# Linking the Gross National Happiness Concept to Smallholder Farm Level: An Empirical Application


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ABSTRACT

*This study aims to refine the gross national happiness (GNH) development concept of Bhutan at the farm level and to show the major temporal and spatial trends in the development of rural areas with differing agroecological conditions and adoption of cattle crossbreeding. The study areas (four localities) are described as extensive, semi-intensive, intensive, and intensive peri-urban. Technical, social, economic, and environmental data from 183 households in the study areas were collected in 2000, 2004, and 2015. Participatory methods were used to select from the collected data the most relevant issues and their corresponding indicators at the farm level. The issues identified during the field workshops conducted in the study areas could be grouped as social, economic, and environmental. Next, the indicators were aggregated into economic, social, and environmental indices. In 2000 and 2004, the intensive peri-urban area showed the highest performance in the economic and social indicators. Livestock farming, despite its potential for dairying, was prohibited in one of the localities in 2010 when the territorial coverage of the capital Thimpu expanded. On the other hand, the dynamics of the indicators in the other three localities indicated that the social and economic indices were highest in the intensive area, followed by the semi-intensive area, and lastly, by the extensive area. This could be because different crossbreeding techniques were implemented in these areas. In the period 2004–2015, the reference values of the social indices declined, which could be attributed to increased rural-urban migration and intensified farm labor shortages in the study areas. The environmental indices did not change much during the monitoring periods. In summary, this study presents a methodological approach for examining the GNH in Bhutan based on participatory identification of social, economic, and environmental issues and indicators along with the reference values for the selected indicators. Likewise, this study showed that an integral assessment can complement the implementation of the GNH philosophy in the rural areas of Bhutan.*



**Keywords:** cattle, crossbreeding, indicators, sustainability, smallholders, Gross National Happiness
**JEL Classification:** C63

## INTRODUCTION

Gross national happiness (GNH) is the overarching development philosophy of Bhutan (DoP 2004; Rinzin, Vermeulen, and Glasbergen 2007; GNHC 2010). GNH is based on the following four pillars: sustainable and equitable socioeconomic development, environmental preservation, preservation and promotion of culture, and promotion of good governance (CBS 2012).

GNH as a concept was initially conceived by the fourth king of Bhutan in the late 1980s (Ura and Galay 2004). Priesner (1999) concluded that the GNH philosophy has evolved from the socioeconomic system of the country, which had been based on a Buddhist and feudal set of values, before Bhutan opened to the world in the 1960s.

GNH has been a major source of international attention for Bhutan. The first time it drew attention was during the millennium meeting for Asia and the Pacific in Seoul, Korea in 1998 (Thinley 1999). Subsequently, GNH gained international popularity following the 1st (Bhutan in 2004), 2nd (Canada in 2005), 3rd (Thailand in 2007), 4th (Bhutan in 2008), and 5th (Brazil in 2009) international conferences on GNH. In July 2011, the UN adopted Bhutan's proposal of "happiness" as a resolution, and the UN General Assembly invited countries "to pursue the elaboration of additional measures that better capture the importance of the pursuit of happiness and well-being in development to guide their members' public policies" (UNGA 2011).

At present, GNH is officially defined as a development approach that seeks "to achieve a harmonious balance between material well-being and the spiritual, emotional, and cultural needs of an individual and society" (GNHC 2010). Efforts to operationalize GNH are mainly directed at the national level (Ura and Galay 2004); the linkages between development and GNH at the district, community, and farm levels have not received much attention (Samdup, Udo, and van der Zijpp 2014).

About two-thirds of the Bhutanese population lives in the rural areas where poverty is a main issue (GNHC 2013). The socioeconomic development of the regions differs due to the differences in altitude and climatological conditions (Rinzin, Vermeulen, and Glasbergen 2007). Cattle are the most dominant livestock in Bhutan, with over 78 percent of the rural households owning cattle. The government promotes intensification of dairy production through crossbreeding of the local Siri cattle with Jersey or Brown Swiss, and such method is seen to be a way to enhance rural livelihoods (MoA 2009). However, the large variation in Bhutan's altitude, climate, and market access can affect the outcome of the dairy production intensification initiative in the country. Before 1998, for example, crossbreeding was promoted only in areas with suitable agroecological conditions. From 1998 onward, farmers have been allowed to choose their desired cattle breed regardless of the agroecological conditions. However, empirical studies have yet to be done to determine the extent to which intensification has contributed to the development (from a GNH perspective) of farming communities in the different agroecological areas of Bhutan.

The current methods being used to assess development efforts are generally based on identifying and monitoring relevant indicators (Becker 1997; Singh et al. 2009; de Olde et al. 2016). Also, national and international conferences on GNH have emphasized the need to operationalize the GNH index by way of practical indicators (Thinley 1999; Ura and Galay 2004; GNHC 2010; CBS 2012). In Bhutan, the Centre for Bhutan Studies (CBS) (2012) uses 33 indicators to build the GNH

index—an index that reflects how the degree of happiness of people across the country have developed.

To measure GNH, researchers create a profile of each person. A person is then asked certain questions (answerable by "yes" or "no") pertaining to each of the 33 indicators. This accordingly measures whether (s)he has achieved sufficiency in that indicator or not (Ura et al. 2015). If a person scores sufficiently, which is achieved by answering "yes" in six of the nine domains (at least two-thirds [66%] of all the indicators), then (s)he is considered "happy". In 2015, about 55 percent of the people in urban areas were "happy", whereas, only 30 percent were considered the same in the rural areas (Ura et al. 2015). This finding underscores the need to specifically address the GNH issues at the smallholder farm level. However, hardly any of the 33 indicators can be used to assess the impact of the intensification efforts at the farm level.

This study aims to link the GNH concept to the farm level through the following:

1. Selecting the most relevant issues and their associated indicators
2. Assessing the indicators in four agroecological areas in 2000, 2004, and 2015
3. Aggregating the indicators into indices that show the major temporal and spatial trends in development in the rural areas of Bhutan

The year 2000 was chosen since this was the year when the government promoted cattle crossbreeding intensification in accordance with the revision of the 1998 cattle breeding policy. Subsequently, the medium-term (2004) and long-term (2015) changes at the farm level in four study areas were assessed.

## MATERIALS AND METHODS

### Study Areas

Bhutan is a small, land-locked country in the Eastern Himalayas. The altitude in the country varies widely, resulting in a wide range of climate zones: alpine, cool temperate, warm temperate, dry subtropical, humid subtropical, and wet subtropical (FAO 2005). Four areas were selected based on varying climate zones, cattle breeds kept by smallholders, cattle management practices, and market access. The selected study areas are:[1]

1. ***Khaling geog[2] in Trashigang district.*** Located in the eastern part of Bhutan with warm temperate zone, it is classified as extensive.[3] The main livestock raised are the local Siri cattle grazing in forests and communal lands. There are no paved roads and the walking distance to the local markets is 30–60 minutes.
2. ***Dala geog in Chukha district.*** Located in the southern part of Bhutan with subtropical temperate zone, it is classified as semi-intensive. Local people raise Siri and Jersey crossbred cattle that graze in forests and communal lands; regular local transport services is unavailable, and walking distance to local markets takes 1–2 hours.
3. ***Chokhor geog in Bumthang district.*** Located in the central part of Bhutan, it

1 For detailed description of the study areas, see Samdup et al. (2010).

2 A *geog* is an administrative unit comprising 7 to 112 villages.

3 Extensive: low external inputs, low outputs; semi-intensive: medium inputs and outputs; intensive: relatively high inputs and outputs; intensive peri-urban: relatively high inputs and outputs, located near a town

has a cool temperate zone. It is classified as intensive, and dairy production is done through stall-feeding of Brown Swiss and Jersey crossbred cattle. No regular local transport services is available, and the walking distance to local markets takes 30–60 minutes.

4. ***Chang geog in Thimphu district.*** Located in the western part of Bhutan, it has cool and warm temperate zone. It is classified as intensive peri-urban, and the cattle raised are the Jersey crossbreds and pure Jerseys, raised through stall feeding. It is located close to the capital.

The government implements the crossbreeding program by supplying the communities with exotic breeding bulls or with the semen of exotic bulls. These are then artificially inseminated to the female cattle at artificial insemination (AI) centers throughout the country. The government provides AI to the farmers at no cost.

## Methodology

The key activities implemented in the study are as follows:

1. Participatory field workshops participated in by farmers and other stakeholders in the four areas
2. A national workshop with experts to identify the relevant issues and accordingly select the corresponding indicators
3. Assessment of the indicators based on the collected technical, social, economic, and environmental data
4. Integral assessment of the indicators

The field workshops with farmers and other stakeholders were organized in 2000. The collecting of technical, social, economic, and environmental data on the study areas started in 2000, and was repeated in 2004. Part of these data were used to analyze the technical and economic performances of Bhutanese farmers and their use of natural resources (Samdup et al. 2010; Samdup et al. 2013).

The most relevant issues and indicators for the present study were selected in 2002 during a national-level workshop with experts and farmers' representatives. The empirical assessment of the selected indicators was based on the data collected in 2000, 2004, and 2015. Specifically, data were used to characterize the farms in the four study areas and to assess the selected indicators for the present study. Subsequently, an integral assessment was conducted, considering the social, economic, and environmental indicators to develop indices to evaluate progress in GNH development in the four study areas.

### Selection of Issues and Indicators

In 2000, a field workshop was organized in each study area to identify the main GNH issues (Samdup, Udo, and van der Zijpp 2014). The participants in the workshops were composed of 120 farmers, who were the locally elected farmers' representatives; one private retailer dealing with crop and livestock products; 28 government stakeholders involved in the agriculture sector; forest and livestock extension officers; and representatives from the veterinary offices of each district and from the national dairy center based in Thimphu. Government stakeholders facilitated the workshops and provided their views only when asked.

A national-level workshop was held in Thimphu in 2002 to further identify the relevant GNH issues and their corresponding indicators for the present study. A total of 20 participants attended the workshop—the livestock, agriculture, and forestry officers in each of the four study areas; four farmers, each representing one study area; a livestock production specialist; a social scientist; a veterinarian; a policy officer; and a planning officer. The moderator briefed this multidisciplinary expert group

about the various issues derived from the four field workshops and the resulting problem tree analysis (see Samdup, Udo, and van der Zijpp 2014 for details).

The results of the field workshops indicated that the farmers are mainly concerned about the issues relating to the socioeconomic and environment GNH pillars (Samdup, Udo, and van der Zijpp 2014). Therefore, it was decided to segregate the socioeconomic GNH pillar into social and economic issues to allow us to explicitly address these issues, separate from the environmental issues (Samdup, Udo, and van der Zijpp 2014).

## Empirical Assessment

### *Data collection*

The empirical assessment was done through the household surveys conducted in 2000, 2004, and 2015. In this study, a household refers to adults and children who are officially registered as living together. About 30–40 percent of the villages in each study area were selected for the household survey: 6 villages in the extensive area Khaling, 9 villages in the semi-intensive area Dala, 16 villages in the intensive area Chokhor, and 6 villages in the intensive peri-urban area Chang. In each village, 5–15 percent of the households were randomly selected to be the survey respondents. This resulted in 63, 35, 55, and 30 household respondents in the extensive, semi-intensive, intensive, and intensive peri-urban areas, respectively.

In the 2000 and 2004 surveys, the enumerators visited the same households. In 2015, however, the research team was able to revisit only 47, 29, and 47 of the same households in the extensive, semi-intensive, and intensive areas, respectively. This is because the remaining households had migrated to other areas of Bhutan, particularly to Thimphu. In Chang, all the households that had been identified in 2000 have given up farming since their villages came under the Thimphu city corporation area in 2010. In such urban areas, livestock rearing is no longer permitted.

The household interviews were administered by trained enumerators using a pretested questionnaire. These enumerators were the two extension officers (from the national livestock and agriculture departments) in each district and regional livestock officers in the respective districts who had experience in collecting field data. Each farmer respondent was interviewed with regard to family background, sources of income, land use, crop and livestock practices and production, and financial results. For each farm, nitrogen (N) and phosphorus (P) flows were quantified by computing the N and P inputs and outputs of livestock and crops.

### *Data analysis*

Data sets were screened and analyzed for household and farm characteristics and for the selected social, economic, and environmental indicators. For the economic indicators, the monetary values were expressed in BTN (Bhutan Ngultrum). In 2000, the nominal values for the economic indicators were calculated (USD 1.0 = BTN 43.8). In 2004 and 2015, the nominal values were corrected using an inflation rate of 2.7 percent (2005) and 9.1 percent (2016), respectively. Continuous indicators that met the assumptions of normality were analyzed, using the least-squares method (LSM) (Harvey 1977) to explain the variations between the study areas within the three monitored years and between the monitored years within study areas.

The qualitative indicators were transformed into qualitative ordinal data (QOD) (de Wit et al. 1995; Hardi, Ama, and Huletey 2000). As a result, the enumerators categorized the qualitative indicators as bad = 1, poor = 2, medium = 3, ok = 4, and good = 5. Sometimes, they also used halves (e.g., 1.5, 2.5, 3.5, and 4.5). The indicators that did not meet the

assumptions of normality and ordinal data were analyzed using the Kruskall Wallis test in order to determine the overall effects of years (2000, 2004, and 2015) and area (extensive, semi-intensive, intensive, and intensive peri-urban). Depending on the significant effects, a post-hoc analysis was conducted using the Wilcoxon two sample test such that pairwise comparisons could be made between areas within a particular year and between years within a particular area. P-value of $< 0.05$ was considered to indicate a significant difference.

***Integral assessment***

An integral figure was developed to visualize and to communicate the progress in the GNH development of the four study areas. This concept, based on Prescott-Allen's barometer of sustainability (Prescott-Allen 1997), standardizes indicators by establishing a performance value range for the five performance categories of each identified indicator. Based on the expert group discussion in 2002 and based on literature (CSO 2001), the five performance categories were derived by dividing the scale of each indicator into five sectors of 20 points each over a total scale of 1–100. This results in a set of performance measurements for the indicators using the same scale. The five sectors are described as: bad (1–20 points on the 1–100 scale), poor (21–40), medium (from 41–60), ok (from 61–80), and good (from 81–100) (Prescott-Allen 1997). The standardized social, economic, and ecological indicator values with their respective social, economic, or ecological indices were then combined. The expert group considered all indicators as equally important.

The starting point in defining the performance value ranges of the selected quantitative indicators in this study is the medium performance value range. Prescott-Allen (1997) states that a medium performance value range can be based on performances that have been experienced in the past and can be achieved in the foreseeable future. Based on this reference performance value range, the ranges of the other performance value ranges were derived by incrementally increasing or decreasing them, or by basing the ranges on the opinion of the expert group. The enumerators had already scored the qualitative indicators in the bad, poor, medium, ok, and good sectors.

The standardized value *(SV)* of each indicator is calculated as follows:

$$SV = (SV_i * \text{multiplier of 20 for the sector width}) + \text{base value of that sector}$$

where:

$SV_i$ = $(Y_i - Min_i)/(Max_i - Min_i)$,

$Y_i$ = actual value of indicator *i,*

$Min_i$ = minimum performance value of the indicator *i* on its specific sector, and

$Max_i$ = maximum performance value of the indicator *i* on its specific sector.

In the qualitative ordinal indicators, $Min^i$ is the minimum and $Max^i$ is the maximum performance value of indicator *i.* The base value of the sector is $Min^i$ in the sector (Prescott-Allen 1997).

*Illustration of an SV calculation:* Assuming that the literacy rate in an area is 49 percent. The performance value ranges for literacy rate are determined as 31–40 percent in the bad sector, 41–50 percent in the poor sector, 51–60 percent in the medium sector, 61–80 percent in the ok sector, and 71–80 percent in the good sector. Then the actual value (49%) falls within the poor sector. The poor sector is scaled 21–40 on a 1–100 scale. As such, this gives the following values for the components of the formula:

$$SV_{literacy} = (49–41)/9 = 0.89$$

| | | |
|---|---|---|
| *Base value of the poor sector* | = | 21 |
| *SV for literacy rate in this area* | = | 0.89*20 + 21 = 39 |

The social, economic, and environmental indices are calculated simply by taking the averages of the social, economic, or environmental *SVs*. The indices are then categorized over a scale of 1–100 using the categories bad (0–20 points on a 1–100 scale), poor (21–40), medium (41–60), ok (61–80), and good (81–100) sectors for the standardized indicators.

## RESULTS AND DISCUSSIONS

### Description of Issues and Selection of Indicators

Table 1 gives the definitions of the selected indicators for the social, economic, and environmental issues. The reasons for choosing these indicators are given below. Meanwhile, Table 2 gives the description of the qualitative indicators that have been transposed into qualitative ordinal data.

#### *Social issues and indicators*

An emerging issue in Bhutan is the migration of rural people to urban areas;[4] this was accordingly selected as an indicator in this study. The rapid rural-urban migration has decreased rural population; thus, the expert group suggested quantifying labor shortage using the indicator "farm labor shortage".[5] The expert group also considered literacy rate[6] as an indicator to measure development progress. Accessibility to amenities and services (e.g., schools, extension services, drinking water supply) is an important social issue in developing regions (Moorse et al. 2001; Zhen and Routray 2003). The farmers had mentioned that access to piped drinking water was an important accessibility concern for them. Having access to clean drinking water implies that households do not have to spend disproportionate part of the day fetching water; this is also a fundamental and significant factor in lowering child mortality (FAO 2005).

We could not find any feasible indicator for evaluating the water quality and quantity in the study areas. The expert group therefore suggested including the indicator "access to piped drinking water", ranging from bad access (fetch from other sources) to good access (personal or common taps). The expert group proposed including the issue of "quality of rural life", which is expressed through the indicator household living standard. This indicator ranges from "bad", when basic needs (e.g., food, clothing, shelter) are not met, to "good", when all basic needs are met and households had access to household luxuries (e.g., refrigerator, radio, television).

#### *Economic issues and indicators*

The field workshops indicated that low farm income, low crop yield, low milk yield, and limited alternative sources of income were major concerns in the study areas. Accordingly, several authors have proposed using farm gross margin (on a yearly basis) as an economic indicator to assess the economic results of crop and livestock activities (Tellarini and Caporali 2000; Zhen and Routray 2003). The experts also

4 We defined rural-urban migration as the total number of household members who migrated from a study area as percentage of all households members in that area.

5 Farm labor shortage is the percentage of households in the study area that expressed farm labor shortages.

6 Literacy rate is expressed in this study as the percentage of household members that are literate.

**Table 1. Selected indicators and their definitions**

| Indicators | Definition |
|---|---|
| **Social** | |
| Rural-urban migration (%) | Number of HH members that migrated to other areas as percentage of total number of HH members in a study area |
| Farm labor shortage (% of HH) | Number of HH that expressed farm labor shortages as percentage of total number of HH |
| Literacya rate (%/HH) | Number of HH members that are literate as percentage of total number of HH members |
| Access to piped drinking water (QOD) | QOD ranging from bad (0–1) to good (4.5–5.0) based on access to clean piped drinking water using personal/common taps or having to fetch water from other sources |
| HH living standard (QOD) | QOD ranging from bad (0–1) to good (4.5–5.0) based on HH living standards, in terms of availability of basic needs of food, clothing, shelter, and HH luxuries (details in Table 2) |
| **Economic** | |
| Annual income (BTN) | Sum of farm GM2 (livestock and crop GM) and off-farm income |
| Farm gross margin (GM) (BTN/year) | Sum of livestock and crop GM |
| Off-farm income (BTN/year) | Sum of income earned from nonfarm activities (e.g., part-time labor in other farms, construction sites, hotels, etc.) |
| Milk yield/cow/day (kg) | Average milk off-take (kg) per cow per day |
| GM (livestock)/LU (BTN) | GM of livestock subsystem per LU[2] |
| **Environmental** | |
| Excess LU reared | Numbers of "excess livestock (LU)" relative to the feed resources available (on-farm, bought plus grazing CPR) |
| Soil N balance (kg/ha) | Partial nutrient balances of nitrogen in kilograms per hectare of land |
| Soil P balance (kg/ha) | Partial nutrient balances of phosphorus in kilograms per hectare of land |
| Livestock CPR grazing practices (QOD) | QOD ranging from bad (0–1) to good (4.5–5.0) based on the following:<br>1. whether the cattle are accompanied by a herder while grazing in the CPR<br>2. whether the cattle are allowed to wander<br>3. whether controlled grazing is practiced (details in Table 2) |
| Soil erosion of cropland (QOD) | QOD ranging from bad (0–1) to good (4.5–5.0) based on level of water runoff and soil erosion (details in Table 2) |

Notes: (1) Gross margin is the outputs minus the inputs (variable costs)

(2) One LU is defined as an adult animal weighing 300 kg. Cows, bullocks, and breeding bulls are 1 LU. Heifers and young bulls are 0.7 whereas calves are 0.2.

(3) CPR = common property resources; HH = household; N = nitrogen; BTN = Bhutan Ngultrum; K = potassium; P = phosphorus; GM = gross margin; LU = livestock unit; QOD = quantitative ordinal indicator data

(4) "Literacy" is the proportion of the population aged 15 years and over that can read and write a simple short statement related to their daily life (FAO 2005).

selected off-farm income (on a yearly basis) and total annual income as economic indicators to obtain an overview of the off-farm and on-farm income sources. Since milk and milk products are important sources of cash income, the milk yield per cow per day was taken as an indicator. The expert group was concerned about the productivity of livestock farming practices, and thus proposed using the economic indicator "gross margin (GM) livestock per livestock unit (LU)" instead.[7]

7 Details of calculation of these economic indicators for 2000 and 2004 are given in Samdup et al. (2010).

**Table 2. Qualitative indicators transposed into QOD for five sectors (1–100 scale)**

| Sector | Bad (0–20) | Poor (21–40) | Medium (41–60) | OK (61–80) | Good (81–100) |
|---|---|---|---|---|---|
| **Ordinal Scale Indicators** | **1.0** | **1.5–2.0** | **2.5–3.0** | **3.5–4.0** | **4.5–5.0** |
| Access to piped drinking water[1] | Takes more than 30 minutes of walking to fetch water | Takes between 15 and 30 minutes to fetch water | No personal tap water<br>Common taps available<br>Water supply is erratic | Have personal tap<br>Water is not very clean<br>Erratic water supply | Have personal tap<br>Clean water available at all times |
| HH living standard[1] | Basic needs (e.g., food, clothing, and shelter) are not met | Experiences shortages, but basic needs (food, clothing, and shelter) are met | All of basic needs are met<br>No access to other household luxuries | Basic needs are all met<br>Some access to other household luxuries | Basic needs are all met<br>Have access to other household luxuries (e.g., fridge, radio, television) |
| Livestock CPR grazing practices | No herder with the cattle | Occasionally a herder with the cattle | Cattle accompanied by herder<br>Exercises some control on cattle wandering to other areas | Cattle accompanied by herder<br>Cattle are not allowed to wander but rotate occasionally | Cattle accompanied by herder<br>Controlled grazing, rotated to different areas |
| Soil erosion of cropland [2, 3] | Very high runoff and surface erosion<br>High downward movement of soil | High runoff<br>High surface erosion | Moderate surface erosion | Mild surface erosion | No surface erosion or water runoff |

Notes: (1) Based on expert group view
(2) In-situ land degradation (physical) on sloping farm land due to agricultural practices
(3) Norbu and Floyd (2004)
(4) CPR = common property resources HH = household QOD = quantitative ordinal indicator data

***Environmental issues and indicators***

Based on the results of the field workshops, it was confirmed that the farmers were concerned about their lack of knowledge of the livestock carrying capacity of their farms. Therefore, excess LU reared relative to the feeds on offer was selected as an environmental indicator. This was calculated by comparing the total digestible nutrients available from the different feeds to the requirements of the LUs present on a farm (Samdup et al. 2013). In Bhutan, cattle are often blamed for overgrazing, which consequently damages forest vegetation (Roder et al. 2001). Hence, the expert group proposed including the indicator "livestock CPR grazing practices". This indicator ranges from “bad” to “good” based on whether the cattle are accompanied by a herder in the common property resources (CPR), and whether the cattle are allowed to wander or controlled grazing is practiced.

In Bhutan, the soils on the mountain slopes inherently exhibit low fertility. Thus, the low availability of N and P is a major soil fertility concern, while the soil parent materials are

generally rich in potassium (K) (Roder et al. 2001; Norbu and Floyd 2004). Included in this study were the partial nutrient balances of N (soil N balance) and P (soil P balance) as environmental indicators[8] (de Wit et al. 1995; Zhen and Routray 2003). The mountain areas have high soil erosion potential due to heavy rains (Yunlong and Smit 1994; de Wit et al. 1995); therefore, the expert group proposed including "soil erosion of cropland" as an indicator, with the parameter ranging from "bad", when there is very high water runoff and surface soil erosion, to "good", when there is no water runoff and surface erosion in the study areas.

## Performance Value Ranges for Individual Indicators

Table 3 gives the results of the discussions with the expert group on the performance value ranges for the social, economic, and environmental indicators.

### *Social indicators*

In the past, Bhutan's internal migration rate was estimated at around 6 percent per year (UNDP 2009). Taking this rate as a reference value, the expert group categorized the performance value range of 6–10 percent of household members migrating for the medium sector of rural-urban migration. Meanwhile, although labor shortage on farms in Bhutan is viewed as a concern, the data available on this issue are limited. Hence, the expert group recommended a performance value range of 11–15 percent of households per study area for the medium sector of farm labor shortages. Based on the 2000 literacy rate of 53 percent in Bhutan (CSO 2001), the expert group suggested a literacy rate of 51–60 percent per household as the performance value range for the medium sector. Table 2 gives the descriptions of the medium scoring for the qualitative indicators access to piped drinking water and household living standard.

### *Economic indicators*

Performance value range for annual income was based on the estimated monthly household consumer expenditure of BTN 1,097[9] per capita, with an average household size of 5.5 in 2000 (CSO 2001). This translates to an annual income of BTN 91,000–120,000 for the medium sector. In the absence of other literature in Bhutan, the expert group recommended taking the values used by Samdup (1997), which we accordingly corrected for inflation rates, as the reference values for the medium sector of the remaining four economic indicators. Therefore, the performance value ranges of the medium sector for these indicators were the farm GM (BTN 81,000–110,000) per year; off-farm income per farm (BTN 11,000–20,000) per year; milk yield per exotic crossbred cow per day (4.1–6.0 kg) and GM livestock per LU (BTN 6000–10,000).

### *Environmental indicators*

The performance value range for the excess LU reared in relation to the feeds on offer per household was based on the opinion of the expert group. They proposed that a range between 1.1 and 1.5 excess LU per household could be categorized in the medium sector (Table 3).

There was no available literature with regard to the performance value range for soil N balance and soil P balance per kilogram per hectare in Bhutan. Likewise, the experts could not advise on this. Thus, we took the

8 The details of the calculation of these environmental indicators (annual N and P inputs minus N and P outputs of the livestock and the crops, not including soil erosion, sedimentation and N fixation) are described in Samdup et al. (2013).

9 USD 1.0 = BTN 43.8 (2000)

**Table 3. Performance value ranges (minand max) of the five sectors in a 1–100 scale of the social, economic, and environmental indicators**

| Sector | Bad (0-20) | | Poor (21-40) | | Medium (41-60) | | OK (61-80) | | Good (81-100) | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Performance Value Ranges** | **Min (0)** | **Max (20)** | **Min (21)** | **Max (40)** | **Min (41)** | **Max (60)** | **Min (61)** | **Max (80)** | **Min (81)** | **Max (100)** | |
| **Social Indicators** | | | | | | | | | | | |
| Rural urban migration1 (%) | 25.0 | 21.0 | 20.0 | 11.0 | 10.0 | 6.0 | 5.0 | 3.0 | 2.0 | 0.0 | UNDP (2009), expert group |
| Farm labor shortage1 (% HH) | 40.0 | 21.0 | 20.0 | 16.0 | 15.0 | 11.0 | 10.0 | 6.0 | 5.0 | 0.0 | MoA (2005), expert group |
| Literacy rate (%/HH) | 31.0 | 40.0 | 41.0 | 50.0 | 51.0 | 60.0 | 61.0 | 70.0 | 71.0 | 80.0 | CSO (2001), expert group |
| Access to piped drinking water (QOD) | 0.0 | 1.0 | 1.1 | 2.0 | 2.1 | 3.0 | 3.1 | 4.0 | 4.1 | 5.0 | NSB (2013), expert group |
| Household living standard (QOD) | 0.0 | 1.0 | 1.1 | 2.0 | 2.1 | 3.0 | 3.1 | 4.0 | 4.1 | 5.0 | Expert group |
| **Economic Indicators** | | | | | | | | | | | |
| Annual income (BTN x 1.000) | 31.0 | 60.0 | 61.0 | 90.0 | 91.0 | 120.0 | 121.0 | 150.0 | 151.0 | 210.0 | Samdup (1997) |
| Farm gross margin (GM) (BTN x 1,000) | 31.0 | 50.0 | 51.0 | 80.0 | 81.0 | 110.0 | 111.0 | 150.0 | 151.0 | 190.0 | Samdup (1997) |
| Off-farm income (BTN x 1,000) | 0.0 | 5.0 | 6.0 | 10.0 | 11.0 | 20.0 | 21.0 | 30.0 | 31.0 | 50.0 | Samdup (1997) |
| Milk yield/cow/day (kg) | 1.0 | 2.0 | 2.1 | 4.0 | 4.1 | 6.0 | 6.1 | 8.0 | 8.1 | 10.0 | Samdup (1997) |
| GM (livestock)/LU (BTN x 1,000) | 1.0 | 2.0 | 3.0 | 5.0 | 6.0 | 10.0 | 11.0 | 20.0 | 21.0 | 30.0 | Samdup (1997) |
| **Environmental Indicators** | | | | | | | | | | | |
| Excess LU reared[1] | 2.5 | 2.1 | 2.0 | 1.6 | 1.5 | 1.1 | 1.0 | 0.6 | 0.5 | 0.0 | Expert group |
| Soil N balance (kg/ha) | −81.0 | −60.0 | −61 .0 | −40.0 | −41 .0 | −20.0 | −21 .0 | 20.0 | 19.0 | 32.0 | van Keulen (1996) |
| Soil P balance (kg/ha) | −30 .0 | −19.0 | −20 .0 | −11.0 | −10 .0 | −3.0 | −2 .0 | 2.0 | 3.0 | 15.0 | van Keulen (1996) |
| Livestock CPR grazing practices (QOD) | 0.0 | 1.1 | 1.1 | 2.0 | 2.1 | 3.0 | 3.1 | 4.0 | 4.1 | 5.0 | Expert group |
| Soil erosion of cropland QOD) | 0.0 | 1.0 | 1.1 | 2.0 | 2.1 | 3.0 | 3.1 | 4.0 | 4.1 | 5.0 | Expert group |

Notes: (1) lower performance value range is better (min)

(2) BTN = Bhutan Ngultrum; LU = livestock unit; UNDP = United Nations Development Programme; CPR = common property resources; MoA = Ministry of Agriculture; CSO = Central Statistical Organization; N = nitrogen; GM = gross margin; NSB = National Statistics Bureau; HH = household; QOD = qualitative ordinal data; K = potassium; P = phosphorus

(3) USD 1 = BTN 43.8 (2000); BTN 45.3 (2004); BTN 65 (2015)

performance value range for this indicator based on the study of van Keulen, van der Meer, and de Boer (1996). Specifically, the authors mentioned that −20 to 20 kg N per hectare, and −2 to 2 kg P per hectare was not considered a problem. Therefore, the expert group proposed these performance value ranges for the ok sector and the ranges of −41 to −20 kg N per hectare and −10 to −3 kg P per hectare for the medium sectors. Table 2 gives the descriptions of the medium scoring for the qualitative indicators livestock CPR grazing practices and soil erosion on cropland.

### *Household and farm characteristics*

Table 4 shows the LSM of household members, farm sizes, cattle herd sizes, and percentages of crossbreds per farm in the study areas for the years 2000, 2004, and 2015. The results show that the number of household members declined during the monitoring period in the semi-intensive, intensive, and intensive peri-urban areas. This decline is due to migration of people from the rural to the urban areas. The average farm size was smallest in the extensive area due to the difficult farming conditions in the locale (Samdup et al. 2010).

The average cattle herd size declined during the monitoring period mainly because the number of local cattle per farm declined. The average proportion of crossbred cattle per household was highest in the intensive area, albeit the figure remained constant during the monitoring period. In the extensive and semi-intensive areas, the average proportion of crossbred cattle per household increased. It appears that adoption of crossbreeding still strongly differs between the areas.

**Table 4. LSM for number of household members, farm sizes, herd sizes (in LU), and percentages of crossbreds in a herd in the four study areas in the years 2000, 2004, and 2015**

| Area | Khaling | | | | Dala | | | | Chokhor | | | | Chang | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System | Extensive | | | | Semi-intensive | | | | Intensive | | | | Intensive Peri-urban | | |
| | 2000 | 2004 | 2015 | p | 2000 | 2004 | 2015 | p | 2000 | 2004 | 2015 | p | 2000 | 2004 | p |
| HH size | 7.1 | 7.8 | 7.5 | 0.10 | 9.4 | 10.5 | 6.7 | 0.02 | 7.8 | 8.3 | 7.0 | 0.04 | 7.9 | 8.5 | 0.04 |
| Farm size (ha) | 1.2 | 1.2 | 1.2 | 0.12 | 2.6 | 2.5 | 2.4 | 0.15 | 2.9 | 2.9 | 2.8 | 0.20 | 1.5 | 1.1 | 0.03 |
| Herd size (LU)[1] | 8.4 | 6.8 | 6.4 | 0.04 | 7.3 | 7.1 | 5.9 | 0.02 | 9.5 | 9.3 | 7.5 | 0.03 | 7.2 | 6.6 | 0.03 |
| Crossbreed cattle (%/HH/year) | 20.0 | 25.0 | 34.0 | 0.04 | 59.0 | 59.0 | 71.0 | 0.03 | 84.0 | 88.0 | 89.0 | 0.07 | 70.0 | 83.0 | 0.04 |

Notes: (1) One livestock unit is defined as an adult bovine weighing about 300 kg. Cows, bullocks, and breeding bulls are considered as 1 LU. Heifers and young bulls are considered as 0.7 LU. Calves are considered as 0.2 LU.

(2) HH = household LSM = least square mean LU = livestock unit

(3) $p < 0.05$ indicates significant difference between the years within an area

## Empirical Assessment of the GNH Indicators

The results of the empirical assessments of the GNH indicators in the four study areas can be found in Table 5 (2000), Table 6 (2004), and Table 7 (2015). The rural-urban migration and farm labor shortage are presented only as overall percentages per area. Table 8 summarizes the results per area, per year. The main trends for the indicators between areas and between years are presented below.

### *Social indicators*

The social indicators differed considerably between the study areas, particularly in the years 2000 (Table 5) and 2004 (Table 6). Farm labor shortage was highest in the extensive area in 2000 and 2004. In 2015, the rural-urban migration and farm labor shortage were high in all areas. In 2000 and 2004, literacy rate was higher in the intensive peri-urban area than in the other areas. In 2015, the literacy rate was similar in the three remaining areas. Access to piped drinking water and household living standard were higher in the two intensive areas than in the semi-intensive and extensive areas in all three monitoring years.

The changes in the social indicators over the monitoring years (Table 8) show the increase in rural-urban migration and farm labor shortage in 2015. The literacy rate increased in the extensive area from 2000 onward. In the extensive and intensive areas, access to piped drinking water and household living standard improved from 2000 to 2004 and from 2004 to 2015. In the intensive peri-urban area, household living standard improved from 2000 to 2004.

### *Economic indicators*

The differences in the economic indicators between the study areas were rather consistent over the monitoring period. The intensive peri-urban area had the highest annual income, farm GM, milk yield per cow per day, and GM (livestock) per LU. The intensive, semi-intensive, and extensive areas followed in 2000 and 2004. In 2015, the intensive area showed the highest farm GM (Table 8).

Off-farm income remained lower in the intensive area than that in the other areas over the whole study period because there are fewer opportunities for off-farm work in this locale. For example, the intensive area has limited construction work for buildings and roads as most of these had been completed before 2000. Milk yield per cow per day was lowest in the extensive area in the three monitoring years. In 2000 and 2004, it was highest in the intensive peri-urban area. Milk yield per cow per day is about three times higher in crossbred cows than in local Siri cows (Samdup et al. 2010). Thus, milk yields and the economic results of cattle keeping are higher in areas with large numbers of crossbreeds on the farms as in the intensive areas. In 2015, however, milk yield per cow per day was higher in the semi-intensive area than in the extensive area and the intensive area.

In 2015, there was an outbreak of foot-and-mouth disease (FMD) in the intensive area, which consequently negatively affected the farmers' milk yield per cow per day. In 2015, the GM (livestock) per LU in the semi-intensive area was higher than that in the other two areas. This was partly due to the higher milk off-take.

The changes in the economic indicators over the monitoring years (Table 8) showed that only the extensive area had an increase in annual income and farm GM in 2015 compared to 2000 and 2004. There were no changes over the years for these two indicators in the other areas. Off-farm income remained the same in all areas over the years. Despite the large numbers of crossbred cattle in the intensive area, milk yield per cow per day decreased between 2004 and 2015 due to the FMD outbreak.

**Table 5. LSM and medians for the social, economic, and environmental indicators, all study areas, 2000**

| Area | Khaling (n=63) | | Dala (n=35) | | Chokhor (n=55) | | Chang (n=30) | | |
|---|---|---|---|---|---|---|---|---|---|
| **System** | **Extensive** | | **Semi-intensive** | | **Intensive** | | **Intensive Peri-urban** | | |
| **Social Indicators** | | | | | | | | | |
| Rural urban migration (%) | 2.0 | | 0.0 | | 0.9 | 0.0 | | | |
| Farm labor shortage (% HH) | 14.2 | | 5.7 | | 5.4 | 6.7 | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Literacy rate (%/HH) | 47.9[b] | 2.6 | 49.9[b] | 3.5 | 53.2[b] | 2.8 | 69.6[a] | 3.8 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Access to piped drinking water | 2.0[z] | 2.0–3.0 | 3.0[y] | 2.0–5.0 | 3.0[x] | 3.0–4.5 | 4.0[r] | 2.0–4.0 | 0.001 |
| HH living standard | 2.0[z] | 1.5–3.0 | 3.0[y] | 2.0–3.5 | 3.0[x] | 2.0–4.0 | 3.0[r] | 2.0–4.0 | 0.001 |
| **Economic Indicators** | | | | | | | | | |
| | **LSM** | **SE** | **LSM** | | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Annual income (BTN[1] × 1,000) | 75.6[c] | 7.8 | 116.6[b] | 10.5 | 137.7[b] | 8.3 | 207.2[a] | 1.1 | 0.001 |
| Farm GM (BTN × 1,000) | 54.3[d] | 73.8 | 97.7[c] | 9.8 | 130.3[b] | 7.8 | 181.2[a] | 10.6 | 0.001 |
| Milk yield/cow/ day (kg) | 3.0[c] | 0.22 | 5.0[b] | 0.2 | 4.9[b] | 0.2 | 7.0[a] | 0.2 | 0.001 |
| GM (livestock)/ LU[2] (BTN × 1,000)^ | 4.9[d] | 0.8 | 9.9[c] | 1 | 6.6[b] | 0.8 | 18.8[a] | 1.1 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Off-farm income (BTN × 1,000) | 21.0r | 0–72 | 15.0r | 0–76 | 3.5[x] | 0–36 | 18.0[r] | 0–90 | 0.001 |
| **Environmental Indicators** | | | | | | | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | |
| Excess LU reared | 2.1[a] | 0.1 | 1.1b | 0.2 | 0.2[c] | 0.1 | 0.2[c] | 0.1 | 0.001 |
| Soil N balance (kg/ha) | 30.9[a] | 1.3 | −18.2c | 1.7 | −17.8[c] | 1.4 | 1.5[b] | 1.8 | 0.001 |
| Soil P balance (kg/ha) | 6.3[b] | 0.6 | −3.7c | 0.8 | 13.8[a] | 0.7 | −3.9[c] | 0.9 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Livestock CPR[3] grazing practices | 2.0 | 1.0–3.5 | 2.0 | 1.0–4.5 | 2.0 | 2.0–3.5 | 2.0 | 2.0–3.0 | 0.090 |
| Soil erosion of cropland | 3.0 | 2.5–4.0 | 3.0 | 2.0–4.0 | 3.0 | 3.0–4.0 | 3.0 | 2.5–4.0 | 0.867 |

Notes: (1) USD 1 = BTN 43.8 (2000), BTN 45.3 (2004), BTN 65 (2015) (2) ^ Analysis was conducted on log transformed data

(3) [a,b,c,d] LSM with different superscripts between study areas are significantly different ($p<0.05$);
[r,x,y,z] Medians with different superscripts between study areas are significantly different ($p<0.05$) (Kruskal Wallis and Wilcoxon rank sum tests)

(4) BTN = Bhutan Ngultrum K = potassium QOD = qualitative ordinal data CPR = common property resources
LSM = least square means P = phosphorus GM = gross margin LU = livestock unit SE = standard error
HH = household N = nitrogen

**Table 6. LSM, percentages, and medians for the social, economic and environmental indicators, all study areas, 2004**

| Area | Khaling (n=63) | | Dala (n=35) | | Chokhor (n=55) | | Chang (n=30) | | |
|---|---|---|---|---|---|---|---|---|---|
| **System** | **Extensive** | | **Semi-intensive** | | **Intensive** | | **Intensive Peri-urban** | | |
| **Social Indicators** | | | | | | | | | |
| Rural urban migration (%) | 5.5 | | 0.0 | | 2.0 | | 0.0 | | |
| Farm labor shortage (% HH) | 15.9 | | 8.6 | | 7.3 | | 6.7 | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Literacy rate (%/HH) | 52.8bc | 2.6 | 51.1$^{c}$ | 3.5 | 55.1$^{b}$ | 2.8 | 69.1$^{a}$ | 3.7 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Access to piped drinking water | 2.5$^{y}$ | 2.0–3.5 | 3.0$^{x}$ | 2.5–4.0 | 3.5$^{r}$ | 3.0–4.0 | 4.0$^{r}$ | 2.0–4.0 | 0.001 |
| HH living standard | 2.5$^{y}$ | 2.0–3.5 | 3.0$^{x}$ | 2.0–3.5 | 3.5$^{r}$ | 2.0–4.0 | 3.5$^{r}$ | 2.0–4.0 | 0.001 |
| **Economic Indicators** | | | | | | | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Annual income (BTN[1] × 1,000) | 79.0$^{c}$ | 6.8 | 142.7$^{b}$ | 9.1 | 164.2$^{ab}$ | 7.3 | 183.8$^{a}$ | 9.8 | 0.001 |
| Farm GM (BTN × 1,000) | 61.1$^{c}$ | 6.5 | 119.1$^{b}$ | 8.8 | 155.5$^{ab}$ | 7 | 149.2$^{a}$ | 9.5 | 0.001 |
| Milk yield/cow/day (kg) | 3.1$^{c}$ | 0.2 | 5.6$^{b}$ | 0.2 | 5.6$^{b}$ | 0.2 | 7.3$^{a}$ | 0.3 | 0.001 |
| GM (livestock)/LU[2] (BTN × 1,000)^ | 4.9$^{c}$ | 0.9 | 10.7$^{b}$ | 1.2 | 8.6$^{b}$ | 0.9 | 24.6$^{a}$ | 1.2 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Off-farm income (BTN × 1,000) | 15.0$^{x}$ | 0–60 | 13.5$^{rx}$ | 0–88 | 6.0$^{y}$ | 0.0–39 | 30.0$^{r}$ | 0–135 | 0.001 |
| **Environmental Indicators** | | | | | | | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | |
| Excess LU reared | 1.1$^{a}$ | 0.1 | 0$^{b}$ | 0.1 | 0$^{b}$ | 0.8 | 0$^{b}$ | 0.1 | 0.001 |
| Soil N balance (kg/ha) | 30.7$^{a}$ | 1.3 | −19.7$^{c}$ | 1.7 | −14.6$^{d}$ | 1.3 | 2.7$^{b}$ | 1.9 | 0.001 |
| Soil P balance (kg/ha) | 5.5$^{b}$ | 0.6 | −5.3$^{d}$ | 0.9 | 15.5$^{a}$ | 0.7 | 2.6$^{c}$ | 0.9 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Livestock CPR[3] grazing practices | 2.0 | 1.0–3.5 | 2.0 | 2–4.5 | 2.5 | 2.0–3.5 | 2.0 | 2.0–3.0 | 0.070 |
| Soil erosion of cropland | 3.0 | 2.5–4.0 | 3.0 | 2–4.0 | 3.0 | 2.5–4.0 | 3.5 | 3.0–4.0 | 0.090 |

Notes: (1) USD 1 = BTN 43.8 (2000), BTN 45.3 (2004), BTN 65 (2015) (2) ^ Analysis was conducted on log transformed data

(3) $^{a,b,c,d}$ LSM with different superscripts between study areas are significantly different ($p<0.05$);
$^{r,x,y,z}$ Medians with different superscripts between study areas are significantly different ($p<0.05$) (Kruskal Wallis and Wilcoxon rank sum tests)

(4) BTN = Bhutan Ngultrum K = potassium QOD = qualitative ordinal data CPR = common property resources
LSM = least square means P = phosphorus GM = gross margin LU = livestock unit SE = standard error
HH = household N = nitrogen

**Table 7. LSM, percentages, and medians for the social, economic and environmental indicators, three study areas, 2015**

| Area | Khaling (n=63) | | Dala (n=35) | | Chokhor (n=55) | | |
|---|---|---|---|---|---|---|---|
| **System** | **Extensive** | | **Semi-intensive** | | **Intensive** | | |
| **Social Indicators** | | | | | | | |
| Rural urban migration (%) | 14.0 | | 23.3 | | 12.4 | | |
| Farm labor shortage (% HH) | 23.4 | | 17.2 | | 36.2 | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Literacy rate (%/HH) | 58.8 | 3.2 | 55.6 | 4.1 | 58.9 | 3.2 | 0.790 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Access to piped drinking water | 3.0$^{z}$ | 2.0–4.0 | 3.5$^{y}$ | 2.0–5.0 | 4.0$^{x}$ | 3.0–4.5 | 0.001 |
| HH living standard | 3.0$^{z}$ | 2.5–4.0 | 3.0y | 2.0–5.0 | 4.0$^{x}$ | 2.5–5.0 | 0.001 |
| **Economic Indicators** | | | | | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | **P** |
| Annual income (BTN[1] × 1,000) | 93.7$^{b}$ | 11.4 | 148.2$^{a}$ | 14.6 | 170.6$^{a}$ | 11.4 | 0.001 |
| Farm GM (BTN × 1,000) | 75.4$^{b}$ | 10.8 | 123.8$^{a}$ | 13.7 | 161.9$^{c}$ | 10.8 | 0.001 |
| Milk yield/cow/ day (kg) | 3.6$^{c}$ | 0.1 | 6.0$^{a}$ | 0.2 | 4.2$^{b}$ | 0.1 | 0.001 |
| GM (livestock)/ LU[2] (BTN × 1,000)^ | 12.6$^{b}$ | 1.9 | 23.4$^{a}$ | 2.5 | 12.3$^{b}$ | 2.0 | 0.042 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Off-farm income (BTN × 1,000) | 12.0$^{r}$ | 0–60 | 12.0$^{r}$ | 0–88 | 3.0$^{x}$ | 0–39 | 0.004 |
| **Environmental Indicators** | | | | | | | |
| | **LSM** | **SE** | **LSM** | **SE** | **LSM** | **SE** | |
| | 1.2$^{a}$ | 0.1 | 0.1$^{b}$ | 0.1 | 0$^{b}$ | 0.1 | 0.001 |
| Excess LU reared | 24.6$^{a}$ | 0.9 | −7.1$^{b}$ | 1.2 | −5.5$^{b}$ | 0.9 | 0.001 |
| Soil N balance (kg/ha) | 4.6$^{b}$ | 0.7 | −3.9$^{c}$ | 0.8 | 10.3$^{a}$ | 0.7 | 0.001 |
| | **Median** | **Min–Max** | **Median** | **Min–Max** | **Median** | **Min–Max** | |
| Soil P balance (kg/ha) | 2.5$^{z}$ | 2.0–4.0 | 3.0$^{yz}$ | 1.0–4.5 | 3.5$^{xy}$ | 1.0–4.5 | 0.001 |
| Livestock CPR[3] grazing practices | 3.5$^{z}$ | 3.0–4.0 | 3.5$^{xy}$ | 2.0–4.5 | 4.0$^{x}$ | 3.0–5.0 | 0.040 |

Notes: (1) USD 1 = BTN 43.8 (2000), BTN 45.3 (2004), BTN 65 (2015)

(2) ^ Analysis was conducted on log transformed data

(3) $^{a,b,c,d}$ LSM with different superscripts between study areas are significantly different ($p<0.05$);
$^{r,x,y,z}$ Medians with different superscripts between study areas are significantly different ($p<0.05$)
(Kruskal Wallis and Wilcoxon rank sum tests)

(4) BTN = Bhutan Ngultrum K = potassium QOD = qualitative ordinal data
CPR = common property resources LSM = least square means P = phosphorus
GM = gross margin LU = livestock unit SE = standard error HH = household
N = nitrogen

**Table 8. LSM and medians for the social, economic, and environmental indicators within an area**

| Area | Khaling/ | | | | Dala/ | | | | Chokhor/ | | | | Chang/ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System | Extensive | | | | Semi-intensive | | | | Intensive | | | | Intensive Peri-urban | | |
| | 2000 | 2004 | 2015 | P | 2000 | 2004 | 2015 | P | 2000 | 2004 | 2015 | P | 2000 | 2004 | P |
| **Social Indicators** | | | | | | | | | | | | | | | |
| Rrural urban migration (%) | 2.0 | 5.5 | 14.0 | | 0.0 | 0.0 | 23.3 | | 0.9 | 2.0 | 12.4 | | 0.0 | 0.0 | |
| Farm labor shortage (% HH) | 14.2 | 15.9 | 23.4 | | 5.7 | 8.6 | 17.2 | | 5.4 | 7.3 | 36.2 | | 6.7 | 6.7 | |
| Literacy rate (%/HH) | 47.9c | $52.8^{b}$ | $58.8^{a}$ | 0.027 | 49.9 | 51.10 | 55.6 | 0.207 | 53.2 | 55.1 | 58.9 | 0.395 | 69.6 | 69.1 | 0.912 |
| Access to piped drinking water | $2.0^{z}$ | $2.5^{y}$ | $3.0^{x}$ | 0.001 | 3.0 | 3.0 | 3.5 | 0.237 | $3.0^{z}$ | $3.5^{y}$ | $4.0^{x}$ | 0.001 | 4.0 | 4.0 | 0.189 |
| HH living standard | $2.0^{z}$ | $2.5^{y}$ | $3.0^{x}$ | 0.001 | 3.0 | 3.0 | 3.0 | 0.093 | $3.0^{z}$ | $3.5^{y}$ | $4.0^{x}$ | 0.001 | $3.0^{y}$ | $3.5^{x}$ | 0.001 |
| **Economic Indicators** | | | | | | | | | | | | | | | |
| Annual income (BTN × 1,000) | $75.6^{b}$ | $79.0^{b}$ | $93.7^{a}$ | 0.014 | 116.6 | 142.7 | 148.2 | 0.146 | 137.7 | 164.2 | 170.6 | 0.09 | 207.2 | 183.8 | 0.198 |
| Farm GM (BTN × 1,000) | $54.3^{b}$ | $61.1^{b}$ | $75.4^{a}$ | 0.001 | 97.7 | 119.1 | 123.8 | 0.204 | 130.3 | 155.5 | 161.9 | 0.098 | 181.2 | 149.2 | 0.069 |
| Milk yield/cow/day (kg) | $3.0^{b}$ | $3.1^{b}$ | $3.6^{a}$ | 0.006 | $5.0^{b}$ | $5.6^{ab}$ | $6.0^{a}$ | 0.006 | $4.9^{b}$ | $5.6^{a}$ | $4.2^{c}$ | 0.001 | 7.0 | 7.3 | 0.598 |
| GM (livestock)/LU2 (BTN × 1,000)^ | $4.9^{b}$ | $4.9^{b}$ | $12.6^{a}$ | 0.001 | $9.9^{b}$ | $10.7^{b}$ | $23.4^{a}$ | 0.004 | $6.6^{b}$ | $8.6^{b}$ | $12.3^{a}$ | 0.001 | $18.8^{a}$ | $24.6^{b}$ | 0.017 |
| Off-farm income (BTN x 1,000) | 21.0 | 15.0 | 12.0 | 0.459 | 15.0 | 13.5 | 12.0 | 0.992 | 3.5 | 6.0 | 3.0 | 0.953 | 18.0 | 30.0 | 0.264 |
| **Environmental Indicators** | | | | | | | | | | | | | | | |
| Excess LU | $2.1^{a}$ | $1.1^{b}$ | $1.2^{b}$ | 0.001 | $1.1^{a}$ | $0.0^{b}$ | $0.1^{b}$ | 0.001 | $0.2^{a}$ | $0^{b}$ | $0^{b}$ | 0.004 | $0.2^{a}$ | $0^{b}$ | 0.003 |
| Soil N balance (kg/ha) | $30.9^{a}$ | $30.7^{a}$ | $24.6^{b}$ | 0.001 | $-18.2^{b}$ | $-19.7^{b}$ | $-7.1^{a}$ | 0.001 | $-17.8^{b}$ | $-14.6^{b}$ | $-5.5^{a}$ | 0.001 | $1.5^{b}$ | $2.7^{a}$ | 0.001 |
| Soil P balance (kg/ha) | $6.3^{a}$ | $5.5^{a}$ | $4.6^{b}$ | 0.001 | −3.7 | −5.3 | −3.9 | 0.532 | $13.8^{b}$ | $15.5^{a}$ | $10.3^{b}$ | 0.001 | $-3.9^{b}$ | $2.6^{a}$ | 0.001 |
| Livestock CPR[3] grazing practices | $2.0^{z}$ | $2.0^{y}$ | $2.5^{x}$ | 0.001 | 2.0 | 2.0 | 3.0 | 0.275 | $2.0^{z}$ | $2.5^{yz}$ | $3.5^{x}$ | 0.001 | 2.0 | 2.0 | 1.00 |
| Soil erosion of cropland | $3.0^{z}$ | $3.0^{y}$ | $3.5^{x}$ | 0.001 | $3.0^{z}$ | $3.0^{yz}$ | $3.5^{xy}$ | 0.017 | $3.0^{z}$ | $3.0^{y}$ | $4.0^{x}$ | 0.001 | 3.0 | 3.5 | 0.075 |

Notes: (1) USD 1 = BTN 43.8 (2000), BTN 45.3 (2004), BTN 65 (2015) (2) ^ Analysis was conducted on log transformed data

(3) $^{a,b,c,d}$ LSM with different superscripts between study areas are significantly different ($p<0.05$)
$^{r,x,y,z}$ Medians with different superscripts between study areas are significantly different ($p<0.05$) (Kruskal Wallis and Wilcoxon rank sum tests)

(4) BTN = Bhutan Ngultrum K = potassium QOD = qualitative ordinal data CPR = common property resources LSM = least square means
P = phosphorus GM = gross margin LU = livestock unit SE = standard error HH = household N = nitrogen

(5) Please refer to Tables 5, 6, and 7 for the number of households (n) and standard errors (se) of LSM and min-max values of medians.

In general, the reasons why the increase in the farmers' milk yield per cow per day was slow or even stagnant were the lack of systematic breeding programs and the poor quality of the feeds available (Samdup et al. 2010). Despite the lower milk yield per cow per day, GM (livestock) per LU increased between 2004 and 2015 in the intensive area. Also, in the extensive and semi-intensive areas, the GM (livestock) per LU significantly increased between 2004 and 2015. One reason why the GM (livestock) per LU increased is perhaps because LUs per farm decreased.

***Environmental indicators***

The environmental indicators "excess LU reared" and "soil N balance" were higher in the extensive area than in the other areas in all three monitoring years. The soil N balance was (relatively) high in the extensive area probably because of the large N input into the farms from manure through CPR grazing. The semi-intensive and intensive areas showed negative soil N balance, which was probably due to higher outputs from the crop subsystem (Samdup et al. 2013). The soil P balance was higher in the intensive area than in the other areas in all the monitoring years probably because of the high use of single super phosphate fertilizers for cropping, especially for potatoes (Samdup et al. 2013). The CPR grazing practices and soil erosion on sloping land did not differ significantly between the study areas in 2000; in 2004 and 2015, however, they were better valued in the intensive area than in the other areas. Farmers have become more aware of grazing practices and erosion as a result of extension efforts.

Excess LU reared significantly in 2004 and 2015 as compared with that in 2000 in all the study areas. This may be because of the smaller number of animals per farm due to sales; thus, the LU was more balanced with the feeds available in 2004 and 2015 than in 2000. The soil N and P balance reduced in 2015 due to more prudent use of the fertilizers compared to that in the other monitoring years, except for the soil P balance in the semi-intensive area, which remained slightly negative over the years.

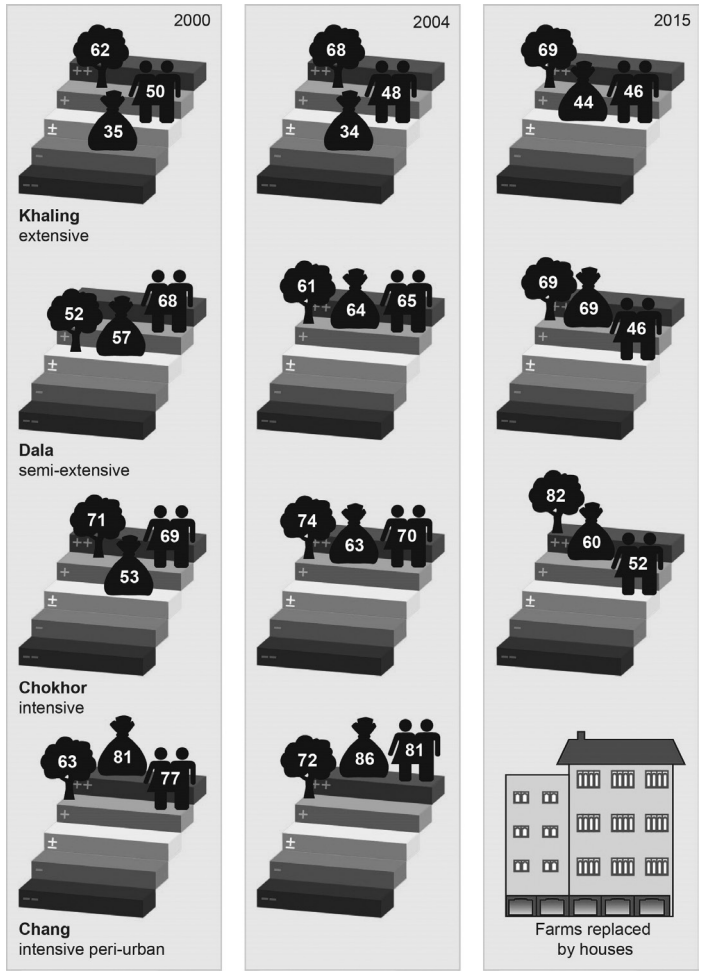
**The Integral Assessment: An Innovation**

Figure 1 illustrates the integral assessment methodology that we adopted in this study. In particular, the figure presents the SVs of the social, economic, and environmental index values of each study area in the years 2000, 2004, and 2015. The performance value ranges (Table 3) were used to calculate the SVs. This figure shows how the empirical results can be communicated to policymakers and other relevant stakeholders.

Figure 1 shows that one of the main challenges to implementing the GNH concept in rural areas is the need for equitable socioeconomic development. Overall, the extensive area had lower social and economic indices than the other areas. This indicates that this area has witnessed lower social and economic progress than the other areas over the years. Development efforts in remote locations (e.g., extensive area) have been less effective than those in the other areas (Rinzin, Vermeulen, and Glasbergen 2007). Farmers' adoption of crossbreeding in the extensive area has been slow due to its difficult topography and its distance to the input and output markets. In 2015, however, the economic index in the extensive area moved from the "poor" sector to the "medium" sector in 2000 and 2004, mainly because the economic indicators, except for off-farm income, increased (Table 8). Thus, farming gave slightly better economic results in 2015 than in the earlier years partly due to a slowly increasing crossbred cattle population (Table 4).

In the semi-intensive area, the economic index moved from the medium sector in

**Figure 1. Standardized indicator values of the social, economic, and environmental index values per study area, 2000, 2004, and 2015**




2000 to the ok sector in 2004 and 2015; farm income moved from the ok to the good sector. The major reasons for this change were the increased milk sales. In the intensive area, farm income was relatively high. The good income opportunities from farming are the result of the large numbers of crossbred cattle in this area. Likewise, opportunities stemmed from the higher livestock GMs derived from crossbred cattle than those derived from local cattle and from the high crop GMs from potatoes (Samdup et al. 2010). The off-farm income was categorized under the bad sector in this area due to the very limited off-farm possibilities.

A striking finding was that the social index declined in the semi-intensive and intensive areas by 19 and 18 scale points between 2004 and 2015. This decline may be due to the increase in rural-urban migration and due to farm labor shortage. The rural-urban migration calculations in this study, which are based on the percentages of migrated family members, only involved the households present for the survey. However, in 2015 (as compared to 2000 and 2004), the number of households declined in our survey by 25 percent, 17 percent, and 14 percent of the initial households in the extensive, semi-intensive, and intensive areas,

respectively. All members of the missing households had moved to other areas. It is not known for certain whether they moved to other rural areas or urban areas. Nevertheless, the rural-urban in 2015 could be higher than the 2015 results indicate since households that had moved to other areas with all family members was not included.

A disappointing finding is the stagnant economic situation in the intensive area, albeit the economic indices in the extensive and semi-intensive areas gradually improved between 2000 and 2015. It is hoped that more interventions in dairy development will be implemented in the 12th five-year plan (GNHC 2016). In particular, the interventions in these areas should be more focused on strengthening and consolidating existing farmers' groups and on supporting emerging groups on dairy. Smallholder farmers operating in groups could help each other by consolidating their supply volume and by increasing their bargaining power in the purchase of inputs. These efforts would consequently lead to marketing advantages and to exchange of knowledge and experiences.

The intensive peri-urban area had the highest social and economic indices in 2000 and 2004. All economic indicators were higher in this area than in the other areas in both years. Most of the cattle kept here were crossbreds, which would have contributed to economic results from the cattle component of these farms (Samdup et al. 2010). Despite the considerable potential of dairying in Chang, considering that inputs are readily available and that it is near the market, farmers had to stop dairy production as Chang had been demarcated as an urban area. Cattle rearing has thus been prohibited in the area from 2010 onward; however, the farmers considered this as a blessing in disguise since the value of land have increased 10 times.

Bhutan is one of the 10 biodiversity hot spots of the world (Banerjee and Bandopadhyay 2016). Environmental conservation is as equally important as socioeconomic development. There was, however, not much progress in addressing the environmental issues over the period 2000–2015. The environmental indices in the study areas remained in the ok sector over the whole study period. The semi-intensive area started in the medium sector in 2000, whereas the intensive area moved to the good sector in 2015.

Despite this, what is encouraging is that the number of LU reared in the semi-intensive and intensive areas was in line with the feeds available. The number of LU is based on the existing production levels as shown by the "good" sector for excess LU reared.

Another main challenge is that the social indices in 2015 decreased as compared with those of 2000 and 2004. This is mainly because rural-urban migration increased; thus, farm labor shortages also increased. Rural-urban migration keeps on increasing in Bhutan (Gosai 2009; Gosai and Sulewski 2013). The main reasons are better employment opportunities in urban areas, accessibility to cash income, and escape from drudgery of farm work (MoA 2009). Accordingly, farmers have adapted by shifting to farming practices that require less labor (e.g., orchards, vegetables, keeping fewer cattle, backyard poultry farming) and to nonfarm activities (e.g., weaving).

## Future Prospects

Bhutan will continue to implement the GNH concept. GNH-oriented policies have initiated many development projects in the areas of tourism, agriculture, and hydropower (Hoy et al. 2016). Nonetheless, our assessment technique shows that the two main challenges to the future implementation of the GNH concept in rural areas are equitable socioeconomic development and rural-urban migration and farm labor shortage. Addressing these issues would require strong political commitment to make farming and rural life more attractive.

The economic indices were lowest in the extensive area. During the early period of this research, crossbreeding was not substantially practiced in the extensive area. However, the 2015 data show that crossbreeding has been gradually increasing. Crossbreeding could contribute to reducing rural-urban migration and to increasing milk yields and farm income; however, crossbreeding programs should not be limited to providing exotic semen or exotic breeding bulls only. The critical government interventions that need to be strengthened in close collaboration with farmers include establishing dairy farm groups, building milk collection centers and breeding infrastructure, and implementing trainings on cattle husbandry and on clean milk production practices.

**Key Aspects and Issues Distilled**

One main difference between our approach in assessing development progress in rural areas and the CBS GNH index is that we focused only on two of the four GNH pillars and used fewer indicators than the 33 indicators in the GNH index (CBS 2012). The GNH index aims to guide policymakers in formulating the annual and the five-year planning of the development activities. Our innovative approach zooms in on the issues of farmers in different agroecological areas. In the future, such efforts can complement the GNH development efforts since farmers' real-life issues are sometimes underscored at the macrolevel of planning.

We selected the indicators we used and identified the performance value ranges for the "bad" to "good" sectors of the indicators based on the experts' judgments and values. A different composition of the expert group—for instance, including experts from other fields of expertise—might have yielded a different list of selected indicators. Determining the performance value ranges was challenging because there were no official standards for the indicators selected. This issue needs to be further studied to develop a "less arbitrary" performance value ranges. Nevertheless, this approach is a first attempt to define benchmarks for development targets for rural areas in Bhutan.

The indicators used in the integrative assessment are equally important. The literature on weighing of indicators in composite indices is extensive (Blanc et al. 2008; Rowley et al. 2012). Rowley et al. (2012) stated that it is important to choose an approach that fits the user's information needs. Our approach is based on the equal weights of the indicators. Accordingly, this is in line with the fundamental idea of GNH, which prescribes that all domains in the GNH concept are equally important. Several authors (e.g., Mollenhorst 2005; DEFRA 2009) have stated that aggregating indicators into a single index may not improve understanding of the system and could even mask the details. However, other researchers (e.g., Singh et al. 2009; UNCSD 2012) argue that composite indices are increasingly recognized as a useful tool for communicating findings. The level of aggregation highly depends on the potential users. Policymakers need a rather high level of aggregation, whereas scientists or development practitioners might be interested in the trends of the individual indicators. Our approach also presents the trends in empirical and standardized values of the different indicators; these can explain the dynamics in the indices.

To obtain views on the integral assessment methodology from potential users, concepts and results were presented during a meeting with some of the officials of the GNH Commission Secretariat of Bhutan in 2016. This institution is responsible for planning and coordinating the government's five-year planning processes. It also allocates budget to the different government agencies. In general, the officials appreciated the idea of studying development trends and problem areas at the farm level using

social, economic, and environmental indicators and indices. It is hoped that the methodology presented in this study could be adopted, and that the results will be used while framing future policies for rural areas. This could best be done in a five-year time frame, coinciding with the five-year planning process of the government.

## CONCLUSIONS

The approach presented in this study is based on the participatory identification of social, economic, and environmental issues and indicators along with reference values for selected environmental indices. Accordingly, our approach can complement the implementation of the GNH philosophy or concept in Bhutan, particularly at the micro (smallholder/farm) level. It may generate more awareness among policymakers and other stakeholders through evidence-based findings for necessary interventions, such that the concerned individuals can make informed decisions that would benefit the largely agrarian population.

The implementation of the present approach can best be done in a five-year time frame, coinciding with the five-year planning process of the government. The results of this study's integral assessment have indicated that more equitable social and economic development is required. The intensive peri-urban and intensive areas showed the highest performance in all monitoring years in most of the social and economic indicators, and consequently, the respective indices. Between 2004 and 2015, the social indices declined in the semi-intensive and intensive areas. The main policy challenges to implementing the GNH concept in the rural areas are the increases in rural-urban migration and farm labor shortages, and the need for more equitable socioeconomic development.

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