farming. It improves the soil's physical properties by improving aeration, water holding capacity, reducing bulk density, increasing porosity, etc**.(Table 1).** It is strongly believed that organic farming will lead to increased crop production and an improvement in land quality and long-term soil conservation. This is because organic matter slowly releases macro and micronutrients to a soil solution when decomposed which becomes available to plants during the crop season to increase the consumption of nutrients and enhance the soil properties and health **(Table 3).** Cultural, biological, and chemical methods incorporate organic farming. It takes advantage of and offers a favorite habitat for natural resources, flora, and fauna. It is complex and contains complementary species in the system. Neither inorganic fertilizers nor organic manures can sustain productivity on their own.

Table 1: Crops Response to integrated nutrient management in soil physical properties

Crop	Response to INM	References
Soybean	Significant reduction in bulk density	**Aziz *et al.*,2015**
Maize	Significant increase in porosity, Humified Organic Carbon (HC), and soil moisture content	**Nwite *et al.*, 2014**
Wheat	A combination of RDF and FYM @ 5 tonnes ha^{-1} reduced bulk density significantly	**Kusro *et al.*, 2014**
Maize	Reduction of Bulk density and particle density but an increase in the percentage of pore space	**Kannan *et al.*, 2013**
Cotton-Wheat	Significant improvement total porosity and lowered Bulk Density	**Hassan *et al.*, 2013**
Wheat-Soybean	Significant reduction of Bulk density and increased the Soil Organic Carbon	**Bhattacharyya *et al.*, 2007**
Soybean	Bulk density is significantly lowered with FYM application	**Aziz *et al.*, 2015**
Rice–Wheat	Increased in water holding capacity (WHC) and total porosity	**Rasool *et al.*, 2007**

However, neither inorganic fertilizers nor organic manures can sustain productivity on their own. Due to its slow effect and its bulky nature of organic nutrients, farmers opted for chemical fertilizers. To minimize this, combined use of organic and inorganic nutrients will be more sustainable than the sole application of inorganic or organic nutrients. This will reduce the total dependency on inorganic fertilizers and their ill effect on the environment. Different organic nutrients are available with different nutrition concentrations, they contain more micro-nutrients while chemical fertilizers contain only particular nutrients that are applied. Integrated use for yield and yield components of chemical and biological fertilizer is important for food safety. The goal is to maintain or change fertility in soil and plant nutrient supplies to an optimal level to support the required crop productivity by optimizing the advantages of all potential plant nutrients sources in an integrated way. It maintains and enhances soil fertility **(Table 2)** by balanced fertilizer usage combined with chemical and biological sources. In this system, the use of compost, chemicals, and organic agents to achieve sustainable cultivation and soil health improvement is adopted.

Table 2: Crops Response towards integrated nutrient management, soil fertility, and crop productivity

Crop	Response to INM	References
Wheat-Maize	Soil Organic Carbon (SOC), Total Nitrogen (TN), and enzymatic activities are increased	**Liang *et al.*, 2014**
Maize	The combination of RDF and vermicompost enhance the availability of primary nutrients and microbial activity	**Kannan *et al.*, 2013**
Wheat-corn	FYM and Composted Municipal Solid Waste enhance the Soil Organic Carbon	**Hemmat *et al.*, 2010**
Wheat	Organic carbon and primary nutrients are increased	**Jat *et al.*, 2013**
Rice-Rice	Significantly increased in Nitrogen use efficiency (NUE) and Soil Organic Matter is increased	**Xu *et al.*, 2008**
Maize	Increased in grain yield of maize was observed with 3/4th RDF and Vermicompost	**Kumar *et al.*, 2012**

Maize	Vermicompost and RDF Increases 100 seed weight, grain yield	**Kannan *et al.*, 2013**
Cereal-Legume	Green Manure with mineral fertilizer increases crop productivity and soil fertility	**Rahman *et al.*, 2013**

There is a remarkable number of benefits to farmers from INM activities and environmental benefits. As given by (**Jat *et al.*, 2015**), future strategy for the development of INM are given as (i) combined soil and plant analysis (ii) harmony with local environmental conditions (iii) mechanization for serious labor shortage (iv) conservation tillage and rainwater-harvesting technologies (v) organic nutrient recycling (vi) innovations of new technology, and (vii) appropriate policy interventions. Research is needed to adopt suitable strategies and to enhance sustainability in the future.

Table 3: Crops Response towards integrated nutrient management, the effect of biofertilizer in crop performance, soil fertility and health

Crop	Response to INM	References
Mung bean	Crop productivity and soil fertility status with bio inoculants 67 and mineral fertilization was enhanced significantly	**Rana *et al.*, 2011**
Wheat	Substantial response of biofertilizers on growth and crop productivity	**Singh and Prasad, 2011**
Sunflower	Higher grain and biological yield with biofertilizer in combination with N fertilizers and Farmyard manure	**Akbari *et al.*, 2011**
Corn	Bioinoculants with a half dose of RDF attained a significant result in ear length, ear weight, and grain yield of corn	**Sumagaysay, 2014**
Lentil	Improve soil health by the use of FYM and biofertilizer	**Moraditochaee *et al.*, 2014**

Integrated Pest Management for sustainable agriculture

Pests have afflicted agriculture ever since people started the domestication of plants and animals. Farmers have over the years worked on a variety of approaches to fight these pests, but with varying success levels. The introduction of commercial pesticides revolutionized the regulation of pesticides in the 20th century. These new pesticides have contributed significantly to the management and reduction of crop and livestock losses. However, the use of these pesticides creates some of the main environmental and health issues today: reductions in wildlife abundance and diversity, human health risks associated with chronic or acute exposure to hazardous chemicals at the workplace, and polluted air, food, and water (**Conway and Pretty, 1991; Gips, 1987; Pimbert, 1985**).

In recent years, the self-defeating complexity of the chemical control strategy dominating the efforts to protect crops and livestock has become evident. For this purpose, the development of pest control methods more and more consistent with the objectives of sustainable, efficient, stable, and fair agriculture are increasingly needed by crop protection experts. To achieve these purposes, research must attempt to incorporate various complementary pest control methods, like Integrated Pest Management (IPM). In many agroecological systems, IPM is a crucial component of sustainable development. IPM focuses on five control areas (1) Cultural control, (2) Host plant resistance, (3) Biological control, (4) Chemical control based on economic thresholds, (4) Legal control (**Pimbert, 1991**). Pesticides are used only after surveillance has been identified and treatments are taken to eliminate only the target organism. The products for pesticide control are chosen and used in ways that reduce threats to human health, beneficial and non-target organisms, and the environment. Long-term prevention is based on IPM. The management approach can be adapted to establish adverse conditions and minimize the chances of potential outbreaks by studying the environmental factors affecting a pest.

The use of pesticides as a method of control is not eliminated by IPM; the IPM for a particular crop determines the amount of pest damage that can be practicably tolerated before chemical control is needed to control pest populations to maintain viable crop conditions (**SAREP, 2017**). Farmers can reduce the effects of non-target organisms and environmental impacts while decreasing the frequency and the related costs of applications, by properly timing and concentration of pesticide applications. However, despite its theoretical importance and sound principles, integrated pesticide management (IPM) in developing countries continues to suffer at anemic rates. The main reason being insufficient technical support and training to the farmers after researching 96 countries. Some constraints have also been identified, such as research weaknesses, weaknesses in outreach, farmers' weaknesses, interference with the pesticides industry, and poor adoption of incentives. In developing country the main constrain is identified as the requirement of collective actions within the farming community whereas, in developed countries, a shortage of skilled IPM experts and extensionists is reported (**Parsa, 2014**). The main crop protection paradigm has been encouraged globally since the 1960s, with Integrated Pest Management (IPM). Its adoption by farmers from developing countries is nevertheless extremely poor. Surprisingly, the literature overlooks some of the obstacles that are prioritized in developing countries. We propose that a more rigorous study and debate on the factors that hinder the adoption of IPM in developing nations could speed up the necessary progress to achieve its full potential.

Water use efficiency for sustainable agriculture

Water use efficiency (WUE) is a given level of biomass or grain yield per unit of water used by the crop. As there is growing concern about water supplies available in irrigated and rainfed farming, there is an increased interest in trying to gain an understanding of how WUE can be enhanced and how irrigation systems can be changed to make water usage more effective (**Raza *et al*., 2012**) The world's population is projected to rise by 65% (3.7 billion) in 2050, which will place more huge pressure on freshwater supplies on the additional food needed to feed future generations. This is because agriculture accounts for 75 percent of current human water use, the largest single consumer of freshwater. Just 10 to 30% of available water (for example rainfall, flood, or groundwater) is consumed as transpiration for plants in both irrigated and rainfed agriculture globally. This figure is almost 5 percent in rain-fed crops of arid and semi-arid areas where water is poor and population growth is high (**Wallace, 2000**).

There is therefore a great potential to improve the efficiency of water use in agriculture, particularly in areas that are most in need. A large quantity of water is lost in irrigated agriculture as evaporation and/or the leaking of water during storage and transport to the fields of cultivation. (**Bos, 1985**) has estimated that only 70% of the irrigation reaches the field where it is needed which is further loss in runoff or drainage. The amount of water that transpires is significant, as only the water that passes through the crop is essentially related to growth and yield. However, the crop only transpires a fraction of the overall water evaporated during one crop season. In irrigated fields, global transpiration is just 13–18 percent of the initial water resources **(Wallace, 2000)**. Combined losses in runoff and drainage are often 40–50 percent of precipitation, comparable in general to equivalent losses in irrigated farms and in rain-fed crops it is expected to be about 15 to 30 percent of the precipitation under Sub-Saharan conditions (**Wallace and Batchelor, 1997**).

Hence, in rain-fed and irrigated agriculture, water supplies are used inefficiently. Therefore, the issue of providing food for future populations is becoming more tractable and the main focus is to increase water efficiency in agriculture. This global figure covers temperate areas with relatively high rain-fed yields. The share of food produced from rainfed agriculture would therefore be much higher in semi-arid developing countries and is over 90 percent in some countries (**Roosegrant *et al.*, 2002)**. Moreover, the majority of the world's population is forecast to grow in those regions and the improvement of rainfed agriculture would boost production in the areas where food is needed most. Moreover, the more rainfed food is grown, the less pressure the freshwater supplies will be put on irrigated agriculture. In theory, the productivity of water applied in agriculture is only increased by two means. First, more water resources should be used as transpiration where more of the initial water supply can be transferred into transpiration by reducing any loss of water that occurs before or when the water enters the crop field. Secondly, more carbon per water unit transpired can be fixed. However, the latter requires more scientific skill and creates a great opportunity for researchers and scientists of different fields for the successful implementation of technical solutions (**Wallace, 2000)**.

A variety of hydrological, physical engineering, and agricultural techniques are applicable for irrigated and rainfed areas by increasing transpiration, reducing runoff, evaporation, and minimize losses from the storage in case of irrigated conditions. Runoff increases as the slope increases and heavy precipitation with a decrease in infiltration rate of the soil. A mechanical alteration in the ground surface or the addition of additional materials to the surface or both may be expected to minimize runoff. Terracing is the most outstanding mechanical transition. This is widely used in Asia as an upland paddy rice system for hundreds of years. The benefits of contour bunding in reducing runoff have been demonstrated (**Butterworth, 1997**) by increasing the amount of rainfall entering the soil system. (**Stroosnijder and Hoogmoed, 1984**) also demonstrated that surface tillage using local tools has reduced runoff to almost fifty percent. Another method of reducing runoff is by using cover crops, crop residues or contour hedgerows (**Lal, 1989; Kiepe and Rao, 1994**) mulching also have a positive effect in reducing runoff (**Lal, 1991**) and reduces the evaporation of water from the soil by covering the soil surface **(Barros and Hanks, 1993; Hatfield *et al.*, 1996).** However, it depends on the effects of a mulch on evaporation, infiltration, frequency, and amount of rainfall, whether the balance of soil water is gained or lost. Although the concepts of the techniques used are understood, the above examples demonstrate how necessary research is to implement acceptable and successful measurements in the right conditions on the impact of surface treatments on runoff processes.

Use of modern high tech system like drip irrigation increase the water use efficiency due to reduction in the surface flow of water. However, in certain places highly costly devices can not be used, but the same concepts may be applied to reduce water exposure by conducting more research. The ability to abstract water from the depths of the soil from the perennial shrubs has been reported (**Gash *et al.*, 1997**). Agroforestry also has the potential for increasing water use efficiency. It provides shade to the main crops and reducing water losses or utilizes water outside the rooting zone of annual crops. Research is needed to identify crops with rapid root growth, in particular in the exploitation of the depth of soil. There is also a need to research and find viable tree/crop mixtures that allow better utilization of the water supplies available. Despite plenty of potentials to improve water efficiency in agriculture, this field has not yet received enough attention from the global scientific community. However, farming in rainfed and irrigated as well as on both the field and the catchment scale should be examined for certain efficiency measures.

Economic and ecological viability of sustainable agriculture

The practice of agriculture has evolved with increasing needs for human development and comfort from "subsistence to benefit" and "local to global" domains, directly affected and adapted by dynamic demand on the market, changed through socio-economic-political constraints. While economic viability is directly connected with productivity, this is not stagnant or stable because the demand for farmed products varies according to dynamics and the population demand and the policies of local, state, and national governments on agriculture and non-agricultural matters (**Nair, 2019**). Farmers' economic return is important to safeguard sustainable agriculture. At a global level, the price of their agricultural products can be determined in various circumstances. Countries such as the United States and Western European nations, including the Netherlands, are producing far more than their own needs and turning agriculture into an export advantage. Its policies are also different from those of the countries requiring food imports. These countries give enormous subsidies to farmers to make exports easier and maintain a low local food price. Pricing policies must be different to balance local people's affordability, export competitiveness, or import rates of deficit commodity for countries such as India and China, where a large fraction of the population relies on agriculture and where the agriculture share in the national economy is disproportionately huge (**Hedge, 2016**). According to the 2020-21 Economic Survey, agriculture's share of the gross domestic product (GDP) has reached close to 20% for the first time in 17 years, which is the sole highlight in the GDP results (**Economic survey, 2020-21**) Development of agriculture and related industries in GVA (gross value added) has fluctuated over time. In 2020-21, GVA growth for agriculture remained positive at 3.4%, whilst the entire economy is shrunk by 7.2 percent," the survey says.

Social acceptability of sustainable agriculture

Social justice and equity are complex terms, it is an outward-looking phenomenon of farming and natural resources, but human values that affect farming practices and the degree of technology adoption appropriate to social standards in farming communities. It is also related to the governmental and national macroeconomic policies that promote or limit the adoption through curbs and promotions of particular technologies or resources. It also includes an extensive range of definable and ambiguous criteria such as livelihoods, household, poverty, cultural influences, education, social capital, justice and equality, regional and national food security, and government policies (**Hedge, 2016**). There are wide variations in whether the farmer is primarily a subsistence farmer or a commercial farmer. Admissibility or otherwise of a particular cultivation method often depends on sufficient physical resources. For example, Poor farmers and farmers in complex and risky lands such as those of India and Africa that have arid and semi-arid regions cannot use Green-Revolution technology requiring levels and reliable irrigation with healthy soil and other inputs for timely plant activity such as fertilizers, pesticides, and tractors (**Nair, 2019**). The definition of social equality often appears to involve utopian concepts without taking their economic and ecological consequences into account. (**Pretty, 2005**) gives the efficiency and status of sustainability of various agroecosystems **(Table 4).**

Conclusion

Sustainability is a perpetual issue in this time scale with related dynamics in terms of variety and quantity in the resource base and outputs. Sacrificing sustainability in agriculturally based nations would pose a serious challenge to basic food security in developing Agrarian countries. As a result of the technological developments in manufacturing, transport, communications, supply chain, and networks to meet the demands of global citizens the agricultural market is no longer location-specific for production or product distribution.

Table 4: The efficiency and status of sustainability of various agroecosystems

Property	**Natural ecosystem**	**Modern agroecosystem**	**Sustainable agroecosystem**
Productivity	Medium	High	Medium (possibly high)
Species diversity	High	Low	Medium
Functional diversity	High	Low	Medium-high
Output stability	Medium	Low-medium	High
Biomass accumulation	Low	High	Medium-high
Nutrient recycling	Closed	Open	Semi-closed
Trophic relationships	Complex	Simple	Intermediate
Natural population regulation	High	Low	Medium-high
Resilience	High	Low	Medium
Dependence on external inputs	Low	High	Medium
Human displacement of	Low	High	Low-medium

ecological processes			
Sustainability	High	Low	High

Source: (**Pretty, 2005**)

The system of values associated with primary agricultural products with their related limitations has turned it into an era of value-added products and specialty services. Climate change, the diminishing quality and quantity of natural resources, the glaring catastrophic forecast of the rising population, and industrial raw materials (foods, fodder, fibers, and forest woods) are urgently necessary for sustainable agricultural activities. Realizing our planet's decrease carrying capacity to sustain mankind is important to avoid over-exploitation, protecting the natural resources, and making demographic changes simpler and more essential. Sustainability assessment and research should be carried out by incorporating several physicals, economic, demographic, and ecological indicators that have short-term and long-term interrelationships and modifying impacts. The dynamics of the changes in the availability, efficiency and use per se with times and newer scenarios arise and should be assessed in its entirety of inter-relationships

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