Organic farming in Nepal: A viable option for food security and agricultural sustainability

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INTRODUCTION

Organic agriculture as a holistic production management system that avoids use of synthetic fertilizers, pesticides and genetically modified organisms, minimizes pollution of air, soil and water, and optimizes the health and productivity of interdependent communities of plants, animals and people. The Nepalese government is aware of the problems of agricultural chemicals, and in some areas is promoting integrated pest control in order to reduce the use of pesticides (PMRD, 2008). The organic agriculture has proven to be effective in increasing and stabilizing yields, particularly in marginal lands. This means it is a system that empowers farmers to restore and uphold food security (Maxwell and Frankenberger, 1992; Menezes, 2002). Organic agriculture also helps to increase resistance to pests and diseases, which is crucial to building food security (Patel, 2009). Recent analysis suggests that organic farming offers a way to reduce the use of synthetic pesticides for the management of animal pests and pathogens without increasing their levels of infestation.

The five-word sentence "Nepal is an agricultural Country" has become hackneyed these days. The problem of brain-drain and muscle-drain escalating in tandem, leaving Drudgery as a quotient is obviously not a good sign for transcending the existing...
agriculture system of Nepal. With Nepal’s unemployment rate hovering at 40%, its compulsion of a number of people to choose foreign destination temporarily or permanently. The 2015 earthquake affected the social economic, political and environmental atmosphere. Of the total, 24% population lives under poverty (Sen, 1981; CBS, 2018). The nation with 29 million population has sent its 10% of the population between 20-40 years of age who are compelled to do 3D work (Dirty, Dangerous, Difficult) (DoFE, 2014). The data has revealed a total of 1400 migration/day which is really a matter of pity and shame. As the country’s agricultural GDP shares 26.98 percent while the remittance share 52.4 percent (MoF, 2019), the percentage share contribution of emigrants via remittance is almost double the share from agriculture. (Adhikari, 2018) mentioned that Nepal is predominantly an Agrarian country. However, the scenario of haphazard pesticide use is reducing the quality of soil and products. About 3035 trade (commercial products) of pesticides under 170 common names are registered in Nepal (PQPMC, 2019). The existing population involved in agriculture is sufficient to feed such a small country if interventions on the parameters affecting agriculture are made. It includes production of quality inputs such as quality seeds and seedlings, effective pest management practices, mechanization and ICT based agriculture alike. While targeting the sustainable Development goal, the Zero Hunger Challenge, are we really prepared for achieving the target? The answer is, “a big No”. Government of Nepal has banned 21 pesticides in the country (PQPMC, 2019). However the use of such proscribed pesticides is being used throughout the Terai region especially near to the border. The use of pesticides has created four-fold problems through trophic levels; the health problem, the environmental problem, yield loss due to non-target pesticide application and burden to farmers (Koirala et al., 2009). Pesticides use has a harmful effect on the environment (Ibitayo, 2006). The existence of non-target organisms in the nature is also in challenge due to the use of pesticides (Aatreya et al., 2011). The major challenge that has encumbered the sustainability in agriculture production system and self-sufficiency is irrational and haphazard use of agrochemicals, the pesticides and thus, leaving organic agriculture as a only way to food and nutritional security.

Organic agriculture improves the health of people. Organic farming uses carbon-based fertilizers and biological pest control and does not use synthetic fertilizers. It reduces the cost of agricultural production and also improves the soil health. The organic farming system has the potential to improve soil fertility by retaining crop residues and reducing soil erosion (Reganold et al., 1987; Siegrist et al., 1998). The organic farming system has the potential of reducing the use of irrigation water and sequencing CO₂ (Niggli et al., 2009). The organic farming system has the potential to reduce the emission of greenhouse gases by agronomic practices as the nitrogen application rates in organic farming systems are 62-70% lower than those compared to conventional agriculture due to recycling of organic crop residue and use of manure (Kramer et al., 2006). The organic matter has a stabilizing effect on the soil structure, improves moisture retention capacity and protects soil against erosion (Reicosky et al., 1995). The haphazard use of chemical fertilizers and pesticides has resulted deleterious effects on the human health causing immune-suppression, skin cancer, hormone disruption, reproductive abnormalities, birth defects and liver and kidney problems. Organic agriculture improves the health of people. Since consumption of organic food products is the best remedy to prevent the numerous health hazards caused by conventionally produced foods, the global market has experienced exceptionally high growth in organic foods in the United States,

Organic farming as a boon

Organic farming uses carbon-based fertilizers and biological pest control and does not use synthetic fertilizers. It reduces the cost of agricultural production and also improves the soil health. The organic farming system has the potential to improve soil fertility by retaining crop residues and reducing soil erosion (Reganold et al., 1987; Siegrist et al., 1998). The organic farming system has the potential of reducing the use of irrigation water and sequencing CO₂ (Niggli et al., 2009). The organic farming system has the potential to reduce the emission of greenhouse gases by agronomic practices as the nitrogen application rates in organic farming systems are 62-70% lower than those compared to conventional agriculture due to recycling of organic crop residue and use of manure (Kramer et al., 2006). The organic matter has a stabilizing effect on the soil structure, improves moisture retention capacity and protects soil against erosion (Reicosky et al., 1995). The haphazard use of chemical fertilizers and pesticides has resulted deleterious effects on the human health causing immune-suppression, skin cancer, hormone disruption, reproductive abnormalities, birth defects and liver and kidney problems. Organic agriculture improves the health of people. Since consumption of organic food products is the best remedy to prevent the numerous health hazards caused by conventionally produced foods, the global market has experienced exceptionally high growth in organic foods in the United States,
Europe, and in other countries, yet market shares remain quite small (Piyasiri and Ariyawardana, 2002; Torjusen et al., 2004).

Organic farming and soil health
Organic farming has the potential to improve soil fertility and help building both nutrient and carbon stocks (IFOAM, 2008). The organic matter improves the soil quality and crop yield by increasing the carbon content and other plant nutrients in the soil (Stanhill, 1990). When it comes to building, maintenance, and replenishes the soil health, organic farming is far superior to conventional agriculture (RI, 2011). A sound and systematic organic practice is always a prudent way of enhancing a better agriculture system with minimum loss to ecology. Once the practice of organic agriculture is flourished, healthy soil system is developed and according to the views from representatives of different organizations, healthy soil will support healthy plants and in turn, healthy humans and animals (Soil Association, 2002) (IFOAM, 2005). The major advantage to small farmers shifting to organic production are enhancement of soil fertility; the closeness to traditional and existing system; reversal of soil erosion and the low cost of self-reliance existing technology (IFAD, 2003). The organic agriculture can help maintain fertility of the fragile land, contributing to maintain agriculture productivity by avoiding the loss of biodiversity, Adhikari (2012) and Deshar (2013) mentioned that heavy use of chemical fertilizers, mainly in suitable and remunerative farming pockets of Nepal, has resulted farm land degradation (Kanshakar, et al., 2002). Also, major soil indicators (OM, N, P, K and pH) were found to be influence heavily in Nepalese soil by the use of organic manures (Regmi et al., 2006). Several examples are found to be supportive and evident on the preference of organic farming over conventional one. The biomass of Mung bean after two pickings of pods when incorporated in rice field increases the rice grain yield by 20% (Khanal et al., 2006). The incorporation of Asuro leaf in the rice field increases rice yield by 45% (Subedi, 1992). Increase in biodiversity of soil micro-organisms has been evident in Mung bean biomass incorporated field that are important in maintaining soil health (Devkota et al., 2006). Also, there has been found more abundance of mycorrhizal population in the roots of crops grown in organic manure -rich soil (Eason et al., 1999). All these evidences support the need and flourish of organic agriculture in Nepalese agriculture indeed.

Organic farming and food security
When all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life, food security prevails (FAO/UNDP, 2003). Until the early 1980s, country used to be exporter and managed to be self-sufficient however, over the past decades, country has been experiencing food shortage and depend on export mainly from India and China. Several studies conducted by Gaire et al. (2015), Chapagain (2014), Chapagain and Gentle (2015) and Adhikari and Hobley (2011) highlighted the challenges Nepal’s facing in accomplishing food and nutrition security. With a global hunger index (GHI) of 19.8, it’s depicting a melancholic situation of hunger in different regions of the country (IFPRI, 2009). Of the total population, almost 50% of the population is undernourished, 41% children under the age of five are stunted, and 29% are underweight. According to World Food Program (WFP, 2019), 4.6 million Nepalese are suffering from food insecurity (Yaro, 2004). In Nepal, the import and formulation of pesticides was about 50 thousand kg in 1997/1998, which was increased to 350 thousands kg in 2011/2012 which six fold increment is showing dependency of agriculture production on pesticides (Kafle et al., 2015). Among cereals, vegetables, cash crops and fruits, the pesticide use was dominant in vegetables (1.60 kg a.i./ha) (PPD, 2015). Further, studies reveal that more than 90% of the pesticides are used in vegetable production (Atreya and Sitaula, 2010). This scenario if persisted for some years is sure to create a serious threat on Nepalese agriculture system affecting food and nutritional security. The only way to get rid of such crises suits for organic farming. Organic farming emanates safe, healthy, nutritious, and mineral-rich tasty food (Worthington, 2001). Several evidences have shown that organic plant-based food usually contains higher antioxidants, minerals, vitamins, and other beneficial substances (Woese et al., 1997; IFOAM, 2008; Worthington, 2001). The scientific communities agree that regarding the pesticide residues, food additives, irradiation etc., such food poses their form and amount in very negligible amount with no considerable health risks (Low et al., 2004; Magkos et al., 2006; Winter and Davis, 2006). Also, while describing from health perspective, such certified organic foods possesses 3-4 times lower risk than conventional food regarding pesticide residues. These scenarios depict the scope of organic agriculture from human and animal health perspective (Winter and Davis, 2006). The organic food and their products have an improvement in taste and nutrient content (Parrott and Marsden, 2002). People preference to organic food has also been reported in the western terai of Nepal because of its good taste (Aryal and Dahal, 2010). Thus, unleashing the pesticide dependent agriculture and embracing organic agriculture is the relevant way to secure national food security and agricultural sustainability.

Organic farming and pest control
Insect pest and diseases are challenging threats responsible for descending the production and thus, various components or forms of organic agriculture can be used for their control without negative impact to the environment. Green manuring, biofertilizers, biopesticides, bio-fungicides, botanical pesticides and trap crops can be the best option for pest control (Aryal, 2006). Crude water extracts of green neem leaves (Azadirachta indica), Chinaberry (Melia azadirach), Malabar nut (Justicia adhatoda) and Indian privet (Vitex negundo) (each 200 g of leaves per liter of water) can be effective for controlling cabbage butterfly, soya bean hairy caterpillar and tobacco caterpillar (Neupane, 1999). A review on eco-friendly management of Diamondback moth (Plutella xylostella) of cabbage in Nepal also addressed botanical, cultural, irrigation measures at their best control DBM (Parajuli and Paudel, 2019) which also supports organic agriculture (Table 2).
**Voyage of Nepalese agriculture: From traditional to organic**

Nepalese farmers have been practicing traditional agriculture since time immemorial with always emphasizing the use of local resources and free of chemical fertilizers. Each house with at least a few pair of goats and chickens, a pair of bullocks, few buffaloes and cows and so on used to be evident. Promotion of organic agriculture first appeared as a priority in the 10th Five Year Plan of the Government of Nepal (NPC, 2003). It is now embedded in the national agricultural policy. The shift of traditional agriculture and often broke down of the agroecological linkage started in “the green revolution agriculture” or “the industrial agriculture” where innovation of DDT (1950s), miracle wheat by Norman E. Borlaug (1970) and many achievements in agriculture were made. More or less, these were responsible to disturb the agroecosystem as they were emphasized on productivity and profitability. Later, the book “Silent Spring” made people realize of the impacts of industrial agriculture. The book put light on “the use of chemical pesticides, limitations of technological advancement and the responsibility of science” (Lear, 2002). With time, several incidents of pest problems, pesticide impacts and so on started encumbering agriculture production causing ecological disturbances. Altieri and Nicholls (2005) grouped these negative ecological disturbances into two categories as; i) disease of the ecotype (physical environment), and ii) disease of the biocoenosis (biotic community). At present, it is being realized that neither ancient agriculture, nor the traditional agriculture could best fit to feed the world crammed with billions of population and on contrary, the present day conventional/commercial agriculture heavily dependent on agrochemicals can’t be the proper option from ecological point of view leading to the emergence of “sustainable agriculture”. However, due to its vagueness, clearness and measurability, the term ‘sustainable’ it is not free of controversy (Petersen and Snapp, 2015). As the sustainability paradigm couldn’t depict what techniques, for example, can be used to get ‘end product’ of sustainability, concept of ‘the best’ agriculture system emerged. Organic agriculture is one of the approaches of sustainable agriculture. Organic agriculture has become a field of trial where farmers/ producers, with long-term suffering associated with risk and cost, constantly try, fail, learn and retry (Tittonell, 2014). It is pointed out that “chemical paradigm is about controlling nature, the organic paradigm is about respecting nature” (Rodale, 2010).

**Organic farming and Nepal’s experience**

Organic agriculture was first appeared as one of the priority sectors in Nepalese agriculture since the 10th Five Years Plan. But nowadays various institutions, individuals and farmers are emergently engaging in this field. The paradigm shift from traditional to the conventional agriculture system depicts the scenario of zero or minimum pesticide use at past; that is, until the 1950s Nepalese farming system was largely organic. Chemical pesticide was introduced for the first time in 1950s (Dahal, 1995) for the control of malaria. DDT made its first impact in 1956 followed by organochlorines, organophosphates, carbamates and synthetic pyrethroids (Delaplane, 1996; Atreya, 2008). In 1997/98, about 51 million rupees (NRS) was spent in pesticide import and formulation. The expenditure rose to more than 374 million (NRS) in 2011/12 (Dhital et al., 2015). In Nepal, the organic agriculture movement was first observed when it was at infancy stage in the US policy level. The philosophy of organic agriculture was accepted by the US National Research Council and put forward as “Alternative Agriculture” in 1989. American research scholar Ms. Judith came to Nepal (Bhaktapur) in 1987 and started “organic agriculture” and on the same year, founded an NGO, Appropriate Agricultural Alternatives (AAA), devoted for research advocacy and marketing of organic agriculture. As she was the pioneer of organic agriculture, local people often referred her as “mother of Nepal’s organic farming” (Bisht, 2011). Organic agriculture was put into light of promotion in the 10th five-year plan (2002-2007) of the Government of Nepal (NPC, 2003). In 2008, the National Coordination Committee for Organic Agriculture Production and Processing System (NCCOAPPS) was formulated and National Organic Standards have been developed. The National Adaptation Plan of Action to climate change (NAPA) has mentioned organic agriculture as an important agricultural strategy to adapt to the changing climate (MOE, 2010). Bhushal (2005) mentioned that many of the farmers are aware of the negative impacts of conventional agrochemicals-based intensive farming system at the same time. Also, some of them are practicing organic agriculture in different agroecological regions of the country independently (Adhikari, 2005).

**Table 1. List of some organic farms of Nepal.**

| S.N. | Name of the farm                      | Location  |
|------|--------------------------------------|-----------|
| 1    | Himalayan Organic Farm               | Kathmandu |
| 2    | Ashapuri Organic Farm                | Kathmandu |
| 3    | Prasiddhi Organic Coffee Estate P.Ltd.| Madanpur  |
| 4    | Green Valley Organic Farm            | Kathmandu |
| 5    | Herb Nepal                           | Bhaktapur |
| 6    | Patale Gaun Organic Farm             | Kashikhandha |
| 7    | Organic Farm House                   | Kapan     |
| 8    | Organic Farm House                   | Pokhara   |
| 9    | Fresh Farms                          | Kathmandu |
| 10   | Everything Organic Nursery           | Patlekhet |
Table 2. Some research findings related to pest controls under organic farming.

| S.N. | Insect pest                                      | Research findings                                                                 | References                        |
|------|-------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------|
| 1    | Potato tuber moth                               | Chopped and shade dried *Chenopodium botrytis*, *Mentha arvensis*, *Artemisia vulgaris* and *Eucalyptus* sp. Leaves with stem. | (Pradhan, 1988)                  |
| 2    | Cabbage butterfly, Diamondback moth and Cabbage aphid on cole crops | Water extract of neem seeds, tobacco stem and leaves, and chinaberry seeds and leaves. | (Joshi, 1994)                    |
| 3    | Flea beetle on Cole crops (Radish, turnip and broad leaf mustard) | Aqueous solution of pyrethrum @ 3 g/L water                                     | (Dawadi et al., 1993)            |
| 4    | Aphids on vegetable crops                        | Aqueous extract solutions of *J. adhatoda*, *Melia azedarach*, seed pomace of *Brassica campestris* (1:4 ratio) | (Vaidhya, 1993)                  |
| 5    | *Brevicoryne sp.*, *Hellula sp.*, *Plutella sp.*, *Trichoplusia sp* for cabbage | Cloves of garlic (50 g/L+) resulted yield gain                                    | (Baidoo and Mochiah, 2016)       |
| 6    | *Brevicoryne sp.*, *Plutella sp*. for pest control of cabbage | Cloves of garlic (30 g/L+) resulted yield gain                                    | (Fening et al., 2013)            |
| 7    | *Sitobion avenae* for pest control of wheat       | Neem cake @ 100 g/L+ resulted pest reduction                                     | (Aziz et al., 2013)              |
| 8    | *Sitophilus oryzae* of stored wheat              | Neem oil (10 ml/kg) resulted weight loss reduction                              | (Kemabonta and Falodu, 2013)     |
| 9    | *Helicoverpa armigera* of chickpea               | Fresh leaves of Neem (50g/) resulted pest reduction                             | (Kumar et al., 2015)             |
| 10   | *Sesamia calamistis* of Sorghum                  | Seed kemels of Neem(5 g/plant) resulted yield gain                               | (Okrikata et al., 2016)          |

**Conventional agriculture versus organic agriculture**

Various evidences suggest that there are many basis that seem logical and scientific to replace conventional agriculture by organic agriculture. With respect to direct energy consumption (fuel and oil) and indirect energy consumption (synthetic fertilizers and pesticides), organic agriculture generally performs better than conventional agriculture (Scialababa and Hattam, 2002). It has been documented from many studies that plants take up pesticide from soil (Fantke, 2013) and use of pesticides is unrestricted in conventional agriculture. The other results of indiscriminate use of pesticides in conventional agriculture are loss of ecosystem resilience, biodiversity loss, pest resurgence and resistance, bioaccumulation and bio magnifications of the pesticides, and food contaminations (Raven et al., 2008). Organic agriculture can reduce farmers’ dependence on energy and the efficiency of energy per unit of production can be increased (Ho and Ching, 2008). According to a study conducted in 18 European countries, organic farming has resulted increase in soil organic matter, improvement in soil biology and lower nitrate leaching and pesticide contamination (Stolez et al., 2000). The net economic return per hectare was often equal to or higher than conventional agriculture (Pimentel and Burgess, 2014). In case of the arid and semi-arid conditions and with low external inputs, organic agriculture generally improves over time (Pretty, 2002; Blaise, 2006). When grown under stress condition marked by drought, heat, excess rain or cold, organic production supersedes conventional agriculture. In contrast, the performance of crops is high in conventional farm under favorable growing conditions (Shearer et al., 1981). Certified organic coffee (90 metric tons) is produced in about 210 ha of land and some 59 ha of land is under conversion (Shrestha, 2011). Adhikari (2008) found that the benefit-cost ratio of organic carrot was relatively higher compared to the conventional one. In the same way, organic coffee production was viable financially under different conditions in Gulmi district (Paudel et al., 2010). Also, they mentioned that Nepalese organic coffee fetches a 10–33% premium in international markets.

**Problems and challenges of organic agriculture**

Emphasis on organic agriculture at policy and program level looks inadequate for its development and promotion. There is a virtual lack of government support to organic growers and marketers. It is necessary that marketability of any organic products, and that too at a premium price over the traditional and modern products has to be assured before starting the cultivation of organic crops. Mass production of organic products and the business volume for market sale are still invisible. Research work on processing and certification are weak and, in many cases, are missing. Organic farming has its own shortcomings in Nepal. Poor technical skills and capacity in managing complex farm land problem, insufficient organic technology to support production, lack of research on processing and certification, poor investment capacity, small and fragmented land holding, and less risk bearing capacity among others are the key constraints at the producers’ level. Poor consumers’ awareness about organic products, quality and availability, lack of trust regarding the authenticity of the products, higher prices of organic products, impoverished market infrastructure are the constraints at marketers’ level.
Conclusion

Organic farming facilitates a healthy agricultural atmosphere by balancing a better soil health, providing a pace of gradual increase in production over time, maintaining a minimal or zero pesticide residue on agricultural produces and thus ensuring national as well as global food and nutritional security. Several botanical pesticides, green manures, biopesticides, bio-fungicides, and even kitchen and field wastes can be better bases to embrace organic agricultural system. Thus, in agrarian countries like ours, where integrated crop-livestock farming system is still in practice, organic agriculture or biodynamic agriculture is best among the better options. A shift from conventional to organic or biodynamic agriculture, government must need to formulate a rigid plan. A crystal clear, holistic and coordinated approach is necessary in the policy level to facilitate the organic agriculture to the portal of food security. The government should have a concrete set of strategies as clearly defined objectives, plausible national organic standards, easy certification mechanisms, banned in pesticides import, reliable market and premium price of organic products, define critical zones and hotspots that need organic system as intervention and so on. Adoption of these strategies can lead to a pathway of food and nutritional security and sustainable agriculture rather than woolgathering a better agriculture embracing conventional farming system. It is time for Nepal to adapt to proper organic farming

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Conflict of interest

The authors declare there is no conflict of interests regarding the publication of this paper.

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