

Article

Geographic Concentration and Development Potential of Poultry Microenterprises and Value Chain: A Study Based on Suitable Sites in Gazipur, Bangladesh

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Abstract: In Bangladesh, many poultry microenterprises (MEs) have flourished through the lending of microcredit to the poor. These MEs are linked to the value chain and play a significant role in poverty reduction. Not all of these MEs are located in favorable places. Almost all are developed utilizing homestead lands, which results in poor input supply and marketing facilities, and causes higher costs and less profit. This paper tries to uncover the constraints in value chain development, mainly those related to its physical and infrastructural environment; verify the potential of MEs through an analysis of their geographic concentration in sites with different suitability levels; and make recommendations as to how to overcome the constraints, with a view to ensuring higher profit levels for vulnerable poor. The suitability of sites was delineated through Geographic Information System (GIS). The analysis—a combination of field survey data with a site suitability map of farms/MEs concentration—is important, because it helps to validate the GIS analysis-based results of sites' suitability, helps supporters to design interventions in areas where the farms exist, and thus, helps farmers in vulnerable sites to lift themselves out of poverty.

Keywords: microfinance; poultry microenterprise; spatial distribution; GIS; sites' suitability; development; poverty reduction

1. Introduction

Bangladesh's economy is agricultural with a poor industrial base. Consequently, the incidence of unemployment and poverty is very high. There is growing potential for the development of microenterprises (MEs), especially of agro-based MEs in rural areas, created through extensive collateral-free lending of microcredit and microfinance mainly by non-government organizations (NGOs) to the poor for any income-generating small business.

In recent years, many poor entrepreneurs have developed poultry farms/MEs extensively, utilizing their inherited homestead lands with the help of microfinance. So, not all of these MEs are located in suitable places, which results in poor input supply and marketing facilities for their products in most cases, and thus, leads to higher production costs and less profit. On the other hand, government, apex funding agencies (*i.e.*, PKSF—Palli Karma-Sahayak Foundation) and donor agencies (such as World Bank; DFID, Department for International Development; IFAD, International Fund for Agricultural Development; ADB, Asian Development Bank) have to apply the same policy for allocating/providing financial and other support to all poultry farmers, irrespective of their location.

The aim of this research is to determine the spatial distribution of poultry farms/MEs and their production competence with respect to sites enjoying different levels of suitability in Gazipur district. This is an area stretched over 1741.53 square kilometers (Figure 1), where the concentration of poultry farms is the highest in the country. Hence, the study potentially enables the government, apex funding agencies and donor agencies to reach a greater understanding of the degree of concentration of poor farmers in several areas. This could help these actors to decide where to allocate more funds or where to direct support services. The study will not only help policy makers to grasp the potential of poultry subsector development but also support the verification of suitability levels. Consequently, by providing greater certainty around demand-driven interventions, the paper will aid the government and PKSF/NGOs in arranging preferential and required support services and infrastructure for unsuitable sites where relatively numerous farms are developed. Public policy makers might be aware of pockets of need for infrastructural improvements. However, the study deals not only with infrastructural facilities; rather, it reveals the favorable and unfavorable environments, derived through a GIS-based analysis of several weighted physical and infrastructural factors.

As the authors have not come across any similar study, several documents and literature related to poultry farming and other agriculture activities were reviewed. For example, Aguilar-Manjarrez and Nath, and Hossain *et al.* in their studies on fish farming potential in Africa and on aquaculture development in Bangladesh consider existing farm locations and the number of farms in determining the suitability of sites [1,2]. Besides, the study conducted questionnaire sample survey of farmers and collected, compiled and analyzed digital geo-referenced data using GIS to find out sites' suitability and geographic concentration of farms/MEs. The analysis reveals that there is a high concentration of poultry farms in sites deemed suitable and as containing potential, while there is a considerable concentration in unsuitable areas too. However, these farms/MEs might have limited productivity due to their unfavorable location, as the analysis shows that there is a limited portion of large poultry farms/MEs in these sites. After describing the definitions, methods of analysis and main findings in Sections 2–5, the present study makes recommendations in the concluding Section 6 to help vulnerable farmers to enjoy better access to facilities and support services; to reduce their production and

marketing costs and increase their profit. Thus, the farmers would be able to expand their business and create more employment opportunities for the poor, as long as proper initiatives are taken by the government and PKSF/NGOs. This would create a kind of homogeneous opportunity for all farmers in the district to achieve competitive advantage and thus, maintain the sustainable development of the poultry subsector.

Figure 1. The study site: Gazipur district, Bangladesh.



Source: GIS Section, BANGLAPEDIA, Asiatic Society of Bangladesh.

2. Definition of Microenterprise and Value Chain

There is no universally accepted definition of microenterprises. Generally, MEs are defined in terms of workers employed. Microenterprise refers to a small business or activity that is independently owned, operated with an investment of at least BDT (Bangladeshi Taka) 30,000, and which has potential for further expansion and employment creation. A microenterprise can be a processing or production-based activity, managed and operated by a progressive microcredit borrower who must be a member of a microcredit providing organization [3]. In Indonesia, most microenterprises are small and farm-based, employ 0–19 employees, make up about 99.8% of total enterprises, and contribute 43% of gross domestic product and 22% of total investment [4]. Microenterprises are considered the ‘upper tier informal sector’ as they make up the dynamic and productive segment of the informal sector [5]. Rooven, Stewart and Wet mention that microfinance services enable microentrepreneurs to build businesses and increase their income and improve the general economic well-being of the poor [6]. In microfinance, several groups are formed who attend weekly meetings at a place near their home.

Credit is provided for individuals within the group, usually for one year, and payments are made weekly [7]. In Bangladesh, microfinance lending is done mainly by NGOs throughout the country, thus creating employment opportunities for the unskilled poor who lack the necessary collateral to access loans from formal banking institutions. These NGOs, in turn, receive funding mainly from the PKSF, an apex funding agency established by the government. PKSF allocates and disburses funds, and provides support to NGOs in different areas of the country. In Bangladesh, collateral-free microfinance accounted for about 40% of the total reduction of poverty [8].

A value chain is defined as a supply chain made up of a series of actors—from input suppliers to producers and processors, to exporters and buyers—engaged in the full range of activities required to bring a particular product from conception to its end use [9]. Coe, Kelly and Yeung mention that geography or territoriality is an important dimension in all commodity chains [10]. According to these authors, territoriality reveals the unequal geographical distribution of value and associated economic development benefits between different nodes along the chain. Creation of value is essential to economic development, and uneven development is a reflection of a relative lack of physical or organizational resources used to create value by people, households or communities/microentrepreneurs.

3. Methodology

3.1. Questionnaire Survey

In Bangladesh, the term ‘poultry’ refers mainly to chicken and different production systems that are undertaken for chicken, such as commercial and backyard production. This research deals with the commercial chicken farm/ME and its value chain in the interest of identifying business-enabling, environment-related constraints, along with its various existing links. The author conducted a sample survey of 166 MEs between December 2010 and February 2011 to collect some basic information, followed by a sample survey using a structured questionnaire of 48 entrepreneur farmers from the 166 MEs to collect information on poultry production and the value chain. The questionnaire involved asking mainly about sources and distances of input materials and support services; the type and amount of support services; places to market the products; means of transport used for input materials and produced materials; the selling price of eggs and chicken; and the problems they face [11].

Furthermore, a case study was undertaken to gain an understanding of how poor villagers are involved in microcredit programs, how they graduate to become microentrepreneurs, and how they are linked to the value chain.

To cross-check the suitability and verification of sites, a survey of 28 farmers was conducted through structured questionnaires. These took place between July and September 2012 at sites with different suitability classes. Farmers were asked about the value they receive, their production size, the transportation costs for input materials, marketing of the production, *etc.* Farms/MEs were selected from unions with dominant areas of different suitability classes. Six farms/MEs were surveyed from highly suitable sites, eight farms from suitable sites, six farms from marginally suitable sites, and eight farms from unsuitable sites in Gazipur district.

3.2. Identification of Criteria for Poultry Farm MEs and Value Chain Development

In order to determine the potential sites for poultry farms/MEs, the most important criteria were identified on the basis of interviews with microentrepreneurs and livestock experts, and the literature review. The most important criteria identified are: (a) the factors, such as highways and roads, location of marketplaces, sources of support services, and landform and flooding; and (b) the constraints, like rivers and water bodies, and the location of forests [12]. The prerequisites for poultry business development include: accessible paved roads that allow for access by large delivery trucks; big marketplaces, at which farmers prefer to buy good quality feed, chicks and medicines; and access to support services from where farmers get credit, vaccines/medicine and training. Feed is a major input, accounting for about 70% of the cost of poultry production [13,14]. It was found that farmers in Gazipur buy feed almost every other day. Proximity to these basic infrastructures was considered in the analysis because, as Herath, Weersink and Carpentier have noted, production increases in regions where the distance to market is smaller due to lower transaction and transportation costs [15]. There are many rivers and water bodies in Bangladesh, and about 30–35 % of the land area of Bangladesh is flooded every year [16]. Accordingly, digital geo-referenced data of all factors and constraints were collected, compiled and analyzed using GIS.

3.3. Classification Procedure of Criteria

To identify suitability of sites for poultry farm MEs' development, each factor was classified into four and given a physical score from 1 to 4. The scoring levels (4 to 1) were 'highly suitable', 'suitable', 'marginally suitable' and 'unsuitable'. For each factor, ranges of data that pertain to a desired level of suitability were selected. Constraints were assigned a score of zero. In all the factor maps, the constraint image was incorporated to exclude areas from consideration. The questionnaire survey findings were used along with several documents related to poultry farming and papers on other agriculture activities, with some justified modifications in the selection of ranges of suitability of factors for poultry farm/ME development. For example, the Environment Protection Authority recommends a 1,000-meter buffer zone from an urban residential area and the national highway for the establishment of poultry farms [17]. In Gazipur, government offices/*upazila* headquarters are located mainly in urban areas [18], and big markets contain urban settlements and infrastructures, where the value of land is extremely high [19]. Therefore, in the classification of these two factors, a 1,000-meter distance was considered unsuitable. Salam, Khatun and Ali consider up to a 2,000-meter distance from the road to be suitable, and more than 4,000 meters as unsuitable [20]. Dealing with the most perishable products of fish farming, Hossain, *et. al.* consider a distance of more than 1,000 meters from the road to be unsuitable, a distance from the market of less than 2,000 meters to be suitable, and a distance of more than 4,000 meters from the source of inputs to be unsuitable [2]. Hence, the above guidelines are reflected with some modifications in the present classification.

Weighted linear combination was used to overlay factor map results and to derive the final suitability model. Weights assigned to the factors for the evaluation of sites for poultry MEs are based on a study by the author that revealed high/low flooding land as the most important factor. The highest weight of 0.442 was assigned to this factor and 0.357, 0.105 and 0.097 to proximity to road, proximity

to government office and proximity to market, respectively [12]. The weighting was derived on the basis of a pair-wise comparison matrix developed by Saaty, known as Analytical Hierarchy Process (AHP). Here, the importance of factors was compared based on the Saaty's ranking scale for criteria [21,22]. The final suitability model was reclassified into five classes, including constraint data, using the equal interval method with the qualitative descriptions of 'highly suitable', 'suitable', 'marginally suitable', 'unsuitable' and constraint areas for poultry MEs.

4. Findings and Results

4.1. Poultry Microenterprises and the Value Chain in Gazipur

The value chain for poultry consists of various actors including producers/farmers, transformers or suppliers of the production, and traders who commercialize (*i.e.*, connect the final product with the market). There remain several MEs involved in these different activities in the chain, but this paper describes the poultry production-oriented MEs in the value chain and examines their relationships with other actors in the chain. This is because, by strengthening one actor in a value chain, it is possible to create competitive advantages for the whole system, which can benefit many people competing in local, regional or global markets [9]. Figure 2 shows a meeting of a microfinance group that is usually held in front of a beneficiary's house and inside/outside view of a poultry farm microenterprise.

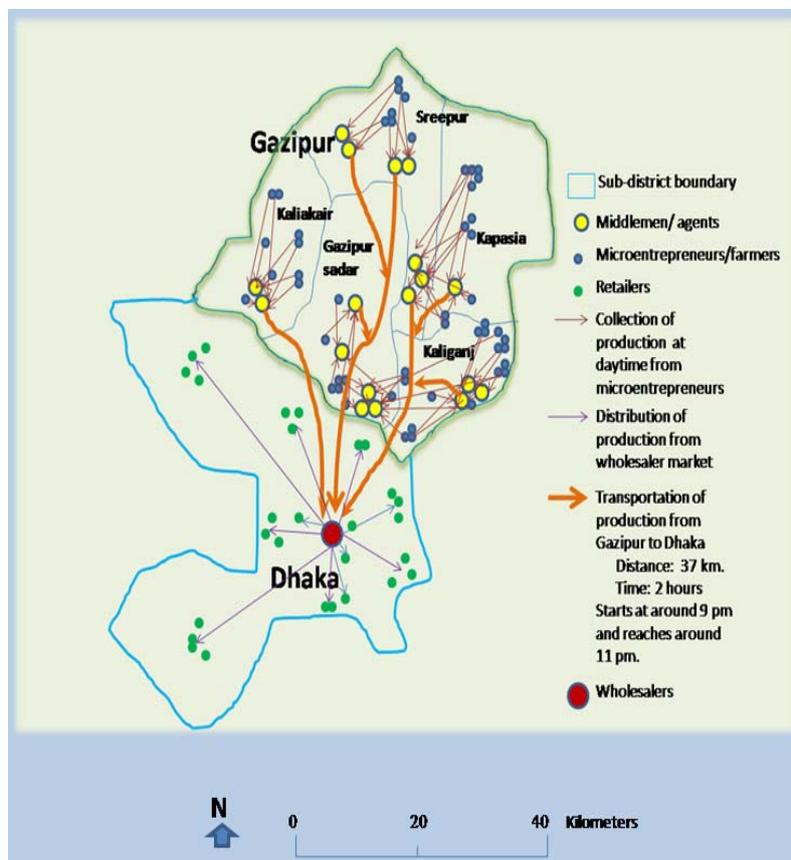
Figure 2. Microfinance group meeting and beneficiaries of microfinance and poultry farm microenterprise in Gazipur.



Questionnaire survey findings reveal that the microentrepreneurs sell eggs almost every day to the agents of wholesalers from Dhaka city, situated in Dhaka district, which is about 37 kilometers from Gazipur district. The agents of wholesalers from Dhaka collect the eggs and chickens from the farm gate, when their pickup vans can reach them, and take the eggs and chickens to Dhaka, the capital city of Bangladesh (Figure 3). However, in the case of some farms—those located far from the wide paved roads—the entrepreneurs themselves have to take the eggs to the pickup vans using small non-motorized rickshaw vans. Sometimes, the agents of wholesalers buy the eggs from middlemen in Gazipur district, who store eggs collected over several days from the doors of entrepreneurs. The microentrepreneurs are paid at the rate fixed by the society of egg and chicken wholesalers in Dhaka. The price fixed by the society sometimes differs from the price received by the entrepreneurs which is dependent on factors such as the proximity of the farm to easily accessible roads, the quantity of eggs in the farm, the size of the eggs, and whether the entrepreneur accepts advance payment from the egg wholesaler in Dhaka (he/she remains bound to sell eggs according to the verbal contract with the

agents). During the survey, only a few respondents reported that they sell the birds, by their own arrangements, to the nearest markets at growth centers in Gazipur [11].

Figure 3. Origin and destination of poultry value chain.



Source: Based on field survey by the first author.

Most of the entrepreneurs surveyed buy feed from rural markets located between about 0.5 km and 2.5 km from their farms because it is difficult and expensive for them to travel frequently to distant markets for quality feed with balanced nutrients. The survey reveals that about 18.7% of the farmers travel up to 4 km, and half of the farmers have to travel about 5–9 km to collect quality chicks, while 10.42% of the entrepreneurs go as far as 20–24 km.

Along with their own equity, the microentrepreneurs use a considerable amount borrowed as microenterprise loans. Out of 166 poultry MEs, 38 farms, which constitute about one-quarter of the farms, have invested up to BDT 200,000, while about half of the farmers have taken out an ME loan of up to BDT 50,000. More than half of the MEs have borrowed less than 20% of their total investment.

4.2. Case Study of a Progressive Microentrepreneur

‘Ariful Islam’ lives in Khilgaon Village of Pubail union in the Gazipur district. He lives along with his mother and sisters. Islam does not know his age but he is probably in his late 30s. After having only 10 years of schooling, he passed the public school certificate examination. Islam possesses two acres of land.

4.2.1. Membership of Microfinance Group and Loans from NGO

Islam is a member of microfinance group of 30, organized by a local NGO. Among these 30 members, 17 borrowed microenterprise (bigger) loans and only 13 were microcredit (smaller loan) borrowers. About five years back, Islam's mother was a microcredit borrower. In other words, she could borrow only a loan of a small amount ranging from BDT 5,000–30,000. His mother's five successive loans (microcredit), each of higher amounts than previous loans, were used in his poultry farm for purposes such as buying chicks, foods, medicines, and repairing poultry sheds. Investing his own money along with these small loans from the NGO, Islam was able to run his business smoothly and make enough profit to repay his mother's loan. His mother could repay the loan regularly in 46 equal installments over the course of a year, while also building her saving deposits, though in much smaller amounts than the loan repayment. Sometimes, they were able to repay the loans in a period much shorter than one year, a period set by the loan product of the NGO. Islam's mother's good track record of loan repayment and his business development and expansion possibility made her eligible for larger amounts through microenterprise loan products offered by the NGO to progressive microcredit borrowers or to their family members. Consequently, Islam could join as a member of the microenterprise loan group of the NGO. He borrowed BDT 0.1 million in the form of a collateral-free loan bearing much lower interest rates than those charged by other informal money lenders. The interest rate charged by the NGO is 12.5 percent. Borrowing and installment repayment procedures are much easier with the NGO than those maintained by formal banks, which are generally bureaucratic and cumbersome. Islam repays the loan installments at a weekly group meeting held at the house of a neighbor, who is also a member of the microfinance group. Hence, Islam does not need to go far from his home and farm. This helps him amortize the loan installments in accordance with the repayment scheme.

4.2.2. Investments and the Supply of Inputs and Outputs

Islam has a long experience of poultry farming. He has been farming chickens for about 11 years and has invested a total of around BDT 1.8 million in three sheds for his birds, each with a capacity for about 950 birds. He raises about 2900 layer hens. He used the borrowed money for additional capital in his farm. He has employed three paid labors in his farm to look after the birds, each of whom he pays BDT 5,000 per month. None of the employed laborers previously had training in poultry keeping. They received training from another NGO on poultry farming.

Islam sells about 5,400 eggs in every other day to poultry agents, who in turn take the eggs by rickshaw van to sell at the Tongi bazaar in Dhaka district, almost 15 kilometers away from his farm. As a gross income per month, Islam expects around BDT 0.45 million from egg sales. On a given day, Islam contacts the egg wholesalers' society at the capital city using his cell phone, enquiring about the price. The market information about the price of eggs on a particular day gives him significant inputs in deciding whether to sell the eggs at that point. If he calculates a loss or less profit, then he opts to sell on the next day or two days later. On average, he receives BDT 550 per 100 eggs (November 2010).

Islam buys poultry feed at a cost of BDT 1,200 per bag. He needs eight bags (400 kilograms) of feed daily from the local market, Mira bazaar, which is about two kilometers away from his farm. He

uses a rickshaw van to bring the feed from the market, paying the van driver BDT 10 per bag. He buys vaccines and medicines from the local rural market, and rarely goes to the local government livestock office for medicine or vaccines, as the quality is not always good and the journey is costly and time consuming. Sometimes, the quantity of the medicine/vaccine does not match the requirements supplied by the government office. He calls for a veterinary surgeon from the rural market for vaccination. He buys chicks every two years from big hatcheries, which are located at Gazipur Sadar, and rears the chicks in a separate chick rearing unit. In that unit, he rears chicks for about six months before they start laying eggs for a period of 18 months.

4.2.3. Business-Enabling Environment

In Islam's opinion, the most important factors in terms of the location of his farm are its location in relatively high land, free from regular flooding, and its location in an area where a very good communication system has been developed. His farm is not far from a paved road, to which his farm is connected through a very short village road. This enables the agents to transport the eggs easily by rickshaw van to their pick-up vans. For this, he receives a little less than the market rate. He has never faced any problems related to the marketing of his production, nor has he faced flooding.

4.3. Result of Suitability Analysis

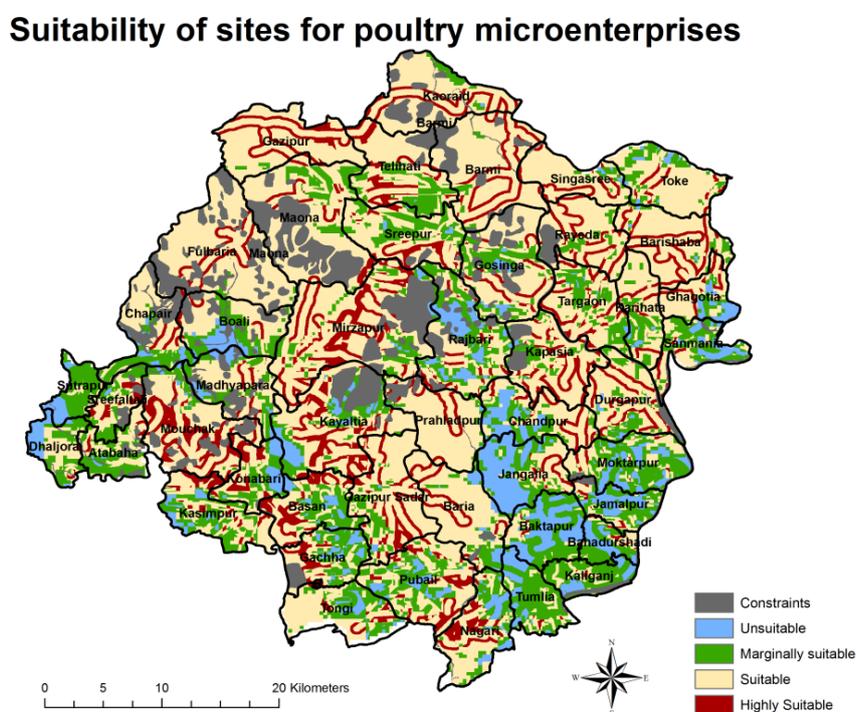
The GIS-based model, the final poultry ME suitability map, quantifies potential through the identification of suitable sites or sites that lack suitability. The results of this suitability analysis indicate that, in Gazipur district, a relatively small percentage of land is highly suitable (212 square kilometers, 11.8%) while a relatively large area is considered suitable (899 square kilometers, 49.9%). A considerable area is considered marginally suitable (356 square kilometers, 19.8%) or unsuitable (137 square kilometers, 7.6%) for poultry ME development. Constraints were identified in five sub-districts that occupy about 198 square kilometers, 11% of the total district area (Figure 4).

The unions, which are the ultimate tier of administration—namely Kaoraid, Telihati, Fulbaria, Shingasree, Rayeda, Mirzapur, Durgapur, Gazipur Sadar, Prahladpur, Barmi, Kapasia, Baria and Mouchak—have extensive areas that are classified as highly suitable/suitable for poultry MEs. More than 70% of the area of these unions falls into the highly suitable/suitable categories. Unsuitable/marginally suitable sites are distributed to a great extent in Sutrapur, Baktapur, Tumlia, Bahadurshadi, Kaligonj, Jangalia, Jamalpur, Moktapur, Dhaljora, and Sanmania, with more than half of the areas of these unions falling into these categories. These areas are located in the south-eastern part of Kaligonj and Kapasia sub-district and in the south-western part of Kaliakoir sub-district (Figure 4). Figure 5 classifies the relative areas by suitability for poultry microenterprise development in the different unions of Gazipur district.

For the purpose of verification, it is important to analyze areas where poultry farming is practiced in terms of suitability levels. In particular, for this study, it is crucial to verify whether the predictions of suitability correspond to the location of existing farms/MEs and to their number, level of production and profitability. The following section involves mainly an analysis of geographic concentration of farms/MEs along with their production to some extent in different suitability sites by using farm location data and intersecting the map with the poultry site suitability model. This identification would

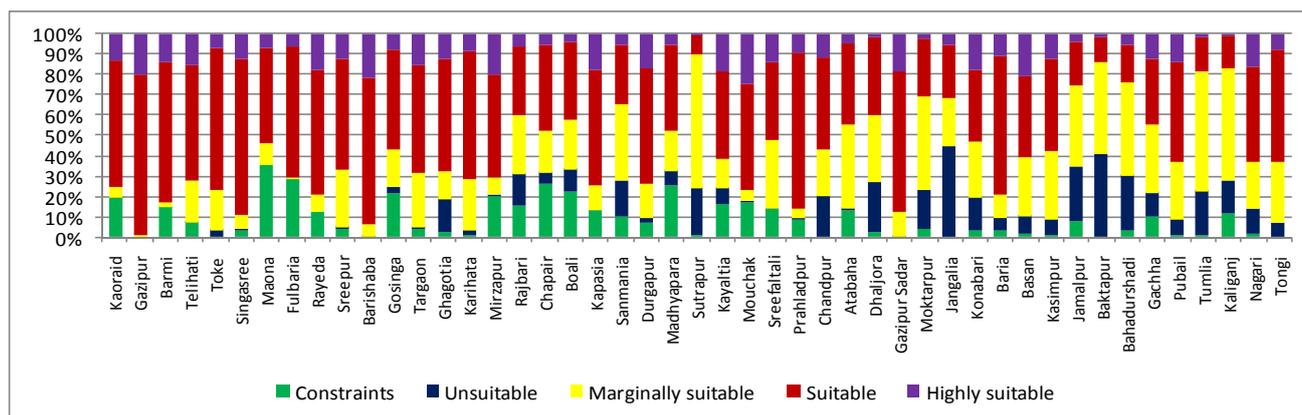
not only benefit the farmers/microentrepreneurs, but would also ensure the best use of the government and NGOs’ limited resources. In unfavorable locations, where there exist several farms/MEs in great need of interventions to improve their situation, any support would be cost-effective, as it would reduce the per capita expenditure for providing the support. It is thus necessary to discern the spatial distribution of farms/MEs in order to make assumptions about demands for the necessary funds and facilities support for their sustainability in different suitability sites. Several studies assign importance to the inclusion of basic information, such as the numbers, location and characteristics of poor livestock keepers in the spatial distribution of livestock maps. This would be of great value to development agencies in the design of interventions that minimize adverse impacts and positively affect the poor households in developing countries [23,24].

Figure 4. Map showing suitability of sites for poultry microenterprises in Gazipur.



Source: Khaleda and Murayama [12].

Figure 5. Relative area (in percentage) with suitability for poultry farm microenterprises by administrative unions in Gazipur.



5. Geographic Concentration of Poultry Farms/Microenterprises

Poultry may be considered the most common microenterprise, particularly among poor people in the rural areas of Gazipur. Many NGOs and development agencies promote poultry farming among the poor as a route out of poverty [25]. A survey conducted among successful microentrepreneurs, funded by PKSF through several NGOs throughout the country, reveals that more than one-fourth (27%) are engaged in the poultry and livestock sector [26]. Another field survey by PKSF on MEs shows that agro-based MEs have a high potential for future growth where the scope for bigger investment and employment is the highest among all kinds of MEs [3]. According to the Government of Bangladesh's Livestock Department, the total number of chickens is steadily increasing, from about 143 million birds in 2001 to 195 million birds in 2006 and 228 million birds in 2010. In the country, poultry egg production meets only about one-third of the total demand—5,742 million against the total demand of 15,184 million eggs. Similarly, all sources of meat production combined satisfies only about one-fifth of the total demand for meat—1.26 million metric tons against the total demand of 6.39 million metric tons. The Dhaka division accounted for more than 53% of commercial poultry, as the demand for and consumption of commercial poultry meat and eggs is high among the capital city dwellers in Dhaka (Table 1).

Table 1. Distribution of poultry by divisions of Bangladesh and districts of Dhaka division.

Administrative units	Number	Percentage
Administrative divisions		
Dhaka	11,634,021	53.3
Other 5 divisions	10,175,628	46.7
Total	21,809,649	100.0
Districts of Dhaka division		
Gazipur	2,783,235	23.9
Other 15 districts	8,850,786	76.1
Total	11,634,021	100.0

Source: Bangladesh Bureau of Statistics, June 2006 [27].

In the Dhaka division, out of a total of 16 districts, Gazipur district ranks first in commercial poultry production, producing almost 24% [27]. The data demonstrates that the highest amount of agricultural land is used for poultry production in Gazipur district, compared with the proportion of land used for the same purpose in other districts of the country.

Gazipur district consists of five sub-districts/*upazilas* and each sub-district consists of a number of unions. These unions—the fourth/ultimate tier of administrative jurisdiction after sub-district, district and division—are considered as spatial units in the analysis for the purpose of identifying the geographic concentration of poultry farms/MEs. The analysis of geo-referenced data of poultry farms/microenterprises in Gazipur district, collected from the Department of Livestock Services (DLS), reveals a further concentration within as twelve of the forty-seven unions account for 48.2% of the total 5,149 poultry farms/MEs, and 51% of produce (birds) linked to value chains sourced predominantly from suitable sites in those unions. In these unions, there are extensive areas identified as suitable for poultry farming and very little or no area defined as unsuitable. Among these twelve

unions, five, namely Kapasia, Durgapur and Chandpur in the east and Kaoraid and Barmi in the north, have an extremely high concentration (4.0–5.0 %) that accounts for about 25% of poultry farms/MEs and 20% of poultry produce in the district. An extremely high (4.0–5.0 %) to high concentration (3.0–3.9%) of poultry farms extends mainly towards the north-west from the east, including five more unions, namely Rajbari, Mirzapur, Kayaltia, Maona and Fulbaria, and the remaining two, namely Mouchak and Pubail in the south (Figure 6a). Kapasia, Kaoraid, Durgapur, Barmi, Mirzapur, Fulbaria and Mouchak have more than 70% of their area identified as highly suitable/suitable, while Kayaltia, Maona, Chandpur, Rajbari and Pubail have 60%, 50%, 56%, 40% and 62% of their area identified as highly suitable/suitable respectively. Of these unions, Kapasia has the highest concentration of poultry farms, accounting for 260 farms, followed by Kaoraid (257), Durgapur (249), Chandpur (223), Barmi (215) and Mirzapur (212). In comparison, there are very low concentrations (0–0.9 %) to low concentrations (1.0–1.9 %) of poultry farms in the unions where there is a large area demarcated as unsuitable and marginally suitable for poultry farms; notable among them are Baktarpur, Jamalpur, Tumlia, Jangalia, Kaliganj, Dhaljora, Sanmania, Sreefal tali, Karihata, Sutrapur and Bahadursadi. Figure 6 shows the geographic concentration of poultry farms/MEs and produce in the different unions of Gazipur. Figure 7 shows the numerical distribution, by union, of poultry farms/MEs linked to value chains in Gazipur.

In Sreepur sub-district, the northern part of the district, an extremely high/high concentration of farms/MEs appears where the union Kaoraid houses 5% of poultry farms/MEs. In Kaoraid, the average size of farms/MEs is large (Figure 6b) and the union lies in the highest range with regard to the percentage of poultry production and birds per square kilometer (Figure 6c and d).

In the eastern part of Gazipur, Kapasia sub-district, poultry farms are extremely highly concentrated in Kapasia, Chandpur and Durgapur, where the land area is mainly highly suitable/suitable. In Sanmania, 25% of whose area is unsuitable/marginally suitable, there are 36 farms, which is only 0.7% of total farms in the district.

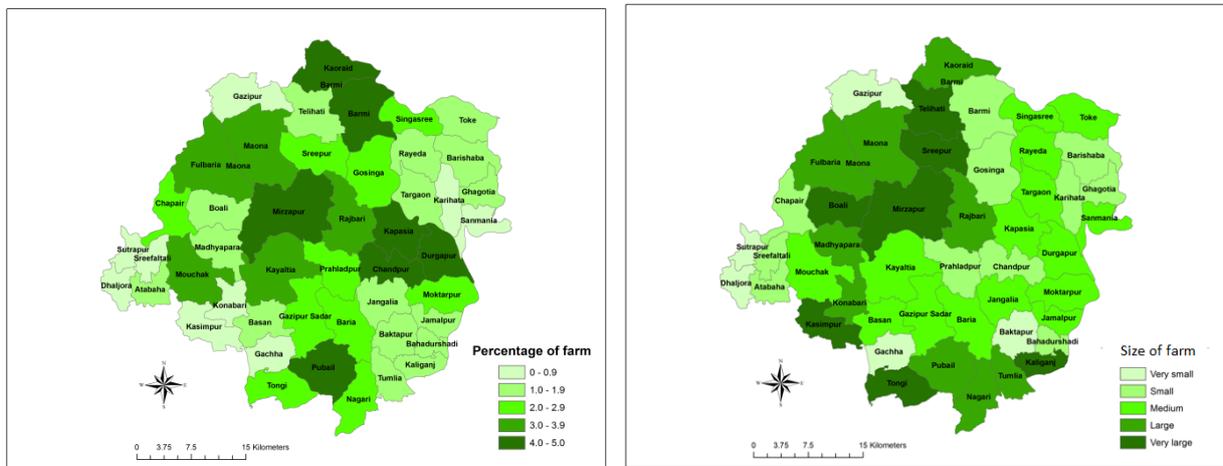
Contrary to the strong concentration of farms in the northern sub-district, which contains a vast suitable/highly suitable area for poultry farms, there is a very limited concentration of poultry farms in the south-eastern sub-district of Kaliganj, which has a large number of marginally suitable/unsuitable areas. No union was found to have an extremely high/high concentration of farms in this region. Among the top eight unions in Gazipur considered to have the largest area identified as marginally suitable/unsuitable, seven unions are located in this south-eastern part of the district: Baktarpur (78 farms, 1.5%), Jangalia (85 farms, 1.7%), Tumlia (81 farms, 1.6%), Kaliganj (97 farms, 1.9%), Moktarpur (109 farms, 2.1%), Jamalpur (79 farms, 1.5%) and Bahadurshadi (57 farms, 1.1%). All these unions, except Moktarpur, have a low concentration (1.0–1.9%) of poultry farms/MEs. Moktarpur, by contrast, lies in the range of medium concentration (2.0–2.9%). In these unions, the average size of farms/MEs is very small to medium (Figure 6b), except in Kaliganj and Tumlia. Most of these unions also lie in the lower ranges with regard to the percentage of poultry production and birds per square kilometer (shown in Figure 6c and 6d).

In the western part of the district—Kaliakoir sub-district, a high concentration of poultry farms was found in Fulbaria (188 farms, 3.7%) and Mouchak (162 farms, 3.1%), where the land area is mainly highly suitable. A very low concentration of farms is found particularly in Sutrapur (47 farms, 0.9%), Dhaljora (29 farms, 0.6%) and in Srefaltali (40 farms, 0.8%), a large section of which lies in

marginally suitable/unsuitable sites. Sutrapur has the highest percentage (89%) of area considered as marginally suitable/unsuitable sites among unions of the district.

In the central sub-district of Gazipur Sadar, there is an extremely high concentration of poultry farms in Mirzapur (212 farms, 4.1%) and in Pubail (204 farms, 4%), and a high concentration in Kayaltia (154 farms, 3%). These unions have access to a range of facilities due to the proximity of government livestock offices, national highways, growth centers/markets and land free from regular flooding, and thus, have an extensive area evaluated as suitable/highly suitable for poultry farming.

Figure 6. Geographic concentration of poultry farms/microenterprises by administrative unions in Gazipur.

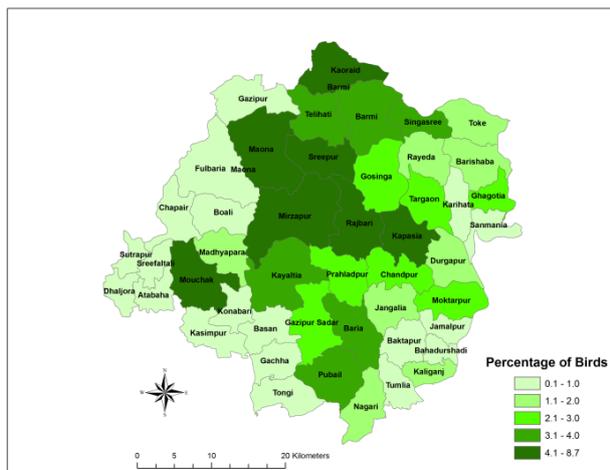


Very low concentration = 0–0.9 %
 Low concentration = 1.0–1.9%
 Medium concentration = 2.0–2.9%
 High concentration = 3.0–3.9%
 Extremely high concentration = 4.0–5.0%

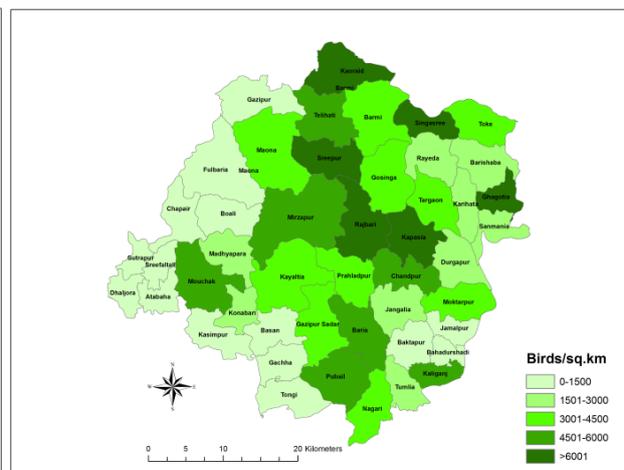
Very small = Less than 1,000 birds per farm
 Small = 1,001–1,500 birds per farm
 Medium = 1,501–2,000 birds per farm
 Large = 2,001–2,500 birds per farm
 Very large = More than 2,500 birds per farm

a) Percentage of farms/microenterprises

b) Average size of farms/microenterprises

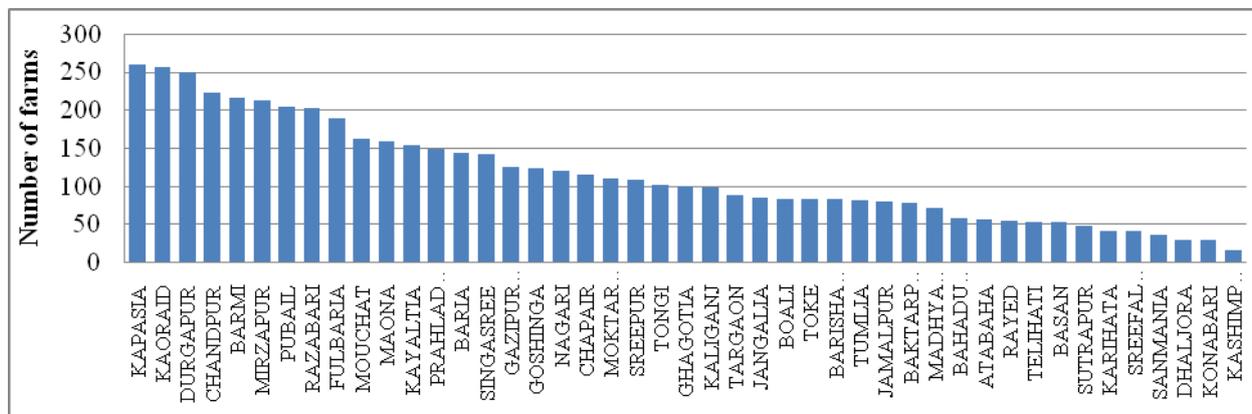


(c) Poultry production/percentage of birds



(d) Poultry birds per sq.km

Figure 7. Rankings of administrative unions by the numbers of poultry farms/microenterprises in Gazipur.



Source: Own calculation based on data collected from DLS, Bangladesh.

The location of the poultry farms/MEs and their production appears to be influenced by the spatial distribution of suitable/unsuitable sites. Table 2 demonstrates that a comparatively low percentage of farms/MEs are linked to value chains from unsuitable/marginally suitable sites. The percentage of production sourced from farms in unsuitable areas is also low, as both the number and percentage of large farms producing more than 2,000 birds are lower in unsuitable areas. This would be evident from Table 3 which shows a clear difference in the number of farms and number of farms with higher production capability between different sites with predominance of different suitability levels. Table 3 reveals that the first three unions (Mirzapur, Pubail and Gazipur Sadar), with a majority of suitable areas, contain a comparatively higher number of farms per square kilometer and a higher number of large farms, while the last three unions (Sutrapur, Dhaljora and Jangalia), with a low proportion of suitable area, contain a comparatively lower number of farms per square kilometer and a lower number of large farms. In Gazipur district, farm size varies from 100–150,000 birds per farm, while the average farm size is 2,000 birds per farm. Okwi, *et. al.* found high poverty rates in environmentally fragile regions of Uganda [28]. These authors also found a link between poverty with agriculture potential, the availability of resources and a lack of market access [29]. They mention that access to roads and markets favors the production of high-value products and contributes to incomes.

Table 2. Number of poultry farms in sites with different levels of suitability in Gazipur.

	Highly suitable	Suitable	Marginally suitable	Unsuitable	Total
Area (Sq. km)	212	899	356	137	1604
Percentage	13.2	56.1	22.2	8.5	100.0
Number of farms	655	2809	921	451	4836
Percentage	13.5	58.1	19.1	9.3	100.0
Number of large farms	95	326	103	31	555
Percentage	17.1	58.7	18.6	5.6	100.0

Note: A comparison between the size of area with poultry production, sites with different levels of suitability and poultry farms in those sites are considered, constraint areas excluded. Due to an inaccuracy/error in digital data, 4836 farms are considered in the GIS analysis.

Table 3. Number of poultry farms in some unions according to predominant suitability sites.

Name of Items union		Highly suitable	Suitable	Marginally suitable	Unsuitable	Total
Mirzapur	Area in sq km	19.3	49.6	9	1.1	79
	No. of farms (farms/sq km)	58 (3)	143 (2.9)	10 (1.1)	0	211 (2.7)
	No. of large farms (%)	21 (36.2)	31 (21.7)	3 (30)	0	55 (26.1)
Pubail	Area in sq km	6.7	23.8	13.9	4	48.4
	No. of farms (farms/sq km)	17 (2.5)	89 (3.7)	66 (4.7)	32 (8)	204 (4.2)
	No. of large farms (%)	3 (17.6)	17 (19.1)	12 (18.2)	2 (6.3)	34 (16.7)
Gazipur	Area in sq km	8.6	32.8	5.8	0.3	47.5
Sadar	No. of farms (farms/sq km)	31 (3.6)	89 (2.7)	10 (1.7)	0	130 (2.7)
	No. of large farms (%)	8 (25.8)	19 (21.3)	0	0	27 (20.8)
Sutrapur	Area in sq km	0.02	1.4	9.2	3.4	14.02
	No. of farms (farms/sq km)	0	1 (0.7)	38 (4.1)	6 (1.8)	45 (3.2)
	No. of large farms (%)	0	0	0	0	0
Jangalia	Area in sq km	2	9.3	8.9	16.4	36.6
	No. of farms (farms/sq km)	2 (1)	10 (1.1)	26 (2.9)	46 (2.8)	84 (2.3)
	No. of large farms (%)	0	0	7 (26.9)	7 (15.2)	14 (16.7)
Dhaljora	Area in sq km	0.3	7.2	6.3	4.8	18.6
	No. of farms (farms/sq km)	1 (3.3)	13 (1.8)	3 (0.5)	14 (2.9)	31 (1.7)
	No. of large farms (%)	0	0	0	0	0

The field survey on 28 farmers, used as another means of verifying the suitability of sites, reveals that production characteristics and environment/factors differentiate between farmers at highly suitable and unsuitable sites. These factors include farm size (production and area), land improvement efforts, the value of production, the supply and transport cost of input materials, and distance to roads/markets/government offices. The evaluation shows that farms in highly suitable sites are rated highly suitable with regard to all factors. That is, with the exception of access to chick markets, which are located an average of 11.7 km from the farms (Table 4). This is because farmers usually prefer to travel far to procure good-quality chicks, even choosing to avoid the nearest small markets on occasion. Farms/MEs in suitable and marginally suitable sites are in sites with different suitability scores with regard to different factors. Farms in unsuitable sites are found in sites rated unsuitable with regard to all factors.

During the field survey, a great disparity was observed in geographic features among four different suitability sites. In the unsuitable site, farms/MEs were found in low-lying land, which is flooded very frequently. The farmhouses were found to be constructed on high ground or on elevated land. Farmers' houses were made from bamboo. The site is located very near to an estuary of the Turag River, within about 10 feet. The farmers in this site were found to use boats in addition to road transports to carry poultry input materials. This site is in a relatively sparsely populated, typical rural area, in a remote corner of the urban developed area. There were no well-paved roads or big markets. In the marginally suitable site, farms/MEs were found on low-lying land, which is flooded almost every year. The farms in the site were found in locations with surrounding green agricultural fields. Very few concrete structures were found in the area. In the suitable and highly suitable sites, farms/MEs were found in a relatively flood-free highland area, which is not flooded. Some of these farmhouses are tin-roofed with

brick walls. The sites are dense in comparison to the marginally suitable/unsuitable sites. Many urban concrete structures—private brick-built houses, mosques, schools *etc.*—were found in both of these sites, especially in the highly suitable site.

Table 4. Environment and characteristics and price of poultry production in different suitability sites.

	Highly suitable	Suitable	Marginally suitable	Unsuitable
Average size of farm (sq feet)	4150	3072	3235	1250
Average number of birds	2708	2025	2003	1135
Average number of employment	3.8	1.8	3.0	1.5
Average distance to market as a source of chick (km)	11.7	10	14	36.3
Average distance to market as a source of feed (km)	1.1	1.5	1.5	2.6
Average distance to paved roads from farm (km)	0.3	0.7	1.0	3.6
Average distance to government livestock office (km)	1.0	2.5	7.0	11.3
Level of flooding (cm deep) during severe floods	0	0	135	211
Average selling price of production (BDT/eggs)	8.9	8.8	8.7	8.5
Average transport cost for feed (BDT/bag of 10 kilograms of feeds)	10	10	15	16.3
Mode of transport used for carrying feed	Rickshaw van	Rickshaw van	Rickshaw van	Rickshaw van/boat

Source: Field survey by the first author done between July and September 2012. Note: Bangladesh Taka (BDT) 83 = US dollar 1.

It was found in the field survey that the price of an egg in the highly suitable site was BDT 8.9 on average, while farmers at unsuitable sites received BDT 8.5 for an egg. In comparison, the retail price/price of an egg at consumer level at Dhaka was BDT 9 to BDT 9.5, according to the TCB (Trading Corporation of Bangladesh). The range of egg prices in different suitability sites demonstrates that the profitability of producers at highly suitable sites is high compared to that of farmers at unsuitable sites. Moreover, it was found that production size and transport cost for feed differ from highly suitable sites to unsuitable sites. This is also related to profitability. Table 4 evidences the relationship between production characteristics and the price of production at sites with different levels of suitability.

6. Discussions and Concluding Remarks

The analysis of the geographic distribution of poultry farms/MEs reveals that 71.6% of poultry farms are located in 69.3% (of total land possible for farming) highly suitable/suitable sites. This demonstrates potential for the development of a poultry subsector in Gazipur, if they utilize the facilities for optimum profit earnings. The analysis also reveals that there are a considerable number of poultry farms/MEs linked to value chains located in unsuitable or marginally suitable areas (30.7% of total land possible for poultry farming), which makes about 28.4% of total farms. These farms need special support to be competitive. The profitability in commercial poultry production depends not only

on efficient production, but also on successful marketing of the product. Production techniques include proper design of poultry houses, and arranging for quality inputs like chicks and feed to ensure high efficiency and productivity [30]. NGOs should intervene in financing the farms, big as well as small. Fulfilling their loan demand and offering loans will help them become larger and create employment.

Several studies reveal that feed costs incur more than 70% of the total cost of poultry production. Therefore, successful poultry production depends largely on the availability of quality feed at a reasonable price, and any endeavor to reduce the cost in feeding would greatly reflect on profitability in poultry businesses. In Gazipur, there are varieties of poultry feeds with different qualities and prices, produced by different feed companies, which are sold by dealers/agents mainly in big market places. Moreover, there are significant differences in transportation costs among different suitability sites. The survey reveals that the farmers usually use rickshaw vans to transport feed from the market to the farm gate, while farmers in unsuitable sites were found to use boats occasionally, which incurs a higher cost. Any arrangement to increase the availability of good-quality feed at a reduced cost would greatly contribute to the overall reduction of production costs and thus, increase profitability. As a solution to this problem, a project that could be undertaken is proposed here. NGOs, which organize microfinance group weekly meetings, can implement the project with the financial help of PKSF. The NGOs have the opportunity to assess the farmers'/microentrepreneurs' need for feed for a certain period of time. Under the project, NGOs would make loan agreements with local dealers/agents at a lower interest rate than the commercial rate. Under this agreement, the dealers/agents would supply good-quality feed regularly, at a reduced price, up to the farm-gate of the microentrepreneurs. This project needs to be implemented particularly in unsuitable/marginally suitable areas for the sustainability of vulnerable farmers. The supply of quality feed would ensure high productivity at reduced cost and thus, lead to higher profitability.

The microentrepreneurs in unfavorable areas need special financial support to construct poultry houses on high ground, as this type of construction involves extra costs, and the local government and NGOs should intervene by constructing quality roads in those areas. This is because the existence of adequate infrastructure is considered very important when providing microfinance. Even the construction of improved roads, or the provision of matching grants for village-determined investments, is considered more cost-effective than providing financial services for the poor to increase their earnings capacity, particularly in areas where infrastructure is underdeveloped [7,31]. The following is an illustration of the cost of preparing a typical 1,250 square feet piece of land and poultry farm structure. The cost also reflects the in addition of a one kilometer road in different levels of suitability sites, especially with regard to the flooding factor, in order to compare costs between sites and help intervention. The construction cost of a wire-netted poultry shed structure with C.I. sheet roofing on a metal truss, supported on brick pillars and walls, including the cost of the foundations, is BDT 850 per square foot. The total cost of constructing a 1,250 square feet poultry farm structure is around BDT 1.06 million in sites with different suitability levels. The cost of preparing land by filling it with sand, for the above-mentioned shed structure, is BDT 24 per cubic foot and becomes around BDT 30,000, BDT 99,000, BDT 207,000 and BDT 375,000 for highly suitable, suitable, marginally suitable and unsuitable sites. The four different levels of flooding here are: less than 30 centimetres; 30 to 90 centimetres; 90–180 centimetres; and 180–300 centimetres.

The preparation of one kilometre of bituminous carpeting road with a 10-foot top width based by sand filling would cost BDT 24 per cubic foot. The total cost of producing a one-kilometre road above flood level in this example amounts to BDT 0.86 million, BDT 3.07 million, BDT 7.55 million and BDT 15.74 million for highly suitable, suitable, marginally suitable and unsuitable sites, respectively. However, the preparation of a more durable 38mm-thick bituminous carpeting road over a 150 metre sand surface with 75mm-thick end edging would cost more, approximately BDT 180 per square foot. In this instance, the total cost of producing a one-kilometre road above flood level amounts to an additional BDT 5.9 million in different suitability sites [32].

With government collaboration, NGOs working in these unsuitable areas should initiate a special program such as arranging for camps to provide veterinary support to the farmers' doorsteps, and inviting government livestock personnel, especially in regions where there is no government livestock office or where it is far away enough from the farms to be considered unsuitable.

The government, its apex funding body (PKSF) and other donor agencies should keep a special/additional allocation of funds to disburse to NGOs working in unsuitable areas with a higher concentration of farms. These additional funds should be directed towards the provision of collateral free microenterprise loan and other support services to the microentrepreneurs and towards infrastructural development activities. This analysis should allow the government, the apex funding body (PKSF) and other donor agencies to select and decide areas/unions in which to provide more support—financial/technical/infrastructural—instead of following homogeneity in their assistance efforts. The results do suggest the effective utilization of the country's limited resources, which is positive for the development of poultry MEs and the ensuing development of the whole subsector in Bangladesh.

Understanding the geographic concentration of poultry farm MEs in different suitability sites can effectively guide the supporter's efforts to reduce the poverty of farmers by adopting more location-specific policy options. Though this study was undertaken in Gazipur, the methodology employed here would be useful and applicable for other poultry production areas in Bangladesh. The effective policy for poultry industrial development should be conducted based upon scientific discussion and spatial thinking.

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Conflict of Interests

The authors declare no conflict of interest.

References

1. Jose Aguilar-Manjarrez, and Shree S. Nath. *A Strategic Reassessment of Fish Farming Potential in Africa*. Rome: Food and Agriculture Organization, 1998.
2. M. Shahadat Hossain, Sayedur R. Chowdhury, Nani G. Das, S. M. Sharifuzzaman, and Abida Sultana. "Integration of GIS and Multicriteria Decision Analysis for Urban Aquaculture Development in Bangladesh." *Landscape and Urban Planning* 90 (2009): 119–33.
3. Syeda Khaleda. "Microenterprise and Entrepreneurship Development through Microfinance: The Key to Entering an SME and Getting out of Poverty." *Regional Development Studies* 11 (2007): 55–69.
4. Aloysius G. Brata. "Spatial Concentration of the Informal Small and Cottage Industry in Indonesia." *MPRA-Munich Personal RePEc Archive*, 2007, Paper No. 12622.
5. Niels-Higo Blunch, Sudharshan Chanagarajah, and Dhushyanth Raju. "The Informal Sector Revisited: A Synthesis Across Space and Time." Social Protection Unit, Human Development Network, World Bank, 2001, Social Protection Discussion Paper Series No. 0119.
6. C. van Rooyen, R. Stewart, and T. de Wet. "The Impact of Microfinance in Sub-Saharan Africa: A Systematic Review of the Evidence." *World Development* 40 (2012): 2249–62.
7. Joanna Ledgerwood. *Microfinance Handbook: An Institutional and Financial Perspective*. Washington: World Bank, 2000.
8. Shahidur R. Khandker. "Microfinance and Poverty: Evidence using Panel Data from Bangladesh." *World Bank Economic Review* 19 (2005): 263–86.
9. DIBD. "Value Chains." Danida Discussion Paper, Danish Industry International Business Development (DIBD), Confederation of Danish Industry (DI), Denmark, 2009.
10. Neil M. Coe, Philip F. Kelly, and Henry W.C. Yeung. *Economic Geography: A Contemporary Introduction*. Oxford: Blackwell Publishing Ltd, 2007.
11. Syeda Khaleda. "The Poultry Value Chain and Sustainable Development of Poultry Microenterprises that Utilize Homestead Lands: A Case Study in Gazipur, Bangladesh." *Land Use Policy* 30 (2013): 642–51.
12. Syeda Khaleda, and Yuji Murayama. "Identification of Suitability of Sites for Microenterprises Using the MCE Method and GIS for Value Chain Development: A Study in Gazipur District, Bangladesh." *Growth and Change* 2013, in press.
13. Velmurugu Ravindran. "Poultry Feed Availability and Nutrition in Developing Countries: Main Ingredients Used in Poultry Feed Formulations." *Poultry Development Review*. Food and Agriculture Organization of the United Nations, 2010.
14. D. Sapkota. "Quality Chicks and Feeds Basic Requirement of Maximum Egg and Meat Production." Proceedings of the 2nd International Poultry Show and Seminar held on 16–17 February 2001. World's Poultry Science Association, Dhaka, Bangladesh, 95–98.
15. Deepananda Herath, Alfons Weersink, and Chantal L. Carpentier. "Spatial Dynamics of the Livestock Sector in the United States: Do Environmental Regulations Matter?" *Journal of Agricultural and Resource Economics* 30 (2005): 45–68.
16. J.D. Milliman, J.M. Broadus, and G. Frank. "Environmental and Economic Impact of Rising Sea Level and Subsiding Deltas: The Nile and Bengal Examples." *Bangladesh Quest* 1 (1989): 11–12.

17. Environment Protection Authority. *Guidelines for the Establishment and Operation of Poultry Farms in South Australia*. Adelaide: Environment Protection Authority, 1998.
18. Bangladesh Bureau of Statistics. *Community Series: Gazipur Zila at a Glance*. Bangladesh Bureau of Statistics, Government of Bangladesh, 2001.
19. A.Z. Khan, and M.S. Akther. "The Role of the Growth Centers in the Rural Economy of Bangladesh." In *Village Infrastructure to Cope with the Environment*. Proceedings of the Housing and Hazards International Conference held on 24–26 November 2000, Dhaka, Bangladesh. Edited by S.M. Seraj, R.L.P. Hodgson and K.I. Ahmed. University of Exeter, United Kingdom, Housing and Hazards Group, Bangladesh University of Engineering and Technology. <http://salekseraj.com/TP8.pdf>.
20. M.A. Salam, N.A. Khatun, and M.M. Ali. "Carp Farming Potential in Barhatta Upazilla, Bangladesh: A GIS Methodological Perspective." *Aquaculture* 245 (2004): 75–87.
21. Thomas L. Saaty. "A scaling method for priorities in hierarchical structures." *Journal of Mathematics Physiology* 15 (1977): 234–81.
22. Thomas L. Saaty. *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. Pittsburgh: RWS Publications, 1990.
23. R.L. Kruska, R.S. Reid, P.K. Thornton, N. Henninger, and P.M. Kristjanson. "Mapping Livestock-oriented Agricultural Production Systems for the Developing World." *Agricultural Systems* 77 (2003): 39–63.
24. P.K. Thornton, R.L. Kruska, N. Henninger, P.M. Kristjanson, R.S. Reid, F. Atieno, A. Odero, and T. Ndegwa. *Mapping Poverty and Livestock in the Developing World*. Nairobi, Kenya: ILRI (International Livestock Research Institute), 2002.
25. Anni McLeod. "Social Impacts of Structural Change in the Poultry Sector." In *Poultry in the 21st Century—Avian Influenza and Beyond*, Proceedings of International Poultry Conference held on 5–7 November 2007, Bangkok, Thailand. Food and Agriculture Organization of the United Nations, 2007.
26. Palli Karma-Sahayak Foundation. *PKSF er Khudro Uddog Rin Karjokromer Agragati Shomhabona o Challenge (Development Potential and Challenge of the Microenterprise Loan Program of PKSF)*. Dhaka: Palli Karma-Sahayak Foundation (PKSF), 2005.
27. F. Dolberg. "Bangladesh Bureau of Statistics, June 2006." In *Bangladesh Poultry Sector Country Review*. Rome, Italy: Frands Dolberg. Food and Agriculture Organization, Animal Production and Health Division, 2008, 172.
28. Paul O. Okwi, H. Hoogeveen, T. Emwanu, V. Linderhof, and J. Beguman. "Welfare and Environment in Rural Uganda: Results from a Small-Area Estimation Approach." PREM Working Paper 05–04, 2005. <http://www.prem-online.org/index.php?p=publications&a=show&id=51>. In *Geographic Determinants of Poverty in Rural Kenya: A National and Provincial Analysis*. A report for the Rockefeller Foundation. Prepared by Paul O. Okwi, Godfrey Ndeng'e, Patti Kristjanson, Mike Arunga, An Notenbaert, Abisalom Omolo, Norbert Henninger, Todd Benson, Patrick Kariuki, and John Owuor. Nairobi: Rockefeller Foundation, 2006.
29. Paul O. Okwi, Godfrey Ndeng'e, Patti Kristjanson, Mike Arunga, An Notenbaert, Abisalom Omolo, Norbert Henninger, Todd Benson, Patrick Kariuki, and John Owuor. *Geographic Determinants of Poverty in Rural Kenya: A National and Provincial Analysis*. A report prepared

for the Rockefeller Foundation. Nairobi: Central Bureau of Statistics (CBS) in collaboration with International Livestock Research Institute (ILRI), 2006.

30. R. Prabakaran. "Good Practices in Planning and Management of Integrated Commercial Poultry Production in South Asia." Animal Production and Health Paper 159. Rome: Food and Agriculture Organization, 2003.
31. J. Yaron, P. McDonald, Jr. Benjamin, and Gerda L.Piprek. "Rural Finance: Issues, Design, and Best Practices." Environmentally and Socially Sustainable Development Studies and Monographs Series 14. Washington D.C.: World Bank, 1997. In *Microfinance Handbook: an Institutional and Financial Perspective*. By Joanna Ledgerwood. Washington: World Bank, 2000.
32. Public Works Department (PWD). "Schedules of Rates." Government of Bangladesh, 2011.

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