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A Review on Organic Farming for Sustainable Soil and Human Health

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Abstract: In Pakistan, the most essential task is to produce sufficient and healthy food for the ever growing population. Therefore, to fulfill the food requirements of population high yielding varieties are being cultivated that requires high unites of fertilizers and pesticides. This combination has helped the country develop a food surplus, as well as contributing to alarms of soil health, environmental pollution, pesticide toxicity and sustainability in agricultural productivity. International scientists, organizations and policy makers are emphasizing on high yield and good quality of agricultural produce on continuous basis. Through organic farming high quality food could be produced without effecting the environment; however, a concern is whether large-scale organic farming will produce enough food for ever increasing population of Pakistan. Various organic products comprising rice, wheat, pulses, spices, oilseeds, fruits, vegetables, cereals, medicinal plants and value-added products are produced in Pakistan. The production of these organic crops and products is reviewed with regard to sustainable organic farming in Pakistan.

Key words: Organic farming · Agriculture · Quality food · Soil health

INTRODUCTION

Organic farming is growing rapidly since last decade on sustainable with annual increase of 20% [1,2], according to statistical analysis over 31 million hectares (ha) is under the organic forming with annual revenue of over 26 billion US dollars, worldwide [3]. Although organic farming has been criticized for relying on the build-up of soil phosphorus (P) and potassium (K) by past fertilization before converting to organic [4]. For the socio economic development in developing countries like Pakistan, agriculture is the key sector. Ensuring food security, alleviating poverty and conserving the vital natural resources is critically important [5] and addressed through organic farming and various other means without spoiling natural resources. The major concern that compels scientists is that it very difficult to feed the ever increasing population with organic food [6]. Safe production and secure food supply is one of the major need of low income countries [7] to restore their reserviers. The concept of food security therefore surrounds the components of agriculture, environment, employment income, marketing, health and nutrition and public policy [8]. In Pakistan total 8,138 million rupees used on the purchase of pesticide in Pakistan was estimated at Rs. 19.612 billion against import bill of Rs. 8.138 billion for 2003 [9].

There are several hypotheses about organic farming, organic farming is a production system which avoids, or largely eliminates, the use of synthetic fertilizers, pesticides and growth regulators [10]. The objectives of environmental, social and economic sustainability are the basics of organic farming [11]. Through the use of legumes and biological nitrogen fixation, active degradation of organic manure, including variety of crop debris and livestock wastes could be made. The beauty of organic farming is to maintain long term soil fertility by returning all the wastes to it chiefly through compost to minimize the gap between NPK addition and removal from the soil [12]. From the research it was concluded that the over usage and continuous application of chemical fertilizers have great concerns of human and environmental hazards, therefore, in developed countries farmers are encouraged convert their prevailing farms into organic farm. Elevation in demand of organically produced commodities by consumer due health consciousness and

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public is ready to pay high prices for this produce [13]. The old farmers have their own rules and regulations to maintain the soil health as compared to modern agriculture [14] while recent studies reveled that through the application of only organic inputs alone the nutritional requirements of the crop could not be fulfilled, the need to integrate the two forms in order to achieve better crop yields. The interaction between inorganic and organic matter may cause either decrease or increase soil nutrients, depending on the nutrient and planting material is a question [15].

Source of Organic Matter: In organic farming the yield is slightly low as compared to modern intensive agriculture farming, use of inorganic fertilizer has not been helpful for sustainable production because it is often associated with reduced crop yield, soil acidity and nutrients imbalance [16,17]. Furthermore, fully dependence on inorganic source of fertilizer is not possible for the farmers, as it is not available at right time in remote areas of agricultural farms, other major issue is lack of technical knowledge about the inorganic fertilizers furthermore these are costly and common farmers are unable to use. This is millstone for the agricultural scientists to enhance the crop productivity by utilization of organic source of fertilizers, ultimately results in increases the productivity of quality food sustainably as it improves the soil physical properties [18]. Currently, the utilization of these organic materials in soil fertility management in Africa is not common as compared to Asian countries [19]. The need to use renewable forms of energy and reduce cost of fustigation of crops has revived the use of organic fertilizers worldwide. Major concern is improvement of environmental condition and public health for advocating encouraging use of organic materials [20]. Field experiments confirms the effect of different sources of organic manure (Cow, Sheep and Poultry Manure) have significantly increase growth and yield of okra [21]. Any nutrient(s) deficiency in soil can cause a considerable decline in crop yield, especially under organic agriculture [22]. Nutrient deficiencies in crops can be prevented by using organic and inorganic nutrient sources [23]. However, the long-term use of increased amounts of only chemical fertilizers may degrade soil structure and deteriorate productive capacity of soils [24]. Judicious use of organic and inorganic nutrient sources is important to decrease the solitary dependence on chemical fertilizers for sustainable high crop production by minimizing nutrient losses to the environment and optimizing nutrient use efficiency [25]. Integrated use of organic and inorganic amendments or chemicals may be a way to ensure high sustainable soil productivity, fertility and quality and environmental quality [26]. Low organic matter content is one of the most important contributing factor for poor fertility status of Pakistani soils. Bio-slurry, a by-product from the biogas plant, can successfully be used to improve crop productivity and soil health [27]. While, in neighboring country India almost 25-30 % of nutrient needs of agriculture can be met by various organic sources [12]. Activity of mycorrhizea can be increased by application of organic sources nutrients and other beneficial organisms in the soil and is also helpful in alleviating the increasing incidence or deficiency of macro and micronutrients [28]. Organically grown crops can give good reward to farmers like table pea (*Pisum sativum* L.), aromatic rice (*Oryza sativa* L.) and onion (*Allium cepa* L.), as these crops frequently demanded by consumer of local, national and international markets due health concerns [29]. Manure collected form the animal sheds and wet straw, daily basis and stored for decomposition for the further application, this composted manure was applied, from this study results indicated that not only soil structure and fertility was improved, but also water holding capacity and nutrient uptake efficiency was also improved, ultimately the crop productivity was significantly increased [21].

Crop Productivity in Organic Farming: From the ancient times, with the application of organic matter (Farm Yard Manure) used for increase the crop yield on sustainable basis [30]. The high input agriculture has led to self-sufficiency in food grains but it has posed several new challenges. The conversion of modern agriculture into organic agriculture is now widely debated. Growing of high yielding varieties with indiscriminate use of fertilizers, poor water management practices and inefficient plant-protection measures in modern chemical intensive agriculture has resulted into degradation of lands owing to low crop yields with poor quality of produce [31]. The productivity of most of the crops is declining. Hence, conversion of modern chemically intensive agriculture to a more sustainable form of agriculture like organic farming appears to be an option for maintaining the desirable agricultural production in future [32]. Therefore, the use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetically compounded agro-chemicals appears to be one of the probable options to sustain the agricultural productivity. Generally, it is common thinking that yields of several crops reduce during the initial years under

organic farming, but high market value of organically grown produces may be able to compensate the losses in yields [33]. Application of mustard oil cake or poultry manure alone gave better yield brinjal (*Solanum melongena* L.) compared to only chemical fertilizers. The organic matter content and availability of N, P, K and S in soil were increased by organic matter application [34]. There is substantial increase for grain yield in rice, with the application of organic matter [35]. It was found that with the application of 7.5 t/ha there is significant increase in the yield of rice. It was also found that there is considerable progress in grain yield of Chickpea [36]. Vegetables are highly responsive to organic sources of nutrients and profitable to farmers [37]. Response of chilli (*Capsicum annuum* L.) to vermicompost and observed that the application of vermicompost increased the microbial activities. Vermicompost has a positive effect on the performance of crops due to a higher number of branches and fruits [38] similarly excellent brinjal fruit yield (97 g/ plant) could be obtained, crop grown on vermin-compost [39] similar results were confirmed [40]. In case of sweet pepper (*Capsicum annuum* L. var. grossum) with vermicompost. [41]. It was confirmed that in tomato, yield increased two and half times with the addition of organic matter as compared to inorganic source of nutrients. while is also found that with the addition of vermin-compost in the growing media, resulted to four times increase number of fruits/plant in case of tomato [42]. On commercial basis it was found that application of vermin-compost @ 5 t/ha tremendous increase in the yield of tomato as compared to the inorganic fertilizers [43, 44]. Testified that mixture of soil mine spoil, coir pith vermin-compost (1:1:1) expressively improved number of leaf, plant height and root length in onion (*Allium cepa* L.). Similarly findings were observed in case of cabbage not only head weight in cabbage (700 g) significantly increases but also yield (38 t ha^{-1}) with the application of earthworm compost at 27 and 29 t ha^{-1} [45].

Quality of Organic Produce: For the agricultural scientists and policy makers the prime concern is environmental hazards and to develop such methods of which are helpful to produce quality food, for this basic step is search of alternate fertilizers which can replace the in-organic source of fertilizers; several organic materials have been used as fertilizers in organic crop production [46]. But, usage of these (animal waste and urban sewage waste) materials in modern agriculture invites pollutions, such as heavy metals, chemical residues and parasites. To overcome this problem, farmers have adopted a kind of biological fertilizer called Bokashi in Japanese [47], anaerobically fermented using oil seed sludge, rice bran and fish processing byproduct as materials. A microbial inoculate, including lactic acid bacteria, yeast and actinomycetes, is usually inoculated to materials before fermented. This kind of organic fertilizer is easily stored for long time without bite smell. However, the problem observed is the low nutrient availability at the early growth stage of crops even if the nutrient availability is hold longer than chemical fertilizers. However, the researchers face the same problem that it is difficult for organic farming to get a yield similar to that by conventional farming. Two leafy vegetables were grown under greenhouse conditions and the dynamics of both the organic fertilizer and the plant growth were examined to elucidate the plant limiting factors and advantages of this organic fertilizer. Leaf-picking or leaf-peeling harvest method was adopted to prolong the growth and harvestable period. It has been proved that crop quality, especially the vegetables and fruits, is improved by organic fertilization [48].The nutritional profile of leafy vegetables was studied including fallowing parameters like sugars contents, vitamin C and the ionic-nitrate, from the analysis the comparison between organic and inorganic grown vegetables was made. From results it was concluded that the concentrations of sugars and vitamin C were significantly higher but nitrate was lower in organic-fertilized than chemical-fertilized vegetables [49]. The quality advantages for organic produced vegetables over the chemical fertilized vegetables [50]. Similarly in case of chilies it was observed that protein and carbohydrate concentration was significantly higher, grown on vermin composted vegetable waste [51]. In another experiment, Haase *et al.* [52] recommended that organic potato tubers farming may be expected to have significantly higher dry matter contents (19%) that are considered good for processing into French fries without impairing the texture of the fries when concentrations exceed 23 per cent. Similarly, application of FYM at 10 t ha^{-1} alone increased the economic yield and quality parameters like hulling percentage, milling percentage and protein and amylose content of rice cv. Saket-4 it is observed that organically grown potato cv. Virgo having 66% higher yield than the conventional crop, whereas Raja yielded 47% [53].

Preservation of Soil Fertility: Soil fertility is basic demand that responsible for the productivity of all farming systems. Soil fertility is the ability of a soil to supply nutrients to crops [54], while, Swift and Palm [55] soil

fertility is the ability of soil to produce crops. The key indicator to assess the soil quality is organic matter contents as it affects the soil physical properties (porosity, water infiltration, bulk density and water holding capacity) directly [56, 57]. Verification about the decomposition of organic matter macro and micronutrients are released in the soil solution and available to plant for their growth. Higher crop productivity on sustainable basis is possible through the application of organic matter and improving soil health by developing favorable soil physical properties for plant growth and development [58, 59] concluded that soil reaction is declined due to addition of organic matter in fresh form that uptake the soil and plant nitrogen for the decomposition. While, addition of inorganic nitrogen helps to speed up the soil reaction and decomposition of organic matter [60]. To raise the pH of the soil from 6.0 to 6.5 composed is used that leads reduction in the population of broad leaf weeds in field conditions [61,15]. To evaluate the efficiency of various organic materials like compost, FYM, Sesbania green manure alone and in combination with chemical fertilizer on the chemical properties and fertility status of soil. After the application of treatments, rice and wheat crops were grown. Soil samples were collected after the harvest of each crop from all the treatments, brought to the laboratory, prepared and analyzed for various parameters. It was noted that pHs and SAR of the soil was decreased in all the treatments from their original levels after both the crops. Role of compost was more pronounced when compared with FYM and Sesbania green manure [62]. Organic input in agricultural farm system is thought to enhance carbon sequestration by increasing soil organic matter content. Yet, the findings on the soil carbon concentrations increment in organically managed soil still remain controversial [63].

Sustainable Soil Microbial Activity: Organic matter plays an important roles regarding soil productivity, several physical and chemical properties like improves soil water holding capacity, better aeration for germinating seeds and plant root development [64]. Because of continued cultivation, most of soils in Pakistan are deficit in organic matter [65]. Pakistani soils exhibit poor aggregate stability and are low in iron and aluminum contents. Out of a total of 33, 7714 samples analyzed in the Punjab, 96% of the samples were in the poor to medium range of organic matter and only 4% exhibited a moderate to adequate level. Micronutrient deficiency such as zinc is widespread in all rain fed areas [66]. Continuous cultivation leads to decline in yield due to decrease in organic matter [67]. It is observed that addition of 0.4 t/ha paddy due to incorporation of rice straw increases the soil productivity as microbial activity improves indirectly with organic matter [68]. Soil physical and chemical properties improved with usage of compost ultimately enhance crop yield Nutrient depletion low organic matter content in the Pakistani soils can be compensated only be by applying compost to these soils [69]. SAR and pH of the soil is decreased as compost and other organic materials acidic in nature. As organic acids formed and due to release of Ca cause leaching of Na, this phenomenon leads to slight increase in ECe of normal soil. The available amount of all the major plant nutrients (N, P, K, Ca and Mg) and organic matter increased in the soil [70].

Human Health and Organic Farming: For healthy growth and optimal yield, nutrients must be available to plants in correct quantity, proportion and in a usable form at the right time. To fulfill these requirements, chemical fertilizers and/or organic manures are needed. Fertilization has been reported to have an influence on the phyto-nutritional quality of crops. Inorganic fertilizer is said to reduce the antioxidant levels, while organic fertilizer has been proven to enhance antioxidant content in plants [71]. Applying fertilizers, particularly in the inorganic form, in excess of plant requirements can increase the chances of fertilizer loss and environmental pollution. Organic manures, apart from improving physical and biological properties of soil, help in improving the efficiency of chemical fertilizers [72] Organic manures such as farmyard and poultry manure are known to improve the physical, chemical and biological conditions of soil and ensure sustainable soil health [73]. In the past, agricultural production was focused on maximizing the quantity of crop produced for commercial markets. Hence, compound fertilizer has been used as a common agricultural practice. However, recently health conscious consumers are interested in optimizing the nutritional composition with minimal chemical residues on foods produced through environmentally friendly agricultural practices [74]. Substituting chemicals with organic fertilizers is one of the common principles in this production system. Inorganic fertilizers have had significant effects on World crop production and are essential components of today's agriculture. Humans are dependent on consuming enough diverse foods to provide all the required nutrients to sustain life. If food systems do not provide sufficient quantities and enough diversity of foods to meet these needs continuously, malnutrition will ensue among certain population groups, especially the poor and their health and welfare will

deteriorate [75]. Starvation and regional famines are the commonly recognized results of severe calorie/protein malnutrition and preventing these outcomes was the paramount goal driving the agricultural 'green revolution' during the latter half of the 20th century. However, other more subtle consequences of malnutrition include: impaired immune function, increased mortality and morbidity rates, lower worker productivity, diminished intellectual performance, less educational attainment, a lower livelihood, higher birth rates and a lower standard of living for all those affected [76]. Because agriculture is the primary source of all nutrients required for human life, those national agricultural systems that do not provide sufficient nutrient output to meet these nutritional needs will ultimately fail, as well the food systems dependent on them. Possibly, changes in cropping systems over the past 60 years that resulted during the 'green revolution' are contributing to the dysfunction of food systems that cannot meet all the nutritional needs of billions of people in various developing world regions [76]. However, there were some unforeseen consequences of this agricultural revolution that have had profound effects on human health, felicity and world development. Today, there are over 3.7 billion iron-deficient individuals and about 1 billion people that are or are at risk of developing iodine deficiency disorders. Additionally, there are over 200 million people that are vitamin A deficient [77]. Other micronutrient deficiencies (e.g., Zn, Se, vitamin C, vitamin D and folic acid deficiencies) may be as wide spread as iron, iodine and vitamin A deficiencies, but there are no reliable data to confirm this although circumstantial evidence suggests that this may be so [77]. Many food systems which sustain life in a number of countries today cannot produce enough of all the nutrients needed to satisfy human requirements. These types of studies clearly indicated that many food systems are failing to provide enough nutrients to sustain healthy, active and productive lives for all citizens in many developing nations [74]. However, current agricultural practices are almost always directed at maximizing production while minimizing costs. Recently, in some nations, preserving the environment is becoming a more important objective of agriculture (i.e., 'sustainable' agricultural goals). Maximizing nutrient output of farming systems has never been a purport of either agriculture or of public policy. Yet, scientific knowledge is available that could greatly improve the micronutrients output of farming systems and the available micronutrient content of the food crops produced. The debilitating effect of micronutrient malnutrition on people and societies and its current magnitude in developing nations certainly testifies to the need to consider doing so now. The use of farm-yard manures and other forms of organic matter can also change plant-available micronutrients by changing both the physical and biological characteristics of the soil. In many circumstances these changes improve soil physical structure and water holding capacity, resulting in more extensive root development and enhanced soil microflora and fauna activity, all of which can affect available micronutrient levels in soil to plants [78]. Combining both human nutrition with improved agricultural productivity from such breeding efforts results in extremely high cost/benefit ratios for investing in this type of micronutrient intervention (i.e., better than 1:50). Furthermore, the adoption and spread of micronutrient-enriched seeds by farmers can be driven by profit incentives because micronutrient enriched seeds increase crop productivity when planted to micronutrient-poor soils [76]. The benefits can be disseminated widely and they are sustainable once developed unlike current micronutrient interventions that rely on supplements or food fortificants [79]. Soil is the pre-eminent source of most biologically active trace elements that reach man through plants and animals. However, identifying and understanding relations between soil and health have been almost exclusively the concern of geochemists, medical scientists and epidemiologists: soil scientists have played little part. Nevertheless, environmental geochemistry and soil science overlap. Soil contamination can cause human health hazards directly and indirectly, Elements from the soil pass through the food chain (plants and animals) and also into the water supply. In general trace elements that are important, many of which are considered essential and although they can all be toxic if the concentrations exceed certain limits [80]. Varied sources of food provide considerable protection against diseases associated with the deficiency or toxicity of elements. In developed countries it is more difficult to detect relations between soil and health. Nevertheless, people there might be less healthy than they should be because of ignorance about factors in their diet [81]. Rapid, cheap and accurate elemental analyses have enabled us to identify factors in the environment that cause ill health in humans and livestock [82]. Such advances have also made it possible to set more precise limits for the recommended intakes of elements by the World Health Organization [83] and to realize that the relations between health and the environment are often more complex than were originally thought. Also, more geochemical surveys and epidemiological investigations

are providing information to map the distributions of elements and diseases. If it can be shown that the risk of developing a particular disease is greater in one area than such information should provide a basis for seeking possible causes in the environment. Although factors in the soil can cause specific diseases, such as goitre, their more general effects on health might be more common and insidious. Since 1973 there has been increasing evidence that anomalies in trace element supply can influence human health and well-being without necessarily producing specific clinical symptoms [83]. Diagnosing the effects of toxicity, which are often not specific, is problematic: this is especially so for lead which accumulates slowly in the body. Some combinations of metals have synergistic toxicity which enhances the risks resulting from small doses and from a short period of exposure [84]. Improved knowledge is also changing our views about the simplicity of the relations between certain diseases and specific elements and about which elements are essential and which are toxic [85]. The effect of the soil on health is confounded by other factors: the trace element status of crops is affected by the species and cultivars [80] and the lifestyle, sex, age and general well-being of the people. Children, the elderly and pregnant women in particular are vulnerable to deficiency or toxicity of trace elements [86] children because they often eat a limited range of foods and are growing rapidly and neonates and the elderly because they absorb trace elements poorly. Human beings require many elements for nutrition and good health. Macronutrients are needed in large amounts and there appear to be few problems with them, either in terms of deficiency or toxicity, that are caused by the condition of the soil. Plants can tolerate fairly large ranges in the concentration of many trace elements in soil. The availability of trace elements to plants depends on the forms in which the elements are held in the soil and the amounts taken up vary considerably among species and cultivars [81]. Both deficiency and toxicity of trace elements affect reproduction [87]. They can affect adversely the development of sperm and of the embryo even though the mother may remain healthy. Many reproductive defects have been observed with iodine deficiency alone. Despite all the research there is a dearth of quantitative information on the relations between elements in the soil and human health; the causes remain putative and there is much speculation and anecdotal evidence. The literature abounds with terms such as ‘suggested’, ‘possible’, ‘suspicions’, ‘might’, ‘could’ and so on, to describe such relations. Much is known about the functions of elements in the body, but there is increasing evidence that the interactions among them are more complex than we originally thought.

CONCLUSION

Through organic farming, provision of good quality food is possible without affecting soil health and environment on sustainable basis. There is need for the standardization of suitable organic source for specific crop and hunting good market for earning good profit from the produce. The whole region as such cannot afford to go for organic at a time because of its commitments to insure food and nutritional security. This will provide ample opportunity for employment and bring prosperity and peace in the region. Organic forming ensures our soil to feed the nation for longer time on sustainable basis.

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