Performance of Organic Agriculture based on Emergent Properties of Agriculture System in Gasa, Bhutan

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ABSTRACT: Organic agriculture proved to be the better alternative to conventional agriculture. Thus, Bhutan, guided by the holistic development paradigm had pledged to become 100 % organic by 2020. In 2004, Gasa district was declared as first organic district in the country and is now almost 14 years into organic agriculture. Therefore, the study was done to examine the progress of organic agriculture in Gasa since 2004. The study was done based on seven emergent properties of agriculture system outlined in Agriculture System Analysis framework by Terry Rambo. The trend analysis since 2004 to 2016 showed the increasing productivity and diversity of crops. Moreover, the district became self-sufficient in vegetables since 2004 from the start of organic agriculture practice. The ratio of population involved in Agriculture farming are much higher than those in civil service. The Gross National Happiness was also highest in Gasa from the total of 20 districts in Bhutan despite majority involved in farming. The farming which is purely organic. This shows that people are happy with their way of living. This can be an indication of the progress of organic agriculture in Gasa.

Keywords: emergent property, environmental friendly, food safety, Gasa, organic agriculture

Introduction

Organic agriculture is the most desired multifunctional agriculture system attesting a better alternative to Green revolution based conventional agriculture (Dinis, Ortolani, Bocci, & Brites, 2015). Having seen the multifunctionality of the system, the transition towards organic agriculture is on the rise. International Federation of Organic Agriculture Movements (IFOAM) is promoting organic agriculture (IFOAM, 2012). The active IFOAM members of organic agriculture are on the increase, resulting in increased organic production and market across the world (IFOAM, 2016).

Bhutan is into bold venture having foreseen the better scope of the concept (Department of Agriculture, 2007b). The total cultivable area in Bhutan is only about 7 % (Tobgay, 2016) out of the total geographical area of 38,394 km^2 (National Statistics Bureau, 2016b). The average land holding is three acres on which integrated agriculture is practiced (Katwal et al., 2015). Bhutan is challenging such situation by producing quality products and setting up niche market (Planning Commission, 1999).

Bhutan officially launched organic policy in 2003 (Tashi, 2015). In 2004, Royal Government of Bhutan [RGoB] declared Gasa as first organic district (McCrae-Hokenson, 2014). In 2012, Bhutan pledged to become 100% organic by 2020 in Rio+20 summit on Sustainable Development (ibid). RGoB reaffirmed the commitment during the International Conference on Organic and Ecological Agriculture in Mountain Ecosystems convened in 2014 (IFOAM, 2014). National Framework

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for organic Farming in Bhutan was launched in 2007 to enable a better understanding of organic agriculture and to clarify how organic practices can serve or hinder small farmers and rural communities - especially poor ones (Planning Commission, 1999). Those are the evidences of Bhutan's movement towards organic agriculture.

Gasa district is the first organic district and is into 14 years since 2004 as a fully organic district. *The objective of this study was to* review the progress of organic agriculture since 2004 in Gasa district, Bhutan.

Basis of the review

The objective was examined based on the Agriculture System Analysis framework outlined in "The Human Ecological Perspective on Agricultural Systems" by Rambo (2015). Author has developed the framework from the work of (Conway, 1985, 1986), and Marten and Rambo (1988). The model outlined six emergent properties of agriculture system performance. Conway (1986), proposed four properties in his two subsequent papers namely productivity, stability, sustainability, and equitability. Marten and Rambo (1988) added three: diversity, integration, and solidarity to construct a comprehensive concept of agriculture system performance (Rambo, 2015).

Table 1 Emergent properties with description

Properties	Description
Productivity	Annual yield or net income per unit area; per unit labor; per unit input; per unit hour; per unit energy or investment
Stability	Based on the reciprocal of the coefficient of variation in yield or income
Sustainability	Ability to maintain productivity despite a major disturbance
Equitability	Evenness in the distribution of products among its human beneficiaries
Diversity	Genetic diversity, species diversity, and diversity of ecological communities within the agricultural ecosystem
Integration	The extent to which the local community is involved in larger social and economic systems.
Solidarity	Level of social cohesion among individuals and households. Cohesive communities are characterized by abundant stocks of "social capital," the existence of which determines the ability of the community to make and enforce decisions about management of its agroecosystem

The eight properties, level of food safety assurance was added since the reason for shift of conventional agriculture to organic agriculture is food safety addressing the organic principles of health and the care which were not addressed in the earlier six properties.

Data sources

The statistics on yield and crop diversity were obtained from Agriculture Statistics 2004-2007, 2009-2012 and 2014-2016 from Department of Agriculture [DoA], Ministry of Agriculture and Forest website. DoA has started maintaining the statistics of agriculture since 2004. The Bhutan 2020: A Vision for Peace, Prosperity and Happiness, government plans, policies, Annual Dzongkhag Statistics and relevant journal articles were referred to examine the sustainability, equitability, integration and solidarity of the agriculture system. Also, the relevant publications from IFOAM were also referred to examine the alignment of Bhutan's strategies to its framework.

The trend analysis was done on productivity and crop diversity using Microsoft Excel 2016. The trend on productivity and diversity analysis were done on four categories of crops: cereal, oilseeds, vegetables, and fruits. Productivity on crops is shown in kg/acre and fruits in kg/tree.

Results and discussions

Performance on productivity (kg/acre)

The crop yield for all the four categories of crops were on rise since 2004 with exception of vegetable yield in 2010 and 2011 where the yield dropped by few kg/acre (**Figure 1**). However, the production remained sufficient for the consumption. According to McCrae-Hokenson (2014), Gasa is self-sufficient in vegetables since 2004. Prior 2004, Gasa imported vegetables (ibid). Gasa is not exception, a study from smallholders in East Africa found that there was a significant yield increase from adopting organic agriculture (Ton, 2013). These results indicate that organic agriculture is alternative to input-intensive conventional agriculture with better yield. Rundgren (2002) mentioned that organic agriculture should be the right choice for increasing productivity in developing countries.

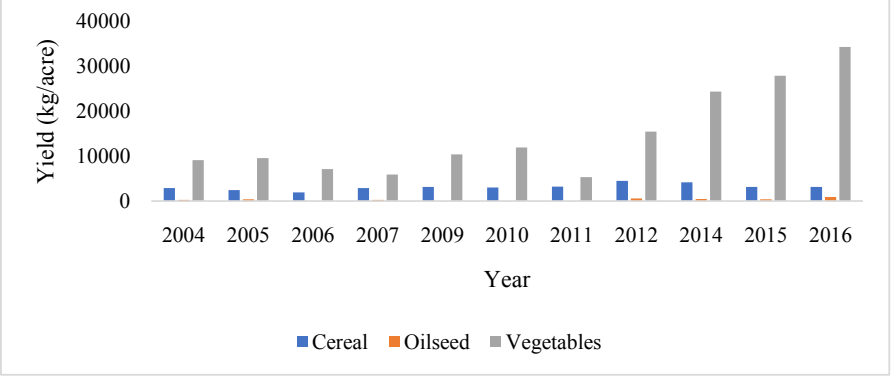

Figure 1 Trends of crop productivity/ yield in kg/acre

Data source: (Department of Agriculture 2005; Department of Agriculture, 2006, 2007a, 2009, 2010, 2011, 2012, 2014, 2015, 2016)

As of now, three crops: potato, garlic and carrot are certified organic by Bhutan Agriculture and Food Regulatory Authority [BAFRA]. The productivity of the potato remains on top because farmers fetch comparatively higher price (Tshering, 2017). The potato is widely consumed in Bhutan irrespective of age and income status (Dorji, Tamang, & Vernooy, 2015). Also, the export potential of potato is high.

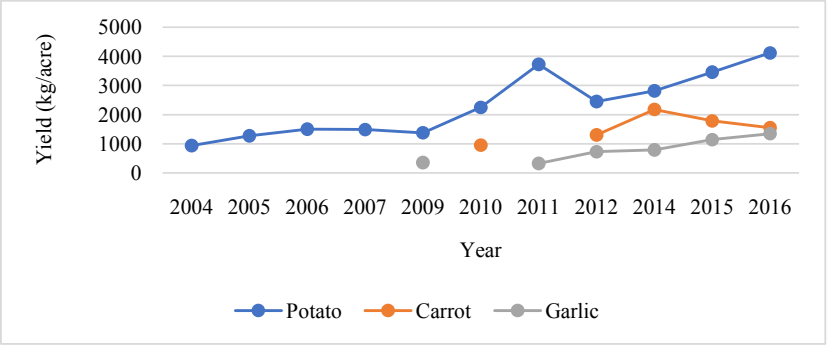

Figure 2 Trends in productivity of certified organic crops

Data source: (Department of Agriculture 2005; Department of Agriculture, 2006, 2007a, 2009, 2010, 2011, 2012, 2014, 2015, 2016)

The performance on yield of fruits was also on increase (**Figure 3**). This shows that fruits are another potential cash crop for Gasa. In fact Planning Commission (1999) identified horticulture as a means of raising the cash incomes of farmers, generating export revenues achieving an improvement in the nutritional status of the rural population. This rising trend of productivity shows that Gasa is performing well in increasing niche products.

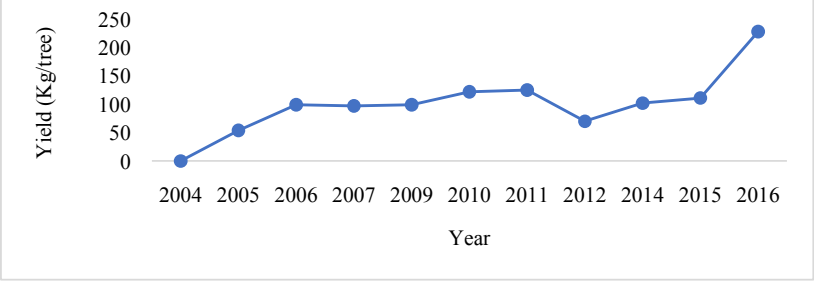

Figure 3 Fruits productivity trend

Data source: (Department of Agriculture 2005; Department of Agriculture, 2006, 2007a, 2009, 2010, 2011, 2012, 2014, 2015, 2016)

However, the statistics on the other component of the productivity such as yield per labor, per input, per energy or investment to measure the performance in productivity. The statistics on these areas should be streamlined to ensure an effective assessment of the performance of or-

ganic agriculture. Also, the certification for other products should be done since district is declared as organic district.

Performance on stability

The crop yield is stable for the last 14 years. This is indicated in **Figure 1** and **Figure 3** showing the rising trend of yield. The achievement in vegetable self-sufficiency since 2004 is also an indication of the stability of the yield (McCrae-Hokenson, 2014). The diversity in crops was increased as shown in **Figure 4** further strengthening the stability of the yield because higher diversity leads to increase in the crop yield.

Performance on diversity

The diversity of crops for fruits, green vegetables, and roots and tubers are higher than cereals, oilseed, and legumes and pulses. The reason being the area lies above 2300 meter above sea level, and most of the crops are not climatically favorable. However, generally the diversity trend is also on rise. The diversity in crops proved to increase the yield. In 2006 and 2011, the crop productivity has decreased (**Figure 1**) during those two years the diversity of crops cultivated was also reduced (**Figure 4**). Also, if one crop fails, the other supplement. In 2011, the other vegetable yield had reduced from 11,860 kg/acre in 2010 to 5,287 kg/acre (**Figure 1**). However, potato yield had considerably increased from 1377 kg/acre to 2248 kg/acre from 2010 to 2011 respectively (**Figure 2**). According to Katwal et al. (2011), agro-diversity plays a pivotal role in sustainable agriculture development, food security and poverty alleviation. Organic agriculture promotes soil fertility, conserve biodiversity (e.g., native flora and fauna), reduces the risk of yield failure, stabilizes returns helping in enhancing food security for small farmers' families (Kilcher, 2007). Organic agriculture promotes diversity which in turn increases ecosystem function and helps protect pests (Crowder, 2010). Accordingly, Bhutan is trying to maintain diversity in terms of genetic, diversity in species and the diversity in ecosystem (National Biodiversity Centre, 2017). To maintain diversity, one of the key principles of organic farming in Bhutan is the "Management and conservation of resources and protection of the environment" embracing diversity, resistant varieties, and the local species of successful traditional seeds and crops (Department of Agriculture, 2007b).

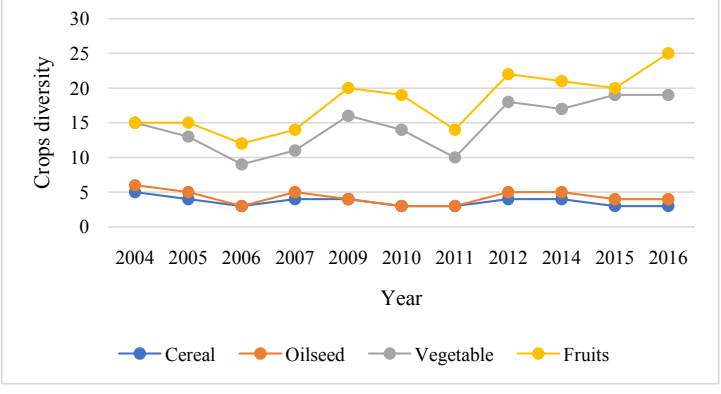

Figure 4 Trends in crop species diversity

Data source: (Department of Agriculture 2005; Department of Agriculture, 2006, 2007a, 2009, 2010, 2011, 2012, 2014, 2015, 2016)

Performance on equitability

One of the pillars of Bhutan's developmental philosophy, Gross National Happiness (GNH) is sustainable and socio-economic development (Asian Development Bank and National Statistics Bureau of Bhutan, 2013). This takes care of the performance on equitability. In line with the development paradigm, GNH Survey Report (2016) showed that Gross National Happiness was highest in Gasa among other 20 districts. Also annual household income was highest in Gasa (Asian Development Bank and National Statistics Bureau of Bhutan, 2013) where more than 95% were involved in organic farming (Gurung, 2017). Out of the total population, 2077 are employed in agriculture farming and rest few are in other sectors (National Statistics Bureau, 2016a). Almost all farmers who actively grow crops for self-consumption and minimal produce for sale. The population density was just 1.18 as of 2015 (National Statistics Bureau, 2016a). The number of farmers owning definite agriculture land area should be maintained.

Performance on integration

Farmers of Gasa sell their products in Thimphu, capital city of Bhutan (Tshering, 2017). The 10 hoteliers committed to buy organic products from farmers of Gasa provided the producers ensure consistency in supply (Gurung, 2017). As of 2016, government has provided irrigation supply covering 54 households and electric fencing to 154.1 acres and 4 power tillers to the district (Planning and Policy Division, 2016). Other support includes establishment of 2 Renewable Natural Resources (RNR) market shed, 2 RNR sales outlet, 4 farm shops and 20 plastic houses (Planning and Policy Division, 2016). This shows the participation of the farmers in larger economic activity and the existence of interaction with the government. As of April 2015, district had five extension staff under department of Agriculture to provide support to the farmers (RNR Statistical Coordination Section, 2015). They are the intermediator between the government and the community.

Performance on solidarity

The vision of the district is "To be the centre for organic farming and eco-tourism, rich in cultural heritage and environment with content, peaceful, and harmonious citizens" (Gross National Happiness Commission, 2016). The vision highlights on creating the sense of solidarity while embracing organic agriculture as their farming system. Moreover, community vitality and psychological wellbeing were the highest domain contributor to GNH Index value (Centre for Bhutan Studies & GNH Research, 2016a). This shows solidarity in the district. The solidarity and community vitality are interrelated (Scott, 2010). The awareness level on organic agriculture was found highest at 80% in Gasa as per study conducted by (Kobayashi, Chhetri, & Fukamachi, 2015). This is an indication of having community solidarity because of which people were able to learn the concept (Scott, 2010). As per Asian Development Bank and National Statistics Bureau of Bhutan (2013), solidarity in terms of trust with neighborhood showed high in rural area as compared to those residing in urban area. Gasa, is under rural category where livelihood is based on agriculture and Nonfood Forest Products (NTFP). There is only one small-town (National Statistics Bureau, 2010).

Performance on food safety measures

Three products: potato, garlic and carrot are certified organic by BAFRA (Gurung, 2017). They have tested the chemical content and assured that those three products are free from chemicals. The potato and garlic samples were tested for pesticide residue levels (MRLs) and heavy contaminants at Export Inspection Agency (EIA) Laboratory, Kolkata. The soil sample was tested for pesticide residues (MRLs) at the Central Laboratory Thai, in Bangkok. The test results received from all these laboratories are within the permissible limits prescribed in the BOCS Guidelines 2013. The water quality test could not be conducted since the potato and garlic were cultivated under natural rain-fed conditions (Staff Reporter, 2016). Also, BAFRA has tested the soil for heavy metals and pesticide residues for approximately 25 acres of farmland owned by 50 members who has applied for organic certification (Staff Reporter, 2016). However, no literature or data was found on other crops and the soil test beyond 25 acres of land.

Performance on sustainability

The stable productivity, increasing crop diversity, equitability, presence of solidarity and integration, and increasing production of safe food indicates organic agriculture is sustainable in Gasa. Also organic agriculture is recognized by scientific community in terms of its multifunctionality (Kilcher, 2007). It is also seen as a solution to biodiversity loss and inhibit climate change (IFOAM, 2013). To sustain the progress, government has initiated various Acts, policies, guidelines and framework.

Conclusion

Review focused on performance of Gasa district in terms of eight emergent properties based on Agriculture Statistics since 2004 to 2016. From the various literatures, the organic agriculture in Gasa district is progressing gradually. Gasa can perform better since there is potential to grow in terms of land expansion and improving farming practices. As per Department of Agriculture (2016), 49 acres of dryland and 12 acres of wetland were left fallow.

However, more research needs to be done to have effective assessment of the organic agriculture performance and to learn more about the challenges and opportunities in the field. From this study, I learned that none of the properties were able to assess its progress satisfactory due to the lack of literature and statistics.

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