FINAL TECHNICAL REPORT

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Improvements in the Production of Livestock Products in Peri-Urban Areas of Cities in Asia

Period: 1 April 1996 to 30 September 1999

Renewable Natural Resources Knowledge Strategy: Livestock Production Programme

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Executive Summary

The purposes of this project are:

1   To compare and contrast the efficiency, organisation, infrastructure and constraints of selected rural, peri-urban and urban livestock production and marketing systems in Bangladesh.

2   To characterise and stratify selected peri-urban livestock production and marketing systems in terms of:

  a) the outputs, supply, demand and quality of livestock products

  b) the availability of services and infrastructure for livestock production, processing and marketing

  c) the causes and extent of product losses.

3   If possible, to develop a computer model to analyse options for the provision of services and infrastructure necessary to increase the productivity and marketing of livestock products in peri-urban systems.

4   To identify opportunities for further technical inputs which would lead to improvements in the productivity of the peri-urban based livestock production system.

Pabna, Mymensingh and Sylhet were selected as the study areas in 1996/7. The choice was based primarily on the socio-economic and topographic conditions of the three district towns. Within each town, urban, peri-urban and rural areas were defined using nineteen criteria available from the 1991 census data for sample mauzas (smallest administrative units) using Cluster Analysis (CA) and Principal Component Analysis (PCA). Primary data from those mauzas were collected to complement and test the accuracy of the secondary data. The analyses were used to define the urban, peri-urban or rural status of all mauzas in the three towns, for which a list is available.

Selected peri-urban livestock production and marketing systems were characterised in the three towns. Data on the inputs, outputs, supply and demand; services availability, processing and marketing; causes and extent of product losses were collected through the administration of 1600 questionnaires which featured over 60 questions. Results from the production questionnaires were expressed in quantified terms of variation from the peri-urban standard eg more farmers (5-32%)borrowed funds from the bank for farming in rural areas and less in urban areas (0%) than in peri-urban areas (4-7%). This is followed by a written description of the production systems. Marketing systems are shown as flow diagrams for the main livestock products in each town to which prices and product volumes were attached. A full description of the system is available in draft as a chapter for the PhD study associated with marketing.

Case-studies of specific production and marketing systems in two towns and surrounding areas were conducted. This was carried out as a series of 12 studies in each town, based on farms in a total of eight peri-urban mauzas of Mymensingh and Sylhet. Inputs to the farms, farming activity, livestock products from the farms and

the destiny, price, volume, quality and losses of the products in the marketing system (to the urban markets of Mymensingh and Sylhet) were monitored on a weekly basis using an *aide memoire*/open questionnaire and farming activity maps. Data from the case-studies were entered onto a computer database and will be written as a description of the farming and marketing systems by research students for their PhD studies. A diary was kept to monitor external influences on farming activity and during marketing of the products. These databases are available on the CD-ROM which accompanies this report.

The researchers brought the databases to UK in July 1999, where they were trained in computer modelling techniques. Three sample computer models were developed in skeleton form, one to show the effects of a poultry vaccination programme on farmer incomes, another to demonstrate the effects of inter-cropping legumes with rice on fodder and milk production and a third to simulate predictable changes in the price of chicken through demand. Models like these could be of use to policymakers in government and non-governmental organisations (NGOs) as they are intended to assist with the prediction of policy interventions. The models developed in by the researchers are examples of what may be achieved with the data collected during the study and are available on the accompanying CD-ROM.

Recommendations

This project has met all of its main objectives in delivering a number of computer models which demonstrate the potential to assist policymakers to test novel policies associated with improved supply of animal proteins to urban markets from peri-urban sources. The main exceptions are that the researcher's PhD theses have yet to be written and submitted to the Bangladesh Agricultural University (BAU) and no scientific papers have been produced. These are important omissions. **It is recommended**, therefore, that the researchers are encouraged by the BAU professors, the researcher's managers, NRI staff and DFID advisers to complete their theses, write their papers and start explaining the usefulness of the study outputs to their employers and other policymakers within Bangladesh. They should undertake this through workshops and individual meetings followed by development of new computer simulation models derived from the outcomes of these discussions.

Another major output from this study has been the development of the method to collect and manipulate data to augment novel policy decisions by Government and NGOs. **It is recommended** that the method be tried in other areas of South Asia. Funding will be sought for workshops to be held where stakeholders from countries surrounding Bangladesh would be invited to participate to determine their interest in such computer simulation models.

These recommendations are made to promote the outputs of this research project and generate a sustainable development impact within the region.

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Background

Between 1960 and 1990, urban populations trebled in less developed countries. Given the resource limitations on urban agricultural development eg land, water, soil fertility, their populations require some provisioning from elsewhere. With increasing urbanisation, peri-urban[1] areas have grown which are often unplanned, unserviced and extremely densely populated (four to five times higher than the average in some cities for which statistics are available eg Calcutta and Manila) (FAO 1986). Poor people who have moved from rural areas in search of opportunities to improve their standard of living often populate them. Although people living in peri-urban areas may have insufficient nourishment (FAO 1986), some of them have retained rural skills which could be adapted to the peri-urban environment to provide food for local and other urban markets. However, there is a need to incorporate these skills into improved strategies for increasing production of livestock products through intensification and increased efficiency, reducing the losses of livestock products and increasing their supply through improved infrastructure and marketing systems. As a consequence, the peri-urban area was selected as a priority for research and development by the Research Task Group (RTG)of the Overseas Development Administration (now the Department for International Development, DFID).

Although there is a requirement to use peri-urban areas to increase food production, there was a general lack of basic information available for use by developers at policy, administrative, advisory, farm and other levels. The sector was generally under-researched. Consequently, it was difficult for planners and researchers to address policy issues regarding the development of peri-urban agriculture and/or marketing services or the future roles of urban, peri-urban and rural production and marketing systems for the supply of livestock products. This project seeks to supply some of this information through a study of the characteristics, dynamics and potential of peri-urban livestock production, processing and marketing systems augmented by studies of livestock product losses and their potential for reduction in different marketing and processing chains. The project also seeks to examine markets in Bangladesh as representative of South Asia. These data are to be collected and analysed by local institutions as part of an institutional-strengthening exercise. They are to be made available to the appropriate and relevant authorities, policy makers, planners and researchers to assist and advise them on the options for cost-effective, sustainable and environmentally-sound delivery of products to the market.

The project contributes to the RTG-derived indicative output 1.2 of the Livestock Production/Peri-Urban Interface Systems: 'Energy efficient and socio-economically acceptable handling and distribution technologies <u>identified</u> and <u>promoted</u>' and indicative output 1.4 'Improved strategies for animal husbandry and nutrition in the intensive livestock production system and in crop/livestock systems in high potential and peri-urban areas <u>developed</u> and <u>promoted'.</u>

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[1]   From the RTG document, the peri-urban interface is characterised by strong urban influences, easy access to markets, services and other inputs, ready supplies of labour, but relative shortage of land and risks of pollution and urban growth.

Brief Review of Literature (as of 1995)

Historically, peri-urban research is directed mainly towards the socio-economic issues of nutrition, health, environment and town planning. Relatively few case studies of agricultural production have been undertaken. Agricultural activity in peri-urban areas is linked to the nature of the market for the produce, potential for land use, and supply of labour and services. Urban encroachment into peri-urban areas leads to intensification of production of livestock and cash crops in preference to subsistence agriculture, changes to marketing chains (particularly to off-farm sales) and responses to technological change, for example the development of refrigeration (Gopi, 1976; Hill, 1986). The nature of peri- urban development is not always conducive to long term promotion of livestock production as the land may be used for establishment of industries which are hazardous eg chemical factories. Labour is attracted to these industries or to other work in town, perhaps making farming a part-time occupation. Peri-urban land may be purchased and farmed in anticipation of an increase in value brought about through continuing urban encroachment. The rapid expansion of the town leads to rapid change in the nature of the peri-urban interface and this makes planning very difficult. Since peri-urban agriculture is a dynamic system, Leeming and Soussan (1979) recommend that peri-urban studies should be conducted over a long period of time. The difficulties of undertaking long-term research, especially that of funding, may explain why there are only a few technical case studies of peri-urban areas.

Peri-urban livestock systems are generally under-researched although some information may be available in documentation covering broader issues (Scott & Okali, 1993). Centres (1991) surveyed livestock production systems generally and commodity chains in Bamako, Mali in particular and noted the importance of the spatial, socio-economic and sanitary constraints as they related to livestock production in the city. Much of the limited information is written about Africa and published by the International Livestock Centre for Africa (ILCA) now renamed the International Livestock Research Institute (ILRI). The focus of most work has been dairy production and constraints to development of the sector (Brumby & Gryseels, 1984; Ateneh *et al*, 1988; Brokken & Seyonm, 1990). The ILRI has developed a conceptual framework for research in the improvement of dairy production to satisfy the growing consumer demand in sub-Saharan Africa (SSA) (Rey *et al.*, 1993) which sets out a schematic representation of a peri -urban dairy system and describes 46 hypotheses which require testing. They are divided into two: the factors which influence development of market-oriented smallholder dairying in SSA and factors which affect farm productivity.

Von Braun (1987) assessed the nature and extent of food consumption and nutrition problems in urban areas of low-income countries and concluded that enhanced service provision of the urban poor is a crucial requirement to improved well-being. Policy options to address this issue included community development initiatives in the poor quarters including urban and peri-urban agriculture. FAO (1989) studied the impact of urbanisation on the supply and demand for food in 12 areas and concluded that regions differed in character and pace of urbanisation and patterns of food consumption. The study identified the need for a review of information policies to improve the collection, quantity, quality and application of data; improved

distribution and marketing of food; stimulation of agricultural and agro-industrial development; and reduction of post-harvest losses.

FAO (1986) indicated that traditional marketing systems led to high food losses. Earlier studies (FAO, 1977) suggested that losses could be reduced through improved animal health, improved processing, product hygiene and handling, by-product utilisation, transport of livestock and products, marketing infrastructure, training and extension, and provision of refrigeration facilities.

Full literature reviews, included in the PhD theses to be submitted to the BAU are available from the author.

Project Purpose

This project was designed to contribute to both of the Peri-Urban Interface and the High Potential Systems (including peri-urban interface) of the Livestock Production Programme (LPP) purposes which are, respectively:

Marketing of eggs, milk and meat for urban populations improved

and

Performance of livestock in high potential and peri-urban intensive farming systems (crop/livestock or livestock) improved.

The indicative outputs are, respectively:

1.1   Energy-efficient and economically viable processing methods for production of established products developed and promoted

1.2   Energy-efficient and economically acceptable handling and distribution technologies identified and promoted.

1.4   Improved strategies for animal husbandry and nutrition in the intensive livestock production system and in the crop/livestock systems in high potential and peri-urban areas developed and promoted

Research Activities

Preamble

Although this project officially started in April 1996, considerable pre-project inputs were made over two to three years previously. At the outset, four project Concept Notes were submitted to the LPP Programme Advisory Committee (PAC) which recommend that they be combined into one, due to serious funding reductions. After several re-iterations of the recommendations of the PAC (always with funding cuts) this project emerged. The remaining funding meant that there was no alternative but to allow the project to be undertaken by researchers at a Bangladeshi institution under supervision of the Project Leader with specialist advice from others.

In November 1995, the Project Leader visited Bangladesh to identify collaborators and locations for the study, look at the probabilities of successful completion of the study and to reduce further the costs of the project. In the report of the visit (NRI report R2300 (S)) it was recommended that the work should be conducted under a Memorandum of Understanding (later changed to an Extra Mural Contract) between the BAU at Mymensingh, and the Natural Resources Institute (NRI), Chatham, UK to commence on the 1 April 1996. The project was to be used as a vehicle for two students to study for a PhD degree at the BAU. One student was to undertake the work on animal production and the other in socio-economics and marketing to describe a seamless chain from producer to consumer. The students were to earn their degrees and be supervised in the normal way at the BAU with technical inputs from appropriate officers from the NRI. Back up expertise from the university was provided in the fields of computer science, social anthropology and from undergraduate surveyors. The NRI was to provide any necessary support for the project, particularly that associated with computer modelling.

Two research students had been selected by the BAU before the second visit in February 1996 but failed to start the work programme devised for them. Two fresh students, again independently recruited by the BAU, started work in September 1996. As it takes three years to complete a PhD degree, the project was extended, following agreement with the LPP Manager, to September 1999 when funding for all activities ceased. The work programme remained very much on schedule, provided regular biannual supervisory visits were undertaken. However, part of the work programme for the students was to write this final technical report or at least provide the majority of its technical aspects (the funding falling well short of that needed for the NRI to complete the full analyses). At the time of writing (October 2000) most of these inputs are not forthcoming.

In spite of these constraints, the project has developed a method which delivers all the scientific objectives of the project as detailed in the Project Memorandum. As the method is as important as the scientific results, the report will refer to this in some detail. Furthermore, the final output of computer models has been developed and demonstrated.

Project development

The project was divided into four main phases:

1   Determination of the urban, peri-urban and rural areas of three study towns

2   Characterisation of the production and marketing systems for livestock and their products in the three areas of the three towns

3   Case-studies on specific production and marketing systems in these towns and their surrounding areas

4   Analysis of the data and construction of a simple model which will indicate the most useful interventions on the production and marketing systems to bring about an improved supply of animal proteins to urban markets

Phase 1 – Determination of the urban, peri-urban and rural areas of three study towns

Selection of towns

Although there were no hard and fast rules about town selection, it was agreed that the choice must be justifiable in some way. The initial selection of towns was to have been based on a dozen or so predetermined criteria eg: Towns should have a municipal population of 80,000 to 500,000 and growing in size (it was thought that a town of over 80,000 would provide the range of animal proteins, production and marketing systems necessary for study purposes); the capital, major ports and other towns within a proximity of 50 km of the international borders with India and Myanmar would be rejected as being atypical of other towns in the region; the towns must not have interlocking hinterlands, ie one rural/peri-urban area must not obviously supply the urban markets of another town. Using these criteria, it was thought that the number of possible sites could be reduced to around 20 (in practice this turned out to be 11). It was then decided to collect data to assess the suitability of these towns for study. For example:

- Population size, structure, age, growth, sex ratio

- Other demographic information relating to ethnicity, religion, income levels and groups, infant mortality rates, education levels

- Number of industries and their nature etc, etc etc

The team visited the Bangladesh Bureau of Statistics and offices of other organisations which collect statistical data to seek the information outlined above. Although considerable data were available, they were not always consistent. The data were analysed statistically but it soon became apparent that each town had some unique feature or other which made comparisons difficult. As expected, there was no 'typical' town. The choice of towns for the study was discussed at meetings with persons with considerable local experience. All persons had opinions about the choice of towns for the study but there was no consensus. A pragmatic approach

was sought. From the original 11 towns, three were chosen on the basis of wealth categories ('rich', 'medium' and 'poor') and accessibility. The obvious candidate for the medium was Mymensingh itself, the home of the BAU and centre of the study. The 'rich' was Sylhet and the 'poor' town was Pabna, just the other side of the Jamna river, over which a bridge would soon be built, making comparisons of economic and social change possible in the future. A visit was made to the three towns to determine a 'feel' for intrinsic wealth, identify collaborative partners and the level of help which might be obtained from production and marketing officials.

Interestingly, a snapshot of prices for proteinaceous foods showed marked differences between the three towns (Appendix 1, Table 1). Inspection of key 'wealth indicators' taken from the 1991 census supported the view that Sylhet is the wealthiest of the three towns although differences between Mymensingh and Pabna were more difficult to observe (Appendix 1, Table 2).

The food prices are in line with the (albeit subjective) classification of Sylhet, Mymensingh and Pabna as towns of above average, medium and below average wealth respectively, as the prices generally increase with the assumed wealth of the town.

Geographical units of analysis

Having selected the study towns, it was then necessary to define the urban, peri-urban and rural areas of the towns if the production and marketing systems for livestock and their products in these areas were to be studied.

Definitions of urban, peri-urban and rural were derived from information at 'mauza' level and, following analyses, each of the studied 'mauzas' was declared as falling into one of the three categories. 'Mauzas' are the smallest administrative unit in Bangladesh, usually comprising an area of two to five square kilometres for which formal data exist. In order to obtain a good cross-section of mauzas to be studied, they were selected in a systematic fashion as follows: For each of the three towns, eight axes were drawn radiating from the centre at 45° angles (i.e. N, NE, E, SE, S, SW, W and NW directions). Points were marked at 2, 5, 10, 15 and 20 km intervals along each axis and the mauza in which the point fell was selected. In theory, this should give rise to 40 mauzas but, in practice, fewer were obtained since sometimes two points fell in the same mauza, particularly at the 2km distance on different axes.

Study of Secondary data

Sample census data (secondary data) were extracted for the selected mauzas. Preliminary statistical analysis of two of the towns showed that two multivariate techniques (Principal Component Analysis – PCA, and Cluster Analysis - CA) were effective in creating an urban/rural index and grouping mauzas into reasonable clusters according to their characteristics thus adding confidence to the technique.

During the preliminary statistical analyses of Mymensingh and Sylhet, 75 items of data were manually extracted from the 1991 census results. These data items were used to calculate 19 variables (measurements) which were felt should show differences between urban and rural areas. These variables, all expressed as percentages and requiring no transposition, were literacy rate, houses with a straw roof, houses with cement roof, school attendance rate, people engaged in housework,

people not working, workers engaged in agriculture, houses with tap water, houses using pond/river water, tube wells, houses with a sanitary toilet, houses with no toilet, houses with electricity, landless households, householder's main income was farming, householder's main income was agricultural labour, householder's main income was non-agricultural labour, householder's main income was from other, Hindu. Population density was not used, since it could not be calculated for mauzas in the town centres. Also, data were not readily available for some of the selected mauzas, reducing the number of mauzas to 33 for Mymensingh and 34 for Sylhet.

Data were analysed using both PCA and CA.

PCA is a multivariate statistical technique which can reduce a large number of variables to a much smaller number of 'components' or indices. The resulting components each consist of combinations of the original variables. The rationale is that if the information contained in a large number of variables can be summarised in two or three indices, it is likely that interpretation of the data can be simplified. The analysis can be carried out either on the untransformed variables or on variables standardised to give a mean of zero and a standard deviation of one. These correspond to analysing either the covariance matrix or the correlation matrix, respectively. In this case, there were 19 original variables and the PCA was carried out separately for each town. Since all variables were expressed on a percentage basis, it was not necessary to standardise the data before analysis.

For Mymensingh, the first principal component accounted for 68% of the variation and the next three components for 9%, 9% and 5%, respectively. For Sylhet, the first component accounted for 49% of the variation, the second accounted for 29% and the next two components for 6% and 4%, respectively. This shows that for Mymensingh, a single index or component will describe well the differences between urban and rural areas but, for Sylhet, two indices are needed. This is caused by four mauzas at Sylhet being tea gardens, adding an extra dimension to the rural/urban continuum.

The coefficients for these indices are given in Appendix 1, Table 3. The index for Mymensingh and the first index for Sylhet are very similar, particularly when only coefficients with an absolute value greater than 0.2 are considered. A positive coefficient shows that a high value of the variable indicates a rural area. These variables are % of houses with a straw roof; % of workers engaged in agriculture; % of houses with no toilet; % of households whose main income is from farming; and, for Sylhet, % of houses using pond/river water. Conversely, a negative coefficient shows that a high value of the variable indicates an urban area. These variables are % of houses with a sanitary toilet; % of houses with electricity; % of landless households; and % of household whose main income is from other sources.

This analysis shows that an index can be derived from the census data to quantify where, on the rural/urban axis a particular mauza is placed. The index values were calculated for each mauza and for Mymensingh the value went from -161 for an area near the town centre to +61 for the most extreme rural area. For Sylhet the range was from -150 to +125. For the second index for Sylhet, all four tea gardens had values greater than +120 whereas virtually all other areas had values less than +5.

The second statistical approach to the analysis of the census data was to use CA. This technique first calculates the 'similarity' between all pairs of mauzas and then

uses this to define a hierarchy or tree. At successive levels of this hierarchy, mauzas are grouped into clusters until finally all mauzas are in a single cluster. The hierarchy can be examined at different levels to see where reasonable groupings occur. This analysis, when applied to the Mymensingh data gave an interpretable clustering with six groups. Three of the groups are rural, two are urban and one peri-urban. For Sylhet, a clustering with seven groups gave interpretable results. Two of the groups appeared to be rural; two groups are comprised of the four tea gardens; one group is urban, one group appears peri-urban and the final group of only two mauzas was difficult to interpret without local knowledge or detailed examination of data. (The tea gardens form two groups because of an apparently inconsistent definition of employment and income categories for the plantation labourers). Appendix 2, Figures 1.1 & 1.2 show the results of these analyses.

The means of selected variables for the groups are given in Appendix 1, Table 4. Relative to the rural groups, the urban groups have a high literacy rate, low percentage of houses with straw roofs, high school attendance, low proportion of people engaged in agriculture and a high proportion of households with a sanitary toilet and electricity. The peri-urban groups are intermediate between the rural and urban groups for many of these characteristics.

Study of primary data

The census data used in the preliminary analyses did not include any which related to livestock production, livestock products or agricultural marketing. This was thought inappropriate for what is, essentially, an agricultural project. So primary data on prices of relevant products, transport costs to town etc were required. These data were obtained from responses to a structured questionnaire by key informants and market traders.

The farmer questionnaire was administered to groups of key informants in selected communities situated as close as possible to the points which had already been marked out on the maps of the three study towns. In most cases, this resulted in one set of key informants per mauza being interviewed, although in some mauzas there were two or three groups of informants. The key informant approach was taken to obtain community level and market information in a cost-effective manner. Information was collected from dairy, poultry and fish farmers and other community key informants who answered questions about cost and time taken to reach the centre of the study town (from the community); chicken and cattle feed costs and availability; location and frequency of local meat, chicken and livestock markets; milk, fish, chicken, egg and livestock marketing; and an indication of the proportion of locally sold milk and fish which find their way to the centre of the study town.

The market questionnaire was administered to traders in markets close to the key informant communities. It was shorter than the community key informant questionnaire, although similar in structure. In brief, it covered: frequency of meat, chicken and livestock markets; milk, fish, chicken, egg and livestock marketing and an indication of the proportion of marketed fish and milk that find their way to the centre of the study town. The full questionnaire is found in Appendix 3.1 on the CD-ROM which accompanies this report.

After the questionnaire data had been collected, they were either incorporated into the PCA and CA along with the census data or studied to examine how prices etc are correlated with the urban/rural index and vary between clusters of mauzas. Having completed data collection, all secondary and primary data were used to conduct the full analyses. Results are given in the 'Outputs' chapter of this report

Phase 2: Characterisation of the production and marketing systems for livestock and their products in the three areas of the three towns

Having determined that each town has three areas with differing infrastructure, social and economic characteristics, Phase 2 was concerned with closer examination of the production and marketing of livestock and their products within them. As these systems in the three areas were studied only in very general terms in Phase 1, a more structured approach was chosen. Questionnaires and checklists of questions were developed to address both systems.

A questionnaire for livestock producers was drawn up after team discussions about the nature of the information required to characterise the production system to the point where livestock or their products enters the marketing or further processing chain. As householders are also consumers, questions concerning household consumption were also included in the form. The researcher, Miss Momotaz Moholl, was responsible for identifying the main headings required and all team members discussed the document at considerable length and made substantial modifications before testing it. Ownership of the questionnaire was considered important.

The questionnaire took about 70 minutes to administer. Generally, this is considered to be too long. In the Bangladesh context, however, each householder was flattered to be given so much attention and this length of time seemed of no real concern to either the householder or the enumerator. The mauzas used in the survey were chosen at random from the three areas determined in Phase 1. The selection of households, the method of data collection, notes governing the interpretation of the questions and a final revision of the questionnaire are to be found in Appendix 3.2 on the CD-ROM which accompanies this report.

Questionnaires to characterise the marketing system from the point where livestock and their products leave the production system were drawn up and tested after team discussions about the nature of the information required. The researcher, Mr Monayem Miah, was responsible for the initial outline of the documents and all team members contributed to their development. These were directed at key informants in the market (eg market administrators); market traders; owners of restaurants and shops; and milk processors. In total, four sets of questionnaires were administered, one for each of class of informant. With the exception of key market informants, questionnaires were divided into two parts - one which investigated the buying behaviour and one which investigated selling behaviour. The questionnaires took between 30 and 60 minutes to complete. Ideally, this should have been a maximum of 40 minutes because trades people have a business to run. Sample selection, explanatory notes and the final revisions of the questionnaires are to be found in Appendix 3.2 on the CD-ROM which accompanies this report.

The quantity of data collected was considerable. There were approximately 900 forms from the producer questionnaires to be processed and approximately 1200 for

market characterisation. This quantity was thought to be beyond the capacity of the two researchers on their own so graduates were employed as enumerators to administer the forms; six enumerators for the producer and four for the market. Enumerators returned completed questionnaires to the researcher for him/her to enter the data onto the computer. The researcher managed the data collection, collation and interpretation. Results of the surveys to characterise the three areas of the three towns are given in the Outputs chapter

Phase 3: Case-studies of specific production and marketing systems in these towns and their surrounding areas

Introduction

Preliminary results from Phase 2 showed little differences between the studied characteristics of Pabna and Mymensingh. Considering the difficulties of reaching Pabna and that Phase 3 required the collection of much more detailed information, data collection in Pabna was discontinued for Phase 3.

This phase was carried out as a series of 12 case-studies in both towns, based on farms in three or four peri-urban mauzas of Mymensingh and three or four in peri-urban mauzas of Sylhet. Inputs to the farms, farming activity, livestock products from the farms and the destiny of the products in the marketing system (to the urban markets of Mymensingh and Sylhet) were monitored, initially on a monthly basis. As farmers quickly forgot events which occurred between monthly visits, monitoring was increased to a weekly visit after a couple of months. A diary was kept to monitor external influences on farming activity and during marketing of the products. The researchers realised that by definition, case-studies cannot be representative of the situation in Mymensingh and Sylhet as the resources required for this type of study would exceed those available.

Objectives

The objectives of Phase 3 were to:

- Determine the operation and efficiency of the production of animal protein and marketing systems on and from 12 farms within the peri-urban areas of Mymensingh and Sylhet to their urban markets

- Align changes which may occur within the farming and marketing systems with identified normal external influences

- Prepare a descriptive model of the farm production of animal protein and its marketing in the urban area of the town over a one year period

- Prepare for Phase 4. Develop a simple computer model that will reflect changes in farm production and marketing outputs following simulated external influences.

Product Selection

Detailed examination of the importance of all livestock products showed that, alphabetically, beef, chicken, egg, fish, goat, and milk were the most important products to be studied.

Mauza Selection

It was hoped that the peri-urban mauzas studied in Phase 2 would used again as characteristics of these mauzas were already known. However, this turned out to be impractical and the method of choice will be described later in the section on Establishment of Marketing Chain.

Farmer Selection

Twelve farmers were selected for the study in Sylhet and 12 in Mymensingh. Two were landless, two were medium scale and two large scale in each town. Additionally, at the suggestion of the researcher's local supervisor, six commercial farmers were chosen in each town. Two operated layer farms, two broiler farms and two were dairy farmers. The classification of farmers was based on land holdings (which they own) plus the land they farm (which they do not own). An average holding, as determined during the Phase 2 characterisation, was be the 'average' farmer for the town, the other two falling in the lower and higher quartiles. If the farmer in the lower quartile farmed about 0.25 ha or less then he was considered as landless. It was hoped that farmers contacted during Phase 2 would be chosen if they had proved to be co-operative but this turned out to be impractical (see later for method employed, in the section on Establishment of Marketing Chain). Each farm produced a marketable surplus of at least two livestock products which were to be sold eventually on the urban market. In each town, all six study products were represented, twice initially. Once the farmers were chosen, they were used throughout the study.

Market Selection

The main urban markets in Mymensingh and Sylhet were chosen as terminal markets. Additionally, other markets in peri-urban areas were used to collect data as it was possible that some farmers sold produce in more than one market and that traders bought in main markets to sell later in peri-urban markets and *vice versa*. Once the markets were chosen, they were used throughout the study. Peri-urban markets were chosen according to product flows rather than ease of access although, in practice, they turned out to be the same place.

Establishment of Marketing Chain

The feasibility of establishing a marketing chain from producer in a peri-urban mauza to the urban market of Mymensingh was confirmed in May 1998. From discussions with retailers in the main urban market of Mymensingh, the source of some of their products was traced to a particular peri-urban market. During a visit to that market, buyers were interviewed who regularly sold livestock products to the main urban market. Furthermore, discussions with farmers selling in the peri-urban market to these buyers showed that they lived and farmed in the peri-urban mauza in which the market was situated. A visit to one of these farms showed it to be potential case-study material, having the pre-determined characteristics indicated above (*Farmer Selection*). The farmer agreed to help with the work. Had he not been suitable, other farmers/sellers would have been chosen. From this simple production/marketing chain the complex marketing chains in both towns were developed; different farmers possibly marketing different products in different ways at different times. The case-studies examined these closely.

Data collection: Livestock Producer

The quality of data collected depended on the development of a professional relationship between researcher and farmer. Initially, it was not thought necessary to develop a structured questionnaire to collect data. A detailed checklist (*aide memoire*) was thought to be more appropriate to collect quantitative data. These data would be used to formulate the model to be developed in Phase 4. Researchers, however, found that it was easier to use a questionnaire which they devised themselves. The questionnaire was based on the *aide memoire* in Appendix 3.3 on the CD-ROM which accompanies this report.

Initially, the farms were described in terms of total activity and resource flows eg rice straw from the farmer's paddy field is fed to his cattle, surplus milk from the cattle is sold to a Goala (milk trader). A map was drawn and verified/modified/redrawn each time a farm was visited (see example in Appendix2, figures 2.1 & 2.2). Measurements of price, quantity and quality of all farm products, services and activities were measured at critical points in the flow of all products coming into the farm, on the farm and at the farm gate. It was intended that a diary should be kept at the farm to monitor changes in the farming environment eg planting and harvesting times, labour flows, family activity, marriage, new children, festivals, prices of fuel, sale and purchase of livestock etc. This depended on farmer literacy however, and became unnecessary once the farm was visited weekly. After an initial assessment of the demography and flows, costs, prices and values, the researcher returned to the farm to monitor changes since the last visit. The opportunity existed to collect quantitative data, such as feed given to stock, milk produced over a few days, eggs collected and sold etc and the researchers were asked to collect this information. Researchers were also asked to note the quality of the produce and analyse samples for nutritive value where appropriate. Finally, researchers were also asked to purchase scales, plastic measuring cylinders etc. for the farmer to use, if he was interested in recording such matters himself, and passing the information to the researcher after training in the use of the equipment.

Data collection: Marketing

The quality of data to be collected also depended on the development of a professional relationship between researchers and farmer/trader. Whereas the farmer is relatively static, the same was not be true for the traders in the marketing chain. Detailed knowledge of the trader's movements was essential.

Initially, the market chain was described in terms of function and flows, and a flow chart drawn (see Appendix 2, Figure 3 for example). However, as the farmers' marketing activities were elucidated, it was found that more than one disposal method was associated with one product or season, and this was included in the scheme. The researcher developed a questionnaire for data collection. Data were collected on prices, quantities, quality, origins, destinations, premiums, subscriptions, losses, transport etc of all six products as carried out in Phase 2 but in much more detail. Data were collected weekly.. Twenty-six traders provided data for the marketing study in Sylhet and 24 in Mymensingh. Six products were studied in each town.

Enumerators

Two enumerators were employed to collect data in each town; one met farmers, the other talked to traders. Each enumerator was selected by the researchers from two candidates identified by word-of-mouth. The enumerators were trained on-the-job by the two researchers. The concept of the *aide memoire* (see above) was difficult to interpret so the researchers developed their own questionnaires for the enumerators to complete during the farm/market visits which they translated into Bengali. This had the advantage of leaving no question unasked but, as a disadvantage, allowed only minimum scope for inventive questioning. This was overcome by the researchers themselves who paid a visit to each town once every four weeks. On these occasions, the researchers undertook data collection and used this time to ask supplementary questions. Farm maps (Appendix 2, figure 2) were re-drawn by Miss Momotaz during each of her farm visits. The questionnaires were assembled into books or large sheaves of papers.

Data use

All of these data were formatted consistently and used not only to write up a chapter for the PhD theses but also to develop the computer model.

Phase 4: Analysis of data and construction of a simple

The construction of the computer models started immediately after data collection had finished in Bangladesh. The two researchers brought all the project data collected throughout the study to UK where they started an instruction programme in computer modelling using these research data. This took place at Imperial College at Silwood Park, under the guidance of Dr Adrian Leach, the modeller who visited Bangladesh in April 1998. Outline models were taken back with them to Bangladesh. They have now been trained in the construction of simple computer models although they will need to practice for some time before they become completely competent.

Production

The quantity, quality and resolution of the data collected during Phase 3 was such that many spreadsheet models could be developed as virtual testing grounds for novel policy issues. The models were developed in Microsoft's Excel ™ spreadsheet package because this software is universally available and could be used to continue model development once the researchers had returned to their usual workplaces. In the seven weeks Miss Momotaz was in UK, two highly flexible policy-testing models were developed to allow the user to determine the impact of a vaccination policy (Newcastle disease and Fowl Pox) on poultry and to assess the benefits of using a leguminous crop planted between traditional rice crops. These two models were used to demonstrate the power of the data used rather than to suggest to the Government of Bangladesh what should be done. It is now for the Government of Bangladesh to suggest what needs policy attention and for the researcher to construct a model to test the hypotheses.

Marketing

Due to the complexity of marketing systems and factors involving human behaviour, such as product switching, it was not possible to develop a fully-working dynamic marketing model in the time available. However, a simple model for chicken marketing was developed during Phase 4 and many useful insights were gained through the process of summarising and analysing the data collected in Phase 3. Marketing channels were identified, summarised and ordered in terms of importance. The influence of religious and social events were identified and assessed in terms of quantifiable impact. Once again, Microsoft's Excel ™ spreadsheet package was used to build a simple stochastic model which simulated predictable changes in price through demand. Additionally, use was made of Crystal Ball ™, an add-in to Excel ™, to simulate uncertainty and view the range of potential gross margins that could occur and their frequency predicted by the model. Once again, maximum training was given in the time available which allows many models to be built to test novel policy interventions. The data are of sufficient quantity, quality and resolution that the number of applications is limited only by the imagination of the researcher.

Outputs

Phase 1: Definition of the urban, peri-urban and rural areas of the three study towns

Analysis of census data

About 35 mauzas were selected for each of the three towns and 19 variables derived from the 1991 census were calculated for each mauza. CA and PCA were used to explore these data. This enabled mauzas to be classified into three main groups which appeared to correspond to urban, peri-urban and rural areas. At Sylhet, a fourth group consisting of tea gardens was revealed by the analysis.

The distinction between urban mauzas and the others was clear. The distinction between peri-urban and rural mauzas was less clear. The urban mauzas, as expected, had a relatively high proportion of households/ individuals with the following characteristics:

- cement roofs
- tap water
- sanitary (water) toilet
- main income from non-agricultural sources
- higher literacy and school attendance rates
- landless
- ethnic minority

By contrast, the rural mauzas had a high proportion of households/ individuals with:

- straw roofs
- no toilet
- main income from agriculture

The peri-urban areas were intermediate between rural and urban in many of these characteristics, but similar to rural areas for some of them. Results, based on the agreed classification discussed below, are given in Appendix 1, (Table 5). When plotted on a map, the peri-urban areas were generally closer to the town centre than rural areas. There were a few exceptions, where peri-urban mauzas were adjacent to a main road, but relatively far from town, see Appendix 2, Figure 4. In Sylhet, four mauzas, all tea gardens, had characteristics which differed from the other three groups. These did not fit the simple urban-rural continuum. They had a large number of landless households and agricultural labourers, low literacy and school attendance rates and a majority Hindu population. In Pabna, two rural mauzas differed somewhat from other rural mauzas. One of these had a high proportion of landless households and agricultural labourers. During the survey (see below) this was found to be in an area where land had been lost to flooding.

Questionnaire results

The questionnaire was designed to be implemented in the same mauzas as used for the analysis of census data above. In two cases, the surveyed mauzas did not correspond with the mauzas used in the census data analysis due to confusion with the map locations. For Pabna, a number of the selected areas were part of Kushtia's hinterland which is separated from that of Pabna by a large river which makes travel to Pabna very difficult and time consuming. These mauzas were, therefore, not considered as part of the Pabna area.

Simple summary statistics and boxplots showed that much of the data exhibited the expected trend from rural to urban (as defined by the census data), but there was considerable variation and overlap between the three areas. For each selected mauza, the researchers made a subjective assessment of whether the mauza was urban, peri-urban or rural. This was cross-referenced with the classification derived from the CA of the census data. A number of discrepancies occurred between the two classifications. Most of these were where a mauza was classified as rural by the researchers but as peri-urban by the census results.

Agreed classification

Four of these discrepant mauzas in the Mymensingh area were visited to try to ascertain the reasons for the different classification. All of these had an apparent rural location. Three were some distance from a 'pucca' (sealed asphalt-surfaced) road and surrounded by rice fields and other crops. However, in agreement with the census data, electricity was available in parts of the mauzas and a considerable proportion of the population worked in Mymensingh whilst others also visited the town daily. The fourth mauza visited was close to the main Mymensingh-Dhaka road but not close to any large village. In contrast to the census data, we were told that most people worked in agriculture in the locality.

A visit was made to an area classified as peri-urban by both the census and the researchers. This was found to have similar characteristics to the discrepant mauzas with the exception of access to a pucca road.

Analysis using survey data

Additionally, the PCA and CA were re-run including data from the survey on prices of eggs, milk, chickens, goats and rice straw and the cost and time taken to travel to town. Milk price data for Sylhet were not included since there was very little marketing of milk in this town. These analyses gave very similar results to those based on the census data alone. Therefore, the classification based on the census data was used for the remainder of the analyses. This was modified for the two mauzas where the interview was conducted in a different mauza from the census data. In these cases, the researchers classification (one urban, one rural) was used. A list of selected mauzas, classified by town and area is given in Appendix 1, (Table 6).

Results

Based on the modified census classification, the questionnaire results were tabulated or graphed to examine differences between areas and between towns. An analysis of

variance was also conducted for price data and other continuous measurements to confirm these differences. The results are given in Appendix 1, (Table 7).

As expected, agricultural produce such as milk, eggs and chickens tended to be more expensive in urban areas than in rural areas. In some cases, peri-urban prices were similar to rural prices and, in other cases, similar to those in urban areas. Sylhet tended to be more expensive than the other two towns. Also in Sylhet, some prices were extremely variable eg chicken prices ranged from Tk55-115 (£0.85-1.77)/kg. We do not have an explanation for this.

The milk marketing system varied from urban to rural areas, with direct delivery to customers being more prevalent in the urban areas and selling to a Goala or at market more prevalent in rural and peri-urban areas. In Sylhet, there was no milk marketing in the majority of communities questioned.

Rice straw was more expensive in urban than in rural areas and dairy farmers in urban areas relied more heavily on purchased straw than those in rural areas.

Conclusion

The analysis of census results alone gave a clear division between urban and other areas, with a good indication of a distinction between peri-urban and rural areas. The researchers visit helped to clarify the situation. This classification of mauzas into these three types of area is reflected in livestock prices and production systems.

In retrospect, for rural and peri-urban areas, it would have been useful to have included questions relating to off-farm employment and income sources and to the relation between the visited community and the town centre.

Phase 2: Characterisation of the production and marketing systems of livestock and their products in the three areas of the three towns

Livestock Production

The method of data collection, their explanatory notes etc and tabulated data were written as part of the thesis document for Miss Momotaz Moholl. Results for the production system are given in approximately 100 tables. The discussion given in the draft thesis chapter, regrettably, simply describes the tabulated data rather than providing analyses and interpretation. This mammoth task has been reduced to a single summary sheet for this report and is given in Appendix 1, (Table 8).

To give some idea of the comprehensive nature of the data available the following observations from the data are submitted along with their possible interpretation. Data to quantify these statements are available. These details are probably no more than 1% of the interpretable data. For the record, Sylhet was considered richer than Mymensingh which is itself considered richer than Pabna.

1. Of those who keep animals, there are more cattle (excluding buffalo) holdings with increasing town wealth ie Pabna has less cattle than Mymensingh which has less than Sylhet. *Possible interpretation: The market for meat and milk is related to wealth.*

2. Pabna has more lactating cross-bred cows than Mymensingh but both are very much lower than in the holdings in Sylhet. *Possible interpretation: The market for milk is related to wealth.*

3. In all towns, cattle holdings in urban areas are higher than in peri-urban which are lower than rural holdings. *Possible interpretation: Cattle are less likely to be kept in peri-urban areas to produce beef or milk than in town or country.*

4. There are more lactating cows in urban areas than in the peri-urban or rural areas of all towns. *Possible interpretation: The market for milk is in the town; milk produced in the rural and peri-urban areas is marketed less easily than in town*

5. Sylhet has fewer lactating Deshi (local) cattle than Mymensingh, which has the most. *Possible interpretation: Deshi cows are far less productive than cross-bred cows which are, in turn, more expensive to keep and maintain. Cross-bred cow ownership is thus related to wealth*

6. There are more Deshi cows in urban areas and fewer in peri-urban areas. *Possible interpretation: Irrespective of cow productivity, cattle are less likely to be kept in peri-urban areas to produce beef or milk than in town or country.*

7. Sylhet has many more adult bulls than Pabna or Mymensingh but there is very little difference between urban, peri-urban and rural ownership. There are more dry cross-bred cows in urban areas than in peri-urban which has more than rural areas. *Possible interpretation: Cattle are kept to breed where they produce milk; the concept of cows breeding in rural/peri-urban areas and brought into urban areas to produce milk is questionable.*

8. Sylhet has more dry Deshi cows that Pabna. *Possible interpretation: Cow ownership is related to wealth.*

9. There are significantly less poultry kept in urban areas than in peri-urban and rural areas. *Possible interpretation: Poultry can be produced and carried into town more cheaply than urban production. Poorer rural people are able to keep poultry but not more expensive stock for local consumption.*

10. More poultry is kept in Mymensingh than Sylhet and Pabna. *Possible interpretation: Local preferences?*

11. Of those who keep ducks, most keep approximately five. *Possible interpretation: ducks are kept on the compound pond which is small and this is probably the most economical number.*

12. There are significantly more goats kept in urban areas than in peri-urban and rural areas. *Possible interpretation: goats, like milk, are produced where they are needed for consumption. There is probably an economic and practical reason for this.*

13. To the question, why not keep more cattle? Over 60% gave limited cash to buy feed as the first reason and this mainly in the rural and peri-urban areas. Farmers did not cite poor feed availability, which is the 'official' reason. NB. The fact that they need cash to buy feed, particularly in the rural areas, suggests that they cannot grow enough for themselves. Thus feed availability may well be a problem. Credit is said not a problem and neither is land availability, generally, but slightly more so in the urban areas. Labour is a big problem, especially in town and sometimes in peri-urban areas but not in rural areas. Disease is a problem everywhere. There is no lack of market and producers always sell , almost irrespective of price.

Full analysis and interpretation should be given in the theses currently being written in Bangladesh. Analyses require cross-referencing.

Marketing of livestock products

The method of data collection, their explanatory notes etc and tabulated and graphic data were written as part of the thesis document for Mr Monayem Miah. Much of this is descriptive of the market and the way it operates. Where numerical data are presented they are, regrettably, descriptive of tabulated data rather than providing analyses and interpretation.

The draft thesis gives an introduction and describes the market for livestock products in general terms. The important livestock products are described, their availability, the *modus operandi* of the market, availability of physical facilities and charges and the problems facing the markets in terms of availability of services. The key players in the egg market, for example are described and these are represented in graphical hierarchical diagrams, which are presented in Appendix 2, (Figure 3).

The marketing systems, marketing channels, transport, financing of trade and mode of payment, variations in quantity and price, problems and marketing bottlenecks of all livestock and livestock products studied are described, analysed and depicted in diagrams in the thesis being written by Mr Monayem Miah.

Phases 3 & 4:

a) Case-studies of specific production and marketing systems and

b) Analysis of the data and construct, if possible, a simple model

All data were brought back to UK and computer models developed. One production model and one marketing model will be described here. The potential for use of the data is thus demonstrated. Further applications are limited only by the imagination of the technicians under instruction of policymakers in Bangladesh. It is stressed that the following are examples of use of the data and models and do not constitute recommendations from this project for application in the field.

Production model: The potential of Dhaincha to improve rice and dairy production on Anowara farm – a small farm in Mymensingh:

The production of dairy/beef on the Anowara farm is characterised by high costs, low stock losses and small profit margins (see Appendix 2, Figure 5a). For many parts of the year the accumulated costs exceed the accumulated return derived from production. This can be contrasted with poultry production where costs are very low, stock losses are high and margins are large (see Appendix 2, Figure 5b). High costs and small margins associated with cattle suggest that policy measures directed at increasing production or reducing costs will be the most effective in increasing wealth for a small farm such as Anowara.

Given that production should be increased and/or costs reduced to increase profitability, a policy measure currently under research by Prof M A Akbar, at the BAU, is the concept for farmers to inter-crop a leguminous crop for fodder between rice crops in paddy fields. 'Dhaincha' (*Sesbania rostrata*) is such a crop and is both nutritious for livestock and fixes nitrogen in the soil so that rice yields for human consumption are improved. A simulation model was developed which tested the potential impact of this policy on farm income. The simulated Dhaincha crop was 'grown' in the short fallow between rice crops. All parameters may be changed externally from the model so that the user can easily add more research findings to the model. The user can define the simulated Dhaincha crop in terms of:

1.   Number of plantings of Dhaincha per year

     a) after Boro paddy harvesting
     b) after Amon paddy harvesting
     c) both

2.   Cost of planting and management per planting per hectare

3.   Yield of Dhaincha (kg/ha/year)

4.   Consumption of Dhaincha per adult cow for Deshi and cross-breds(kg/cow/week)

5.   Percentage increase in milk production for Deshi and cross-bred cows (litres/lactating cow/week)

6.   Percentage increase in rice production per planting for the following rice
        crop.

The model calculates the consumption of the harvested Dhaincha in terms of the numbers of adult cows and the percentage increase in milk for the number of lactating cows. The 'harvested' Dhaincha is a finite stock and is depleted weekly according to consumption by the number of adult cross-bred or Deshi cows present. Benefits accrue in terms of increased milk production per lactating cow which is maintained for as long as the Dhaincha is still in stock. Appendix 2, Figures 6a, b and c show milk production per cow over the course of the year. Figure 6a shows actual milk production in the absence of simulated Dhaincha plantings. Peaks in production start to occur at the beginning of the study period (June 1998) which gradually decline to a baseline production in December. This persists until April/May 1999 when production starts to increase again. The increase in production appears to be correlated with the rainy season which causes a fresh flush of growth that allows cutting to commence in May/June. Figure 7 shows a regression of grazing time against milk production per lactating cow confirming that increased grazing time, when grass is available, increases milk production. Figure 6b illustrates the model prediction of the increase in milk production when two plantings of Dhaincha are simulated. The increase in milk production is not related to a production function within the model. It seems unlikely that the potential for increased production, as a result of *post*-Boro planting of Dhaincha, in June to August (the first 15 weeks) would be as high as predicted by the model as the lactating cows would, already, be close to maximum production. The potential for increasing production would be in the period when production is low, ie in the period from week twenty-one through to forty-nine. This coincides with the *post*-Amon planting of Dhaincha (see figure 6c). In this figure, the production of milk per cow over the course of the year is more even which would correspond to an increased but flatter source of marketable excess.

In this preliminary study, using a simple simulation model of a policy measure, it is suggested that the use of Dhaincha will have a tangible benefit to Anowara farm. The model suggests that the most cost-effective strategy would be to use one planting of post-Amon Dhaincha to improve milk yield during the period when production is at its lowest resulting in a yearly production of 1013 litres as opposed to 656 litres actually obtained in the 1998/1999 trails.

Of course, the practicalities of putting such a policy/intervention into the field rest with the agriculturists on the ground and this is outside the experience of the researchers operating the computer model.

Marketing model: Simulation of predictable changes in price through demand

The most striking aspect of the chicken marketing data was the importance of social and religious events in driving the demand for chicken which is normally considered to be a luxury product. Events such as the religious festival of Eid and the marriage and picnic seasons resulted in steep price rises at certain times of the year as demand increased rapidly for short periods. This has certain advantages in terms of policy recommendations given that religious and social events are predictable in time so that contingency measures for reducing constraints in marketing may be specified for anticipated periods of high demand. It may be that other products such as beef may

show similar troughs and peaks in demand and contrasting the differences between products in terms of their seasonality will be an integral part of policy analysis.

The marketing pathways for chicken were identified and quantified in terms of importance (by weight of product handled). It appeared that the marketing of chicken away from Mymensingh through 'farias'[2] and external 'beparis' was an important and yet relatively poorly-described pathway. The difference between Sylhet, a relatively rich town and a net importer of chickens, and Mymensingh, a relatively poor town and net exporter, has important considerations attached to it. This difference was highlighted by the absence of beparis for chickens in Sylhet where good infrastructure and the filled niche for local supply by small-scale farias means that beparis could not find a margin in chicken marketing. This could be contrasted with Mymensingh where farias acted as important suppliers to external beparis whereas local beparis acted as the principle suppliers to local retailers. This complies with modern thinking that efficient marketing systems (Sylhet) have less diversity in their marketing pathways than poorer markets because the number of potential marketing niches (and therefore players) in efficient systems are less numerous.

A simple stochastic model of chicken marketing was built which simulated predictable changes in prices through demand. The occurrence and duration of religious, social, environmental and agronomically important events were specified by week number as follows:

Event	Start	End
Ramadan	29	32
Eid 1	33	
Eid 2	43	
Wedding/Picnic Season	25	37
Period of flooding	5	12
Period of Boro harvesting	45	52
Period of Amon harvesting	25	28

User interface in the model for entering the nominal week number (1=first week of June 1998) of important price-changing events.

The computer model simulates only the players in the most important marketing channel (by weight of product) for local supply ie farmers to beparis to retailer to consumer.

All the events were arranged on a spreadsheet matrix and price ranges for each player at each price-changing event were added. The price ranges for different players and different events were estimated from the data. The appropriate price

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2   A Faria is a small trader who buys commodities from farmers at the farm gate and sometimes at the gateway to the market. They sell to Beparis. A Bepari is a larger wholesaler who buys mainly from farias, other beparis and occasionally from farmers at markets. Beparis sell to retailers, other beparis but rarely to the final consumer. The investment of the faria is much smaller than that of the bepari.

ranges for each player were associated with each calendar event. A normal baseline price range was estimated and entered into the model. Even though events like Ramadan are very similar to the baseline prices for each of the players, the fact that Ramadan can occur in the middle of some social events such as the wedding/picnic season (as it did in 1998) means that it will have an overriding suppression effect on prices (see the following table for ranges used for each event).

Price location	Eid 1	Eid 2	Picnic/ Wedding	Flooding	Boro	Amon	Normal	Ramadan
Farmer price to Bepari	70	68	65	71	74	62	62	63
Bepari price to Retailer	86	100	85	78	89	67	67	70
Retailer price to Consumer	95	105	93	83	97	76	76	78

Selling prices for persons marketing chicken during different events/seasons in 1998 in Mymensingh. All prices as Taka/kg product. Exchange rate = Tk78/£1 (Nov 1998)

As real data were entered, Figures 8a and 8b (Appendix 2) show that the model simulates price fluctuations well. The model was developed to see how changes in costs, as a result of policy measures, may change profit margins and thus affect consumer and supplier behaviour. Based on mean prices (in the absence of stochasticity) the model predicts that a bepari's mean gross margin for the year is Tk10.04/kg and the retailer's is Tk7.92/kg. However, this does not include the uncertainty implicit in the market place and the fact that prices may vary within certain limits. This uncertainty was simulated through the use of Crystal Ball ™, an add-in to Excel ™, which allows a view of the range of potential gross margins that could occur and their frequency predicted by the model. The model was run 3000 times using Crystal Ball ™ in a MonteCarlo simulation where the prices from each player for each seasonal and non-seasonal (baseline) event were sampled randomly from the price distributions over the course of the year. This gave the results shown in Figures 9a and 9b (Appendix 2) where the potential mean gross margins for the year are shown for beparis and retailers. The figures show that the probability for making more than the average margin is 50%. This is to be expected considering that the prices are normally distributed.

The model was then used to demonstrate what would have happened to mean margins had flooding not occurred. (It could be used to explore the effects of changing times of Eid or a policy change such as reduction in transport costs). The model was re-run without the flooding event included ie prices were not increased from the baseline for the period the flooding actually occurred. Results are shown in Figures 10a and 10b (Appendix 2). These show that the probability of the bepari achieving a larger margin than the previous mean gross margin of Tk10.04 has decreased to 44.7% (from 50%) whereas the probability of retailers exceeding the mean gross margin when flooding occurred has increased to 62.8% (also from 50%). A policy-maker could use these data for predicting the impact of flood prevention schemes in terms of wealth distribution not only at producer level but also in terms of the marketing of certain produce. The model also shows how the margins of retailers and beparis differ in the event of different occurrences as one player benefited from the flood while the other did not.

Contribution of Outputs to Project Goal:

The research goal is to increase the productivity and productive potential of the peri-urban interface through improvement in supply and value of animal products, and improved contribution of livestock to crop production. Research outputs to date present a thorough understanding of the peri-urban production and marketing systems of six key livestock products in two towns in Bangladesh and a measure of the external influences which have a bearing on their production, supply and demand. A method of establishing this understanding is presented and may be adaptable to other countries in the region which have relatively recent and reliable census data based on small administrative units. Data produced may be manipulated through one or more computer models thus presenting an opportunity to determine the effect of exercising a range of policy options designed to increase production and productivity of livestock products in peri-urban areas of larger towns in Bangladesh before they are put into practice.

Dissemination Outputs

Publications:

None

Internal Reports:

1. Report on a visit to Bangladesh to identify collaborators and locations for a research project to increase urban protein supply. 17 November to 1 December 1995 (D Silverside).

2. Report on a visit to Bangladesh to agree with the Bangladesh Agricultural University terms of reference for a research project to increase urban protein supply. 1 to 9 February 1996 (D Silverside and B Baker).

3. Report on a visit to Bangladesh to initiate a research project entitled improvements in the production of livestock products in peri-urban areas of cities in Asia. 12 September to 4 October 1996 (D Silverside and J Sherington and N Marsland).

4. Report on a visit to Bangladesh to supervise the research students undertaking the improvement of the production of livestock in peri-urban areas of cities in Asia. 11 to 17 January 1997 (D Silverside and J Sherington).

5. Report on a visit to Bangladesh to supervise the research students undertaking the improvement of the production of livestock in peri-urban areas of cities in Asia. 1 to 23 May, 1997 (D Silverside and J Sherington and N Marsland).

6. Report on a visit to Bangladesh to supervise the research students undertaking the research project entitled improvements in the production of livestock products in peri-urban areas of cities in Asia. 23 April to 14 May 1998 (D Silverside and N Marsland).

7. Report on a visit to Bangladesh to supervise and instruct research students undertaking the research project entitled improvements in the production of livestock products in peri-urban areas of cities in Asia. 23 April to 14 May 1998 (Dr A W Leach).

8. Report on a visit to Bangladesh to supervise the research students undertaking the research project entitled improvements in the production of livestock products in peri-urban areas of cities in Asia. 18 to 27 November 1998 (D Silverside).

9. Report on Policy Modelling for Livestock Production and Marketing in Two Bangladeshi Towns. July 1999 (Dr A W Leach).

Other Dissemination of Results:

10. Prof M Gill gave a lecture at the Commonwealth Heads of Government Meeting (22-24 October 1997), in Edinburgh, using this project as an example of good partnership development. The lecture was in the session 'Sustainable Communities through Partnership, Panel on Communications – Key to Effective Partnerships'.

11. A presentation of research findings to date was given by D Silverside to research leaders at the inaugural meeting of the Bangladesh Research Group, Leeds, March 1998.

12. A presentation of research findings to date was given by D Silverside to researchers in urban agriculture at the Urban Exchange Day, Imperial College, London 1 April 1998.

13. A presentation of research findings to date was given by Miss Momotaz Moholl and Mr Monayem Miah to a number of Professors and students at the BAU, on 26 April 1998.

14. A presentation was given to all stakeholders by Miss Momotaz Moholl, Mr Monayem Miah, D Silverside and A Leach at a stakeholders meeting on 5 April 2000 at the Bangladesh Institute of Development Studies, Dhaka Bangladesh.

Requirement for Further Research and Dissemination

The original wording of this project was 'to develop a computer model… if possible'. This has been proven possible but the models remain in elementary form as their full development was neither planned nor funded. The project is now poised to develop the computer models further so that policy options may be presented to policymakers in Bangladesh and, perhaps, other countries in the region. The Programme Advisory Committee has accepted a Concept Note on such a project.

Acknowledgements

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Appendix 1   Tables

Table 1
The prices of protein foods in the markets of three towns, in Taka, on 25 Sept 1996:

Protein food	Sylhet	Mymensingh	Pabna
Buffalo meat/kg	65	na	35-40
Cow meat/kg	70-80	60-70	50-60
Goat meat (male) /kg	120-130	100-110	100-120
Goat meat (female) /kg	110 120	90	80
Sheep meat /kg	90 - 100	na	80
Chicken (live f/r local)	110-120	80	80
Chicken,(farmed)	70	75	72
Duck? (live)	125-130	na	na
Eggs deshi chicken/4	16	12	12
Eggs duck/4	16	13	12
Milk/l	24	16-20	14
Fish, Rui 1-2 kg/kg	110-120	120-160	50-70
Fish, Rui 2-3 kg/kg	155-160	na	100-140
Fish, Rui 3+ kg/kg	195-225	na	na
Fish, Katla /kg	145-155	100-140	100-120
Fish, Hilsa/kg	60-65	50-60	60-70
Fish, Prawn (middle)	225	na	na
Fish, Magur	150-170	130-160	na

Source: District Marketing Offices in Sylhet, Mymensingh and Pabna

Table 2
'Wealth Indicators' and other data taken from the 1991 census for the three 'municipal areas'

Percentage	Sylhet	Mymensingh	Pabna
'Other' employment	44	38	39
Tap water	30	28	16
Sanitary toilet	72	60	57
Electricity	81	74	76
Landless	74	66	73
Thatch roof	5	15	na.
Hindu	13	16	8

Table 3: Coefficients from principal components analysis for two towns based on 1991 census data.

Variable (percentage)	Mymensingh Index	Sylhet Index 1	Sylhet Index 2
Literacy rate	-.18	-.18	-.19
Houses with straw roof	.29	.23	.35
Houses with cement roof	-.12	-.07	-.09
School attendance rate	-.13	-.09	-.18
People engaged in housework	.06	.07	-.12
People not working	-.08	-.05	-.01
Workers engaged in agriculture	.41	.40	-.06
Houses with tap water	-.14	-.18	-.10
Houses using pond/river water	.02	.41	-.22
Wells which are tube wells	-.13	.00	-.24
Houses with sanitary toilet	-.28	-.25	-.24
Houses with no toilet	.28	-.04	.50
Houses with electricity	-.38	-.35	-.18
Landless households	-.18	-.21	.28
H/hs main income is farming	.31	.31	-.18
H/hs main income is agric. labour	.14	.11	.15
H/hs main income is non-ag. labour	-.02	.01	.00
H/hs main income is other	-.43	-.44	.03
Hindu	-.03	-.07	.42
% Variation accounted for	68	49	29

Table 4: Groups derived from cluster analysis and mean values of selected variables. (See Table 3 for expanded variable descriptions)

Group	Mymensingh No. of mauzas	Index	Literacy	Straw roof	Attend school	Work in agric.	Pond/ river	Percentage Sanitary toilet	No toilet	Elec tricty	Income farming	Income ag. lab.	Income 'Other'	Hindu
1	14	32	23	63	30	69	3	3	61	3	50	26	21	1
2	4	44	29	65	33	78	11	8	58	6	67	16	16	7
3	4	19	18	75	24	58	3	3	22	0	46	19	29	4
4	7	-23	29	40	32	37	1	6	47	13	26	17	49	4
5	2	-111	46	27	49	5	1	39	10	52	5	1	90	1
6	2	-160	65	10	58	1	0	69	2	89	1	0	96	14

Tentative interpretation: Groups 1 to 3 - Rural ; Group 4 - Peri-urban ; Groups 5 & 6 - Urban

Group	Sylhet No. of mauzas	Index	Literacy	Straw roof	Attend school	Work in agric.	Pond/ river	Percentage Sanitary toilet	No toilet	Elect- ricty	Income farming	Income ag. lab.	Income 'Other'	Hindu
1	12	50	29	41	33	56	82	13	10	0	42	27	25	6
2	3	121	15	79	15	97	92	3	2	0	93	5	0	0
3	2	-62	12	72	7	0	0	0	96	7	0	0	100	84
4	2	5	18	87	18	66	0	2	90	2	0	68	31	87
5	2	23	46	6	53	78	50	54	2	7	58	8	33	4
6	8	-32	40	18	42	23	41	21	6	28	18	8	69	6
7	5	-129	67	4	48	0	1	78	1	80	0	0	98	9

Tentative interpretation: Groups 1, 2 - Rural; Groups 3 & 4 - Tea gardens; Group 5 - to be determined; Group 6 - Peri-urban; Group 7 - Urban.

Table 5 Means of variables from 1991 census data, classified by town and area.

Town	Area	Population density '000s/km	Literacy rate (%)	Houses with straw roof (%)	Houses with cement roof (%)	Children attending school (%)	House-work (%)	Not working (%)	Agriculture (%)	Tap water (%)	River water (%)
Mymensingh	**Rural**	3.75	23.27	65.67	.24	29.70	39.96	14.67	68.78	0.03	3.60
	Peri-urban	5.29	28.99	43.01	1.19	31.06	34.86	20.56	41.23	0.36	3.79
	Urban	20.15	55.55	18.44	22.15	53.51	29.77	29.73	3.03	24.40	0.78
Pabna	**Rural**	2.66	14.44	52.16	.16	23.09	40.38	13.19	72.69	0.00	3.90
	Peri-urban	5.87	25.67	28.74	4.72	33.70	36.03	22.18	26.58	0.64	0.94
	Urban	5.04	48.20	19.25	29.87	48.91	31.80	25.80	8.28	1.57	6.66
Sylhet	**Rural**	2.14	28.89	43.73	5.15	32.31	38.78	16.01	65.63	0.04	79.92
	Peri-urban	5.20	40.25	18.15	3.98	42.31	34.69	20.42	22.83	0.16	41.03
	Urban		66.62	4.30	21.43	47.90	30.24	23.09	0.38	51.03	0.50
	Tea garden	0.93	14.90	79.26	0.00	12.10	12.47	19.21	33.05	0.17	0.00

Table 5 (continued): Means of variables from 1991 census data, classified by town and area.

| Town | Area | Wells which are tubewells (%) | Households | | | | Households whose main income | | | | Hindu population (%) |
			Sanitary toilet (%)	No Toilet (%)	Electricity (%)	Landless (%)	Farming (%)	Agricultural labour (%)	Non-agricultural labour (%)	Other (%)	
Mymensingh	**Rural**	79.21	2.67	52.79	2.08	42.41	51.18	24.16	2.66	22.00	2.79
	Peri-urban	86.05	8.45	49.45	14.19	56.05	33.24	15.04	7.44	44.28	3.20
	Urban	97.16	53.90	6.17	70.28	70.43	3.11	.77	3.11	93.00	7.56
Pabna	**Rural**	94.16	3.72	29.65	4.71	48.14	44.33	31.77	4.26	19.64	2.22
	Peri-urban	97.43	12.68	39.89	18.96	69.87	15.71	14.81	10.78	58.70	1.17
	Urban	93.26	38.28	20.29	58.27	69.69	7.89	3.97	7.30	80.84	10.97
Sylhet	**Rural**	95.08	16.51	7.52	.94	37.18	52.95	20.71	4.53	21.81	4.38
	Peri-urban	98.46	21.17	5.50	27.88	65.69	17.85	8.10	5.35	68.70	5.85
	Urban	97.72	77.70	1.48	80.21	66.30	.41	.18	1.71	97.70	9.19
	Tea garden	58.99	1.04	93.21	4.38	97.58	.00	33.87	.69	65.44	85.33

Table 6: List of selected mauzas, classified by town and area.

		Thana		Union		Mauza	
		Name	geo-code	Name	geo-code	Name	geo-code
Mymensingh	**Rural**	Fulbaria	20	Balian	23	Balian	98
		Fulbaria	20	Kushmail	59	Kushmail	633
		Gauripur	23	Gauripur	31	Chander Satia	172
		Ishwarganj	31	Tarundia	90	Sakhua	859
		Ishwarganj	31	Uchahila	94	Golla Joypor	363
		Mymensingh	52	Borar Char	27	Borar Char	201
		Mymensingh	52	Char Ishwardia	33	Char Haripur	269
		Mymensingh	52	Char Nilakshmia	40	Mahazzampur	665
		Mymensingh	52	Dapunia	47	Katla Sen	576
		Mymensingh	52	Khagdahar	67	Jelkhanar Char	516
		Mymensingh	52	Paranganj	88	Hasadia	493
		Mymensingh	52	Sirta	94	Char Bhabanipur	239
		Mymensingh	52	Sirta	94	Gobindapur	448
		Muktagachi	65	Kumarghata	69	Kumarghata	613
		Muktagachi	65	Mankon	77	Bade Majhira	22
		Phulpur	81	Balikhan	9	Rautanbari	868
		Phulpur	81	Kakni	40	Guatala	448
		Phulpur	81	Kamaria	49	Kamaria	551
		Phulpur	81	Rampur	72	Terasia	964
		Phulpur	81	Rupasi	76	Naihati	720
		Trishal	94	Rampur	66	Rampur	872
	Peri-urban	Gauripur	23	Bokainagar	22	Rasulpur	817
		Mymensingh	52	Akua	10	Barera	127
		Mymensingh	52	Bhabkhali	20	Panghagra	770
		Mymensingh	52	Char Ishwardia	33	Char Ishwardia	276

		Thana		Union		Mauza	
		Name	geo-code	Name	geo-code	Name	geo-code
		Mymensingh	52	Char Nilakshmia	40	Char Ragurampur	293
		Mymensingh	52	Dapunia	47	Dapunia	366
		Mymensingh	52	Khagdahar	67	Kalikapur	538
		Trishal	94	Bailar	9	Kanhar	599
	Urban	Mymensingh	52	Ward 02	2	Goalkandi (part a)	311
		Mymensingh	52	Ward 06	6	Baghmara	29
		Mymensingh	52	Ward 06	6	Uttar Sehara	946
		Mymensingh	52	Akua	10	Akua (part)	14
Pabna	**Rural**	Atgharia	5	Debottar	31	Dhaleshwar	277
		Atgharia	5	Ekdanta	47	Gopalpur	367
		Chatmohar	22	Danthia	25	Dakshin Bamangram	317
		Chatmohar	22	Mulgram	77	Bhabanipur	168
		Ishwardi	39	Dashuria	10	Manikair	695
		Pabna	55	Ataikula	8	Kanklakhali	527
		Pabna	55	Bharara	17	Char Bharara	186
		Pabna	55	Bharara	17	Khas Char Dhubraku	562
		Pabna	55	Bharara	17	Pirpur	812
		Pabna	55	Dapunia	34	Bara Digsail	63
		Pabna	55	Dogachhi	43	Dubkhola	336
		Pabna	55	Dogachhi	43	Radhakantapur	836
		Pabna	55	Gayeshpur	51	Machhimpur	646
		Pabna	55	Maligachha	77	Gharlagra	384
		Pabna	55	Sadullahpur	94	Char Adanga	245
		Kumarkhali	71	Jadu Boyra	34	Bilkati	174
		Kumarkhali	71	Shelaidaha	94	Kalyanpur	530

| | | **Thana** | | **Union** | | **Mauza** | |
		Name	geo-code	Name	geo-code	Name	geo-code
		Santhia	72	Ataikula	8	Gangahati	305
		Pangsha	73	Bahadurpur	5	Suklambadia	934
		Kushtia ST	79	Hatas Haripur	44	Ragunathpur	867
	Peri-urban	Bheramara	15	Bahir Char	27	Paschim Bahir Char	902
		Ishwardi	39	Malduli	42	Chak Naricha Bagba	276
		Pabna	55	Dogachhi	43	Balarampur	59
		Pabna	55	Dogachhi	43	Dakshin Ramchandra	275
		Pabna	55	Dogachhi	43	Mahendrapur	665
		Pabna	55	Hemayetpur	60	Kismat Pratappur	590
		Kushtia ST	79	Ailchara	12	Bara Ailchara	85
		Kushtia ST	79	Hatas Haripur	44	Boaildaha	178
		Kushtia ST	79	Jagati	50	Jagati	459
	Urban	Pabna	55	Ward 05	5	Chak Chatiani	189
		Pabna	55	Maligachha	77	Radhanagar (part)	840
		Kumarkhali	71	Ward 01	1	Kundu Para	383
Sylhet	**Rural**	Balaganj	8	Dayamir	27	Khagdiar	480
		Balaganj	8	Dewan Ba	33	Bashirpu	121
		Biswanat	20	Alankari	10	Rahimpur	826
		Biswanat	20	Biswanat	21	Raj Moha	839
		Biswanat	20	Deokalas	42	Daudpur	259
		Biswanat	20	Khazanch	63	Madanpur	596
		Chhatak	23	Saila Af	90	Rarigaon	813
		Companig	27	Telikhal	71	Taiya Pa	938
		Golabgan	38	Lakshmi	60	Nimadal	805

	Thana		Union		Mauza	
	Name	geo-code	Name	geo-code	Name	geo-code
	Golabgan	38	Lakshana	69	Lakshana	706
	Gowaingh	41	Rustampu	73	Sakar Pe	867
	Sylhet	62	Daudpur	19	Daulatpu	262
	Sylhet	62	Hatkhola	22	Bara Kap	118
	Sylhet	62	Hatkhola	22	Jainkark	391
	Sylhet	62	Jalalpur	28	Burunda	202
	Sylhet	62	Khadimna	35	Kalagul	420
	Sylhet	62	Mogla Ba	60	Naikhai	658
Peri-urban	Golabgan	38	Bagha	8	Bagha	119
	Kanaigha	59	Rajaganj	85	Mirzargh	644
	Sylhet	62	Khadimpa	40	Khidirpu	529
	Sylhet	62	Kuchai	45	Kuchai	549
	Sylhet	62	Kuchai	45	Manipur	618
	Sylhet	62	Kuchai	45	Sreeramp	886
	Sylhet	62	Mollarga	65	Sadharkh	811
	Sylhet	62	Titli	85	Baldi	89
Urban	Sylhet	62	Ward 01	1	Police Line	758
	Sylhet	62	Ward 02	2	Bilpar	148
	Sylhet	62	Ward 04	4	Ambar Kh	28
	Sylhet	62	Ward 04	4	Kumar Pa	492
	Sylhet	62	Ward 05	5	Darjee P	200
Tea Garden	Sylhet	62	Khadimna	35	Charagan	212
	Sylhet	62	Tuker Ba	90	Daldali	247
	Sylhet	62	Tuker Ba	90	Keoya Ch	485
	Sylhet	62	Tuker Ba	90	Tarapur	935

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Distance to road			Distance to town			Transport cost to town (Taka)			Travel time to town (min)		
		Mean	n	SE	**Mean**	n	SE	**Mean**	n	SE	**Mean**	n	SE
Pabna	**Rural**	1.72	18	±0.43	13.7	18	±1.59	6.78	18	±1.39	59	18	±8.9
	Peri-urban	0.20	5	±0.82	6.2	5	±3.02	2.80	5	±2.64	22	5	±16.9
	Urban	0.00	2	±1.30	1.8	2	±4.77	0.00	2	±4.18	6	2	±26.7
Mymensingh	**Rural**	2.92	22	±0.39	15.4	22	±1.44	4.76	22	±1.26	53	22	±8.0
	Peri-urban	1.11	7	±0.69	6.5	7	±2.55	4.43	7	±2.23	26	7	±14.7
	Urban	0.00	4	±0.92	1.1	4	±3.37	2.50	4	±2.96	9	4	±18.9
Sylhet	**Rural**	1.97	16	±0.46	16.9	16	±1.69	12.88	16	±1.48	73	16	±9.4
	Peri-urban	0.78	8	±0.65	10.2	8	±2.39	8.63	8	±2.09	36	8	±13.3
	Urban	0.00	5	±0.82	1.7	5	±3.02	2.00	5	±2.64	60	5	±16.9
F-probabilities	Town	0.103			0.251			0.000			0.31		
	Area	0.000			0.000			0.002			0.00		
	Interaction	0.927			0.959			0.350			0.94		

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Farmers obtaining rice straw from different sources (%)										
		Own local straw			Transporting straw			Purchasing straw			Own + Purchased		
		Mean	**n**	**SE**	**Mean**	**n**	**SE**	**Mean**	**n**	**SE**	**Mean**	**n**	**SE**
Pabna	**Rural**	30.89	18	±6.70	0.00	18	±1.08	21.72	18	±4.59	47.67		±6.66
	Peri-urban	5.20	5	±13.27	0.00	5	±2.05	60.80	5	±8.72	34.00		±12.63
	Urban	0.00	2	±20.98	2.50	2	±3.24	95.00	2	±13.78	2.50		±19.97
Mymensingh	**Rural**	47.73	22	±6.33	0.00	22	±0.98	7.27	22	±4.16	45.00		±6.02
	Peri-urban	41.43	7	±11.21	0.00	7	±1.73	9.29	7	±7.37	49.29		±10.68
	Urban	0.00	4	±14.84	20.00	4	±2.29	78.50	4	±9.75	1.50		±14.12
Sylhet	**Rural**	63.13	16	±7.42	0.00	16	±1.14	5.94	16	±4.87	30.94		±7.06
	Peri-urban	75.88	8	±10.49	0.00	8	±1.62	8.13	8	±6.89	12.88		±9.99
	Urban	0.00	5	±13.27	1.00	5	±2.05	79.00	5	±8.72	0.00		±12.63
F-probabilities	Town	0.000			0.066			0.000			0.036		
	Area	0.000			0.000			0.000			0.001		
	Interaction	0.169			0.000			0.040			0.598		

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Average price (Taka/kg) of various feeds										
		Rice straw			**Mustard oil cake**			**Rice bran**			**Wheat bran**		
		Mean	n	SE	**Mean**	n	SE	**Mean**	n	SE	**Mean**	n	SE
Pabna	**Rural**	1.54	18	±0.17	6.89	18	±0.20	1.71	18	±0.13	7.78	18	±0.37
	Peri-urban	1.52	5	±0.32	7.50	5	±0.39	2.50	5	±0.25	6.99	5	±0.71
	Urban	1.28	2	±0.50	-	0	-	2.56	2	±0.40	8.22	2	±1.12
Mymensingh	**Rural**	1.25	21	±0.15	7.27	22	±0.18	1.83	18	±0.13	7.58	21	±0.35
	Peri-urban	1.62	7	±0.27	7.36	7	±0.33	1.50	6	±0.23	7.21	7	±0.60
	Urban	1.63	4	±0.35	7.06	4	±0.43	2.50	2	±0.40	6.94	4	±0.79
Sylhet	**Rural**	2.10	14	±0.19	7.25	3	±0.50	2.34	15	±0.15	7.16	7	±0.60
	Peri-urban	2.33	5	±0.32	9.17	3	±0.50	2.20	8	±0.20	8.42	6	±0.65
	Urban	3.38	4	±0.35	7.25	2	±0.61	2.12	5	±0.25	6.33	5	±0.71
F-probabilities	Town	0.000			0.052			0.026			0.885		
	Area	0.059			0.065			0.414			0.464		
	Interaction	0.169			0.135			0.011			0.273		

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Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Average price of Molasses (Taka/kg)			Distance to nearest market (km)								
					Nearest market			7-day market*			Livestock market		
		Mean	n	SE	Mean	n	SE	Mean	n	SE	Mean	n	SE
Pabna	**Rural**	5.25	18	±0.33	2.41	18	±0.45	2.41	18	±0.46	4.27	18	±0.43
	Peri-urban	4.75	5	±0.62	1.20	5	±0.86	1.70	5	±0.88	1.88	4	±0.91
	Urban	5.50	2	±0.98	0.88	2	±1.36	0.88	2	±1.39	4.80	2	±1.29
Mymensingh	**Rural**	7.07	11	±0.42	1.63	22	±0.41	2.04	20	±0.44	3.33	19	±0.42
	Peri-urban	6.75	2	±0.98	1.21	7	±0.73	1.21	7	±0.74	2.33	6	±0.74
	Urban	5.69	4	±0.69	0.31	4	±0.96	0.31	4	±0.98	-	0	-
Sylhet	**Rural**	7.98	9	±0.46	3.28	16	±0.48	3.84	16	±0.49	3.00	11	±0.55
	Peri-urban	8.17	3	±0.80	1.76	8	±0.68	1.89	8	±0.70	3.00	3	±1.05
	Urban	7.00	5	±0.62	0.80	5	±0.86	0.80	5	±0.88	1.33	3	±1.05
F-probabilities	Town	0.000			0.053			0.038			0.124		
	Area	0.197			0.008			0.002			0.095		
	Interaction	0.707			0.846			0.757			0.202		

*   7-day market = Open every day of the week

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Price of milk (Taka/kg)										
		Sold to Goala			Sold at market			Sold at farmgate			Delivered to consumer		
		Mean	n	SE	Mean	n	SE	Mean	n	SE	Mean	n	SE
Pabna	**Rural**	10.5	11	±0.44	14.4	17	±0.36	-	0	-	13.6	14	±0.49
	Peri-urban	11.0	1	±1.44	14.0	4	±0.75	-	0	-	14.4	5	±0.82
	Urban	-	0	-	13.5	2	±1.06	-	0	-	15.0	2	±1.30
Mymensingh	**Rural**	12.0	13	±0.40	15.1	20	±0.34	14.3	4	±0.80	15.6	16	±0.46
	Peri-urban	13.0	7	±0.55	17.0	6	±0.61	16.0	1	±1.60	15.7	6	±0.75
	Urban	-	0	-	-	0	-	-	0	-	20.3	4	±0.92
Sylhet	**Rural**	-	0	-	-	0	-	20.0	1	±1.60	15.0	2	±1.30
	Peri-urban	18.5	2	±1.02	-	0	-	20.7	3	±0.92	21.3	3	±1.06
	Urban	21.0	2	±1.02	-	0	-	22.5	4	±0.80	20.7	3	±1.06
F-probabilities	Town	0.000			0.011			0.004			0.000		
	Area	0.087			0.170			0.194			0.000		
	Interaction	0.704			0.039			0.684			0.007		

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Price of different fish species (Taka/kg)										
		Rui			Katla			Hilsa			Carpio		
		Mean	n	SE	**Mean**	n	SE	**Mean**	n	SE	**Mean**	n	SE
Pabna	**Rural**	104	18	±5.2	96	18	±5.2	87	18	±2.8	64	18	±5.8
	Peri-urban	108	5	±10.0	86	5	±9.8	90	5	±5.3	68	5	±11.0
	Urban	118	2	±15.8	110	2	±15.5	83	2	±8.4	58	2	±17.3
Mymensingh	**Rural**	80	19	±5.1	76	19	±5.0	63	12	±3.4	73	12	±5.6
	Peri-urban	84	6	±9.1	80	6	±8.9	64	5	±5.3	80	5	±11.0
	Urban	119	4	±11.2	110	4	±11.0	68	4	±5.9	79	4	±12.2
Sylhet	**Rural**	130	14	±6.0	122	14	±5.9	94	16	±3.0	125	16	±6.8
	Peri-urban	116	8	±7.9	100	8	±7.8	79	8	±4.2	95	8	±8.7
	Urban	136	5	±10.0	124	5	±9.8	92	5	±5.3	108	5	±11.0
F-probabilities	Town	0.000			0.000			0.000			0.000		
	Area	0.014			0.009			0.293			0.516		
	Interaction	0.260			0.256			0.150			0.155		

Table 7 : Adjusted means (and standard errors) for different variables for the three areas within each of the towns

		Price of 4 Eggs*			Price of Chicken (live) (T/kg)			Price of Goat (live) (T/10kg)		
		Mean	n	SE	**Mean**	n	SE	**Mean**	n	SE
Pabna	**Rural**	10.0	18	±0.26	81	18	±2.6	106	18	±4.9
	Peri-urban	11.6	5	±0.49	83	5	±4.8	112	5	±9.4
	Urban	12.8	2	±0.78	79	2	±7.6	107	2	±14.9
Mymensingh	**Rural**	10.2	22	±0.24	67	22	±2.3	107	22	±4.5
	Peri-urban	11.0	7	±0.42	68	7	±4.1	107	7	±7.9
	Urban	13.1	4	±0.55	733	3	±6.2	-	0	-
Sylhet	**Rural**	11.4	16	±0.28	91	16	±2.7	156	16	±5.3
	Peri-urban	12.8	8	±0.39	97	8	±3.8	134	6	±8.5
	Urban	15.5	5	±0.49	95	5	±4.8	144	5	±9.4
F-probabilities	Town	0.000			0.000			0.000		
	Area	0.000			0.496			0.578		
	Interaction	0.394			0.861			0.266		

* Eggs are always sold in clutches of 4

Table 8: Phase 2

Summary of Livestock Production system

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		*Unit* (with remarks)
Occupation of head of household:						
						Percentage
In agriculture	34 - 51	(higher)	13 - 19	0 - 4	(lower)	
In business	15 – 21	(lower)	21 - 42	44 - 60	(higher)	
In service	9 - 16	(lower)	13 – 22	21 – 30	(higher)	
Household demography						
						No/household
Average total no of people	6.19 – 9.35	(higher)	6.88 – 8.81	6.52 – 8.40	(lower)	
Under 15 years	2.40 – 4.10	(higher)	2.40 – 3.10*	1.78 – 2.15	(lower)	* similar in rural Pabna
Between 15 to 55 years	3.48 – 4.36	(lower)	3.82 – 4.95	4.39 – 5.50	(higher)	
Over 55 years	0.31 – 0.89*	(lower)	0.54 – 0.76	0.35 – 0.75	(lower)	* except rural Sylhet
Length of time living in this location						
						Percentage
Born in this locality	90 – 95	(higher)	79 – 85	53 – 74	(lower)	
Movement into area	5 – 10	(lower)	12 – 21	26 – 47	(higher)	

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		*Unit* (with remarks)
Land holding						
Own land holder	57 – 78	(higher)	37 – 50	6 – 25	(lower)	Percentage
Area of total own land	232 – 273	(lower)	171 – 342	369 – 565	(higher)	In decimals * except p-u Mysingh
Total land holder	72 – 82	(higher)	39 – 61	6 – 26	(lower)	Percentage
Area of total land	243 – 278	(lower)	223 – 280	354 – 562	(higher)	In decimals All except p-u Mysingh
Fallow land holder	1 – 9	(lower)	3 – 6	4 – 6	(higher)	Percentage All except Mysingh
Area of fallow land	30 – 132	(lower)	37 – 126*	220 – 736	(higher)	In decimals * except p-u Pabna
Homestead area	27 – 34	(higher)	20 – 42*	9 – 15	(lower)	In decimals *except urban Mysingh
Farming system activity and purpose						
						Percentage
Household has farm	73 – 85	(higher)	53 - 67	12 – 32	(lower)	
Main income is farming	28 – 75	(higher)	13 – 31*	0 – 41	(lower)	* except p-u Pabna
Availability of rented land	74 – 95	(higher)	74 – 76	14-28	(lower)	
Want rented land	33 – 42	(higher)	21 – 47*	0 – 33	(lower)	* except p-u Pabna
Borrow cash for farming	41 – 77	(higher)	17 – 37	0 – 10	(lower)	

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Sources of capital investment						
						percentage
Bank	5 – 32	(higher)	4 – 7	0	(lower)	
Neighbour	18 – 36*	(higher)	31 – 33*	0 – 33	(lower)	* except p-u My & Sy
Relatives	24 – 46*	(higher)	29 – 46*	0 – 33	(lower)	* except p-u Mysingh
Village money man	12 – 17	(lower)	13 – 29	0 – 50	(higher)	
NGO	5 – 10	(higher)	0 – 4	0 – 50	(lower)	
Use of borrowed money						Nobody borrows in Sylhet percentage
Labour	16 – 18	(lower)	17*	0 – 29	(higher)	
Seed	5 – 24	(lower)	10 – 25	0 – 20	(lower)	
Irrigation	7 – 23	(lower)	17 – 29	20 – 29	(higher)	
Fertiliser	23 – 29	(lower)	17 – 31	29 – 40	(higher)	
Pesticide	3 – 13	(similar)	3 – 13	0	(lower)	
Types of crops farmed						Score
Paddy as food	210 – 246	(higher)	126 – 168	21 75	(lower)	
Wheat as food	24 – 66*	(higher)	13 – 35*	4 – 23*	(lower)	* none grown in Sylhet
Vegetables as food	7 – 15*	(higher)	2 – 23*	0 – 1	(lower)	
Pulses as food	6 12	(lower)	10 – 30	3 14	(lower)	
Potato as food	0 – 36*	(higher)	3 18*	0 – 2	(lower)	* except p-u Pabna
Jute as cash	6 – 155	(higher)	0 – 64	0 15	(lower)	
Paddy as cash	12 – 86	(higher)	6 - 15*	9 – 12	(lower)	* except p-u Sylhet

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Vegetables as cash	12 – 21	(higher)	5 – 9*	0 – 9*	(lower)	* similar in Pabna
Livestock/fish						Percentage
Livestock/fish householder	88 – 90	(higher)	81 – 89	42 – 74	(lower)	
Cattle keeper	61 – 63	(higher)	41 – 52	24 – 31	(lower)	
Poultry keeper	88 – 94	(higher)	84 – 90	76 – 88	(lower)	
Duck keeper	35 – 41	(higher)	20 – 30*	26 – 32*	(lower)	* except p-u Sylhet
Goat keeper	16 – 49*	(higher)	15 – 53*	6 – 42	(lower)	* except p-u Pabna
Fish pond holder	41 – 53	(higher)	24 – 53	14 – 26	(lower)	
CATTLE						
Number of cattle held						Number
Average number of cattle	2.8 – 3.6	(higher)	2.4 – 3.9*	4.4 – 10.6	(higher)	* except p-u Sylhet
Average number of cows	1.0 – 1.4*	(higher)	0.83 – 1.58*	2.2 – 4.8	(higher)	* except p-u Sylhet
Average number of bulls	0.5 – 1.3*	(higher)	0.5 – 1.0*	0.1 – 1.8*	(lower)	* except p-u Sylhet
Average number of calves	0.8 – 1.2	(higher)	0.5 – 1.1	1.7 – 3.5	(higher)	
Breeding systems						Percentage
Natural (ie by bull)	46 – 87*	(higher)	59 – 82*	25 – 44	(lower)	* except p-u Mysingh
Artificial insemination	6 – 25*	(lower)	14 – 27*	22 – 75*	(higher)	* except p-u Mysingh
Both	3 – 30*	(lower)	3 – 28*	0 – 33*	(higher)	* except Sylhet
Calving						Percentage
Birth of one calf each year	27 – 53	(lower)	46 - 48	67 – 78	(higher)	
Use of concentrate feed						Percentage
Use concentrate feed	61 – 91*	(lower)	75 – 96*	83 – 100*	(higher)	* except p-u Mysingh

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Rearing and housing **Daytime**						Percentage
Field/verges	32.2 – 47.8*	(higher)	26.3 – 47.1	28.6 – 50.0	(lower)	* except p-u Sylhet
FVG > 3	30.4 – 54.8	(higher)	22.2 – 36.8*	7.1 – 14.3	(lower)	FVG>3 is absent in Sy
Grazing	0 – 63.2***	(higher)	5.3 – 35.3**	25 – 42.9*	(lower)	* except urban and *** rural Mysingh ** No grazing in Pabna
Outside the house	4.3 – 6.5	(lower)	22.2 – 26.3*	14.3 – 42.9**	(higher)	* absent in Sylhet ** expt urban Mysingh
Night-time						
Housed in outside pen	94.7 – 100	(higher)	70.6 – 100*	75 – 85.7	(lower)	* similar in rural Pabna
Housed in pen in building	0 – 5.3	(lower)	0 – 23.5	14.3 – 25.0	(higher)	
Labour						Percentage
Family labour	84.4 – 95.3	(higher)	77.1 – 97.6	49.2 – 92.2	(lower)	
Hired labour	4.7 – 15.6*	(lower)	2.4 – 22.9	7.8 – 50.8	(higher)	* except in rural Pabna
Increase in cattle production						Percentage
Interested in increasing cattle production	89 – 98		85 – 100	67 – 89		
Problems with cattle production						Total score
Lack of cash	309 – 379	(higher)	214 246	23 – 84	(lower)	
Lack of credit	28 – 139*	(higher)	19 – 107*	0 – 13	(lower)	* except in p-u Pabna

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Lack of land	105 – 118	(higher)	56 – 97	16 – 24	(lower)	
Lack of labour	77 – 112	(higher)	62 – 112	16 – 56	(lower)	
Lack of feed	63- 120	(higher)	17 – 43	8 – 25	(lower)	
High price of feed	32 – 137	(higher)	18 – 91	12 – 22	(lower)	
Disease	119 – 259	(higher)	75 – 124	25 – 33	(lower)	
Lack of improved breed	7 – 55	(higher)	0 – 25	0 – 7	(lower)	
POULTRY						
Number of Poultry						Number
Average number of poultry	10.4 – 14.2	(higher)	8.7 – 11.3	7.1 – 10.6	(lower)	
Average no of hen	3.2 – 3.7	(lower)	3.3 – 3.9	2.8 – 4.9	(higher)	
Average number of cocks	.05 – 1.0**	(lower)	0.7 – 1.1*	0.5 – 1.4*	(lower)	* & ** except p-u Sy/Pb
Average number of chicks	4.7 – 9.0	(higher)	3.4 – 6.8*	1.6 – 3.7*	(lower)	* except p-u Pabna
Buying pullet						Percentage
Households buying pullet	19 – 25	(lower)	34*	32 – 50*	(higher)	* except p-u Pabna
From where						
Local market	83 – 100	(higher)	61 – 88*	57 – 86*	(lower)	* except p-u Mysingh
Local farm	0 – 6*	(lower)	0 – 8*	5 – 18	(higher)	* except p-u Pabna
Village	9 – 11	(higher)	6 – 13	0 – 11	(lower)	No purchase in Sylhet
From whom						
Producer	13 – 78	(higher)	4 – 34	18 – 23*	(lower)	* except p-u Sylhet
Middleman	22 – 88	(lower)	66 – 96*	77 – 81*	(higher)	* except p-u Sylhet
Feeding						
Use concentrate feed	83 – 99	(higher)	74 – 95	59 – 91	(lower)	

Rearing

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Backyard	100	(higher)	99 – 100	99 – 100	(similar)	

Housing at night

Housed in outside pen	44 – 94*	(higher)	80 – 87*	51 – 94*	(higher)	* except p-u Sylhet
Housed in building	0 – 1	(lower)	1 – 9	0 – 49*	(higher)	* except p-u Mysingh
Inside farmer's house	7 – 54*	(higher)	11 – 16*	0 – 8	(lower)	* except p-u Mysingh
						Percentage

Labour

Family Labour	97.2 – 98.8**	(similar)	93.5 – 99.0	0 – 100*	(lower)	* except urb Mysingh
Hired Labour	1.25 – 2.77**	(similar	0.96 – 6.51	0 – 6.59	(higher)	** except rural Sylhet
Increase poultry production?	94 – 99*	(higher)	90 – 96	84 – 92	(lower)	* except p-u Pabna

Problems with Poultry production

Total Score

Lack of cash	323 – 349	(higher)	179 – 329	73 – 175	(lower)	
Lack of credit	32 – 167*	(higher)	16 – 131*	0 – 38	(lower)	* except p-u Pabna
Lack of land	81 – 56*	(lower)	59 – 88*	76 – 139*	(lower)	* except Sylhet
Lack of labour	24 – 61*	(lower)	46 – 109*	26 – 98*	(higher)	* except p-u Mysingh
Lack of feed	17 – 89*	(higher)	17 – 66*	0 – 24	(lower)	* except p-u Pabna
High price of feed	0 – 87*	(higher)	35 – 54*	0 – 21	(lower)	* except p-u Pabna
Disease	428 – 468	(higher)	342 – 402	116 – 216	(lower)	
Theft	0 – 6	(lower)	0 – 34	5 – 63*	(higher)	* except p-u Mysingh
Predators	12 – 40*	(lower)	6 – 22*	0 – 22	(lower)	* except p-u Mysingh

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
						Percentage
Fish Production						
Fish Pond	37 – 57	(higher)	21 – 46	9 – 13	(lower)	
Buy fingerlings	28 – 97**	(higher)	36 – 87*	56 – 92*	(higher)	* except p-u Sylhet and all Mysingh
Use feed	12 – 81*	(higher)	23 – 68*	44 – 47	(higher)	* except rural Sylhet
Labour						
Family Labour	90 – 96.3**	(higher)	90 – 95.7	660-100*	(lower)	* except urban Sylhet ** similar in rural Sylhet and Mysingh
Hired Labour	3.8 – 6.0**	(lower)	0 - 10	0 – 34*	(higher)	* except rural Sylhet
Increase fish production?	30 – 95*	(higher)	39 – 87	56 – 85	(higher)	* except rural Sylhet
Problems with Fish production						Total score
Lack of cash	46 – 215	(higher)	39 – 189	7 – 40	(higher)	
Lack of credit	0 – 147	(higher)	0 – 100	0	(lower)	
Lack of land	31 – 157	(higher)	8 – 163	14 – 19*	(lower)	* except p-u Sylhet
Lack of labour	16 – 80*	(lower)	8 – 86	8 – 38*	(lower)	* except p-u Pabna
Lack of feed	12 – 84	(higher)	0 – 31	0 – 4	(lower)	
High price of feed	13 – 56	(higher)	0 – 14	0 – 11	(lower)	
Disease	15 – 197	(higher)	6 – 147*	0 – 19*	(lower)	* except p-u Pabna

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Livestock Products						
Milk production	2.1 – 2.7	(lower)	2.36 – 3.61	9.8 – 21.83	(higher)	kg/day/household
Milk sales	0.6 – 1.3	(lower)	1.2 – 2.4	2.4 – 16.2	(higher)	
Milk sale price	11.1 – 20	(lower)	13.1 - 23	14.4 – 21.4*	(higher)	Tk/kg * except p-u Sylhet
Egg production	225 – 252	(lower)	235 – 280	350 – 378	(higher)	No/yr/household
Egg sales	59 – 88	(higher)	9 – 75	15 – 99*	(higher)	No/yr/household
Egg sale price	9.5 – 12	(lower)	10.2 – 13.9	12 – 15.3	(higher)	Tk/4no
Poultry production	23.8 – 40**	(higher)	20.2 – 31.7*	20.8 – 43.1*	(higher)	No/yr/household * except p-u Sylhet ** in Pabna
Poultry sales	5.8 – 11.6	(higher)	1.3 – 9.2	0.43 – 2.86	(lower)	No/yr/household
Poultry sale price	72.3 – 91	(lower)	69.5 - 95	78.3 – 80	(higher)	Tk/kg
Fish Production						
Fish production	367 – 855	(lower)	448.5 – 1500	1000 – 2288	(higher)	kg/yr
Fish sales	3261 – 5574	(lower)	3675 - 7981	6000 –54928	(higher)	Tk.yr
Fish sale price	Na		na	na		

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		*Unit* (with remarks)
						Percentage
How Livestock Products are sold						
Milk						
To goala	0 – 55**	(higher)	12 – 20	0 – 14*	(lower)	* abs in rural and urb Sylhet ** except rural Mysingh
From home or farmgate	0 – 50**	(higher)	0 – 40*	14 – 56	(higher)	* abs in p-u Sylhet & Mysingh ** abs in rural Mysingh
Home delivery	18.2 – 54.5*	(lower)	0 – 64.3**	44.4 – 71.4	(higher)	** abs p-u Sylhet * Inc in all rural areas
Market	13.6 – 36.4*	(higher)	0 – 35.3	0 – 7.1	(lower)	* except rural Pabna
Eggs						
Home or farmgate	16.7 – 60.5*	(lower)	36.4 – 75	75 100	(higher)	* except rural Mysingh
Market	23.3 – 77.8*	(higher)	25 – 54.5	0 – 18.8	(lower)	* except rural Pabna
Poultry						
Home or farmgate	0 – 8.3	(lower)	4.5 – 32.6	20 – 100*	(higher)	* except urban Pabna
Market	91.7 – 100	(higher)	67.4 – 90.9	0 – 80	(lower)	
Fish						
Home or farmgate	0 – 26.3*	(lower)	28.6 40	16.7 – 66.7*	(higher)**	* No record Sylhet ** except urban Pabna
Market	73.7 – 82.4*	(higher)	60 – 71.4*	33.3 – 50*	(lower)	* no record in Sylhet

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		Unit (with remarks)
Access to Services						
When did you last see a government Extension Worker						Percentage
			5 – 9	6 – 26	(higher)	
Less than one month ago	3 – 6	(lower)	9 – 20	10 – 24*	(higher)	* except urban Pabna
Other	5 – 11	(lower)	74 - 86	43 – 66	(lower)	
Never	82 – 92	(higher)				
When you last see a NGO Extension Worker						
Less than one month ago	1 – 1	(lower)	1 – 3	0 – 10	(lower)	* except urban Pabna
Other	2 – 3.4**	(higher)	0 – 6	0 – 12*	(lower)	* except urban Mysingh ** except rural Pabna
Never	95 – 97*	(higher)	92 - 97	88 – 100*	(lower)	* except Sylhet
Name of NGO: BRAC,	Grameen Bank, SARA, at		Mymensingh IBES at	Sylhet etc		

	In Rural mauzas (relative to peri-urban mauzas)		In peri-urban mauzas	In Urban mauzas (relative to peri-urban mauzas)		*Unit* (with remarks)
Who carries out livestock treatment						
						* except Mysingh
Veterinarian	4.1 –21.9	(lower)	21.7 – 30.7	33.3 – 50.6	(higher)	
Extension worker	4 – 13.3*	(lower)	4.5 – 22.6	3.8 – 18.2*	(lower)	
Local animal doctor	17.5 – 29.5*	(higher)	8 – 24.5	5.8 – 12.3	(lower)	* except rural Pabna
Farmer himself	8.6 – 32*	(lower)	4.7 – 42	6.1 – 28.8*	(lower)	* except rural Mysingh
Quack doctor	7 – 46.4*	(higher)	0 – 17.7	0	(lower)	
Nobody	11.0 – 18.1	(lower)	11.3 – 21.5	8.6 – 30.3*	(higher)	* except urban Pabna
						Percentage
Training						
Has received raining in livestock production	0 – 1.1	(lower)	2.2 – 6.3	2.7 – 6.8*	(higher)	* except urban Sylhet
Interested in training in livestock production	63.2 – 73.3*	(lower)	48.5 – 74.2	59.6 – 74.3	(higher)**	* except rural Mysingh ** except urban Sylhet
Livestock diseases:						
Cattle:	Fever. FMD, Diarrhoea, tympany,		Cold and worm			
Poultry:	Ranikhet, pox and other					
Duck:	Duck plague, cholera and lameness					
Goat:	Diarrhoea and others					

Appendix 2 Figures

HIERARCHICAL CLUSTER ANALYSIS

Dendrogram using Complete Linkage

```
                                 Re-scaled Distance Cluster Combine
        C A S E                0         5        10        15        20        25
      Label           Num      +---------+---------+---------+---------+---------+

      Gharlagra        21      -+
      Kalyanpur        29      -+-+
      Char Bharara     11      -+ I
      Bara Digsail     14      -+ +---+
      Bara Ailchara    30      -+ I   I
      Manikair         05      -+-+   I
      Kanklakhali      10      -+ I   I
      Ragunathpur      32      ---+   I
      Gopalpur         02      -+       +------+
    1 Gangahati        24      -+-+   I       I
      Dubkhola         17      -+ +---+       I
      Pirpur           13      -+ I   I       I
      Bilkati          28      -+-+   I       I
      Dak.Bamangram    03      -+     I       +-----------+
      Kashinathpur     20      -+     I       I           I
      Khaschar Dubrakul 12     -+     I       I           I
      Char Adanga      23      -+     I       I           I
      Dhaleshwar       01      -------+       I           I
    6 Bhabanipur       04      -----------+---+           I
      Ramchandrapur    16      -+              +----------------------+
      Jagati           33      -+---+          I                      I
    3 Boaildaha        31      -+   +----+     I                      I
      Balarampur       15      ---+-+    I     I                      I
      Kismat Pratappur 19      ---+      I     I                      I
      Radhanagar       22      -+        +-----------+ I              I
      Pas.Bahirchar    26      -+-+      I         I I I              I
    5 Mahendrapu       18      -+ +-+    I         +-+                I
      Char Kurul       06      ---+ +----+         I                  I
      C.N. Bagbari     07      -----+    I         I                  I
    2 Suklambadia      25      ----------+---------+                  I
      Shalgharia       08      -+---+                                 I
    4 Chak Chatiani    09      -+   +-----------------------------------+
      Kundu Para       27      -----+
```

Legend: *Rural mauzas*   = *1, 2 & 6*
             Peri-urban mauzas = 3 & 5
             Urban mauzas   = 4

Figure 1.1 Cluster of rural, peri-urban and urban *Mauzas* of Pabna.

Dendrogram using Complete Linkage

Re-scaled Distance Cluster Combine

```
          C A S E          Num   0         5        10        15        20        25
         Label                   +---------+---------+---------+---------+---------+
    Char Bhabanipur       23   -+
    Gobindapur            24   -+
    Char Haripur          14   -+-----+-+
    Hasadia               22   -+     I
    Borar Char            13   -+     I
    Kamaria               29   -+     I
  1 Balian                 1   -+-+   I
    Golla Joypor          06   -+ +-+ I
    Naihati               31   ---+ +--+
    Katla Sen             19   -+-+ I  I
    Terasia               30   -+ +-+- +-------+
    Kushmail              02   -+ I    I        I
    Rampur                33   -+-+    I        I
    Kumarghata            25   -+      I        I
    Sakhua                05   -+-+    I        I
  2 Rautanbari            27   -+ I    I        I
    Mahazzampur           16   ---+----+        +------------------------------+
    Rasulpur              03   ---+             I                              I
    Char Ishwardia        15   -+-+             I                              I
    Char Ragurampur       17   -+ I             I                              I
    Dapunia               18   -+ +--------+    I                              I
  6 Kalikapur             21   -+ I       I    I                              I
    Barera                11   -+-+       I    I                              I
    Panghagra             12   -+         +----+                              I
    Kanhar                32   -+         I                                   I
    Bade Majhira          26   -+-+       I                                   I
    Guatala               28   -+ +-+     I                                   I
  3 Chander Satia         04   ---+ +-----+                                   I
    Jelkhanar Char        20   -----+                                         I
    Baghmara              08   -+-----+-+                                     I
  4 Uttar Sehara          09   -+     +-----------------------------------+
    Goalkandi (part a)    07   -+-----+-+
  5 Akua (part)           10   -+
```
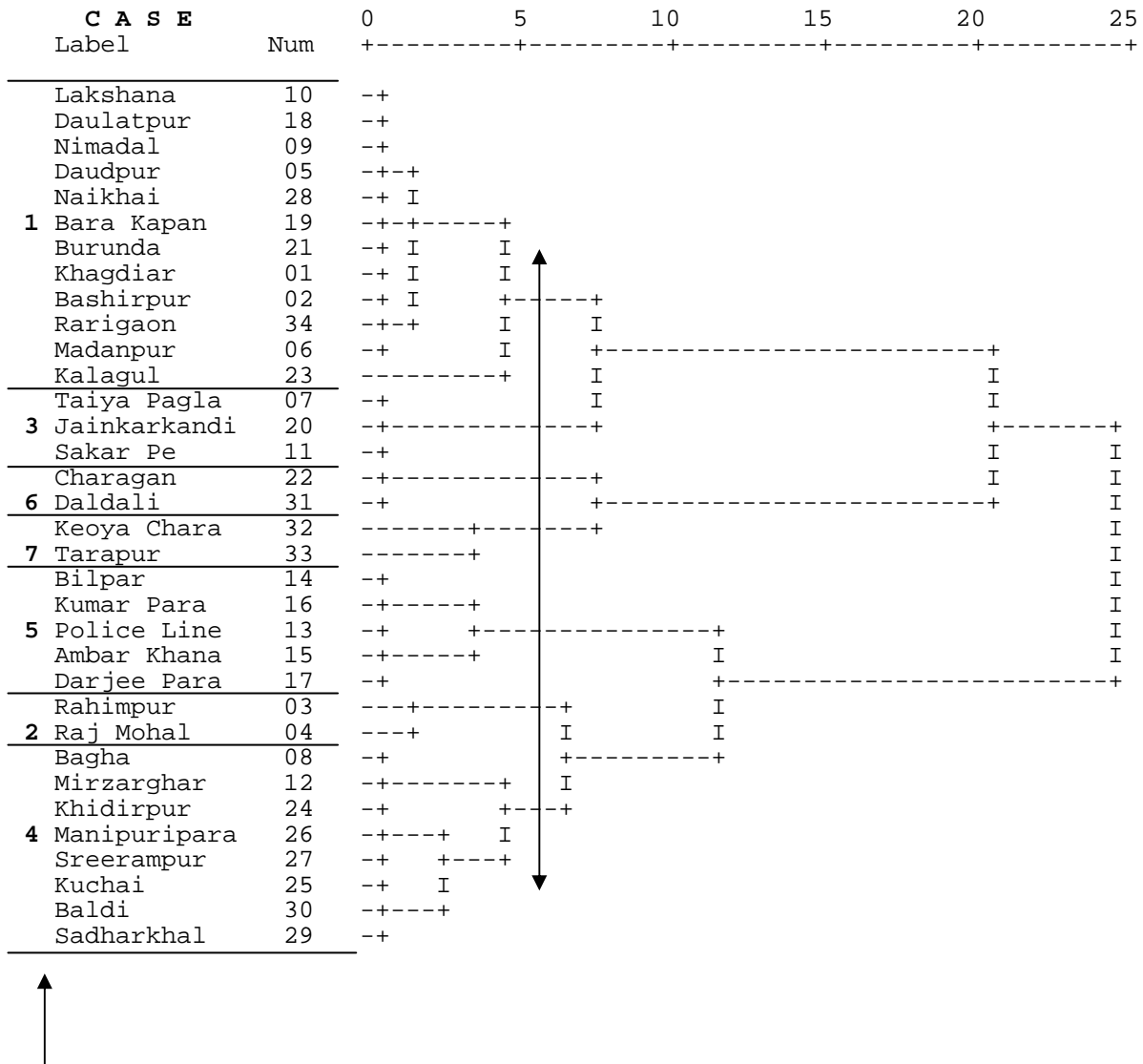
Legend: *Rural mauzas*   *= 1, 2, & 3*
            Peri-urban mauzas = 6
            Urban mauzas   = 4 & 5

Fig 1.2 Cluster of rural, peri-urban and urban *Mauzas* of Mymensingh.

Dendrogram using Complete Linkage

```
                             Re-scaled Distance Cluster Combine

       C A S E               0         5        10        15        20        25
       Label        Num      +---------+---------+---------+---------+---------+

       Lakshana     10       -+
       Daulatpur    18       -+
       Nimadal      09       -+
       Daudpur      05       -+-+
       Naikhai      28       -+ I
     1 Bara Kapan   19       -+-+-----+
       Burunda      21       -+ I     I
       Khagdiar     01       -+ I     I
       Bashirpur    02       -+ I     +-+---+
       Rarigaon     34       -+-+     I   I
       Madanpur     06       -+       I   +-----------------------+
       Kalagul      23       ---------+   I                       I
       Taiya Pagla  07       -+           I                       I
     3 Jainkarkandi 20       -+-----------+---+                   +-------+
       Sakar Pe     11       -+               I                   I       I
       Charagan     22       -+-----------+---+                   I       I
     6 Daldali      31       -+           +-----------------------+       I
       Keoya Chara  32       -------+---+---+                              I
     7 Tarapur      33       -------+                                      I
       Bilpar       14       -+                                            I
       Kumar Para   16       -+-----+                                      I
     5 Police Line  13       -+     +---+------------+                     I
       Ambar Khana  15       -+-----+              I                       I
       Darjee Para  17       -+               +-----------------------+
       Rahimpur     03       ---+--------+-+   I
     2 Raj Mohal    04       ---+        I     I
       Bagha        08       -+          +---------+
       Mirzarghar   12       -+-------+  I
       Khidirpur    24       -+       +-+-+
     4 Manipuripara 26       -+---+   I
       Sreerampur   27       -+   +---+
       Kuchai       25       -+ I
       Baldi        30       -+---+
       Sadharkhal   29       -+
```

Legend: *Rural mauzas*   = *1, 2 & 3*
           Peri-urban mauzas = 4
           Urban mauzas   = 5
           Tea garden   = 6 & 7

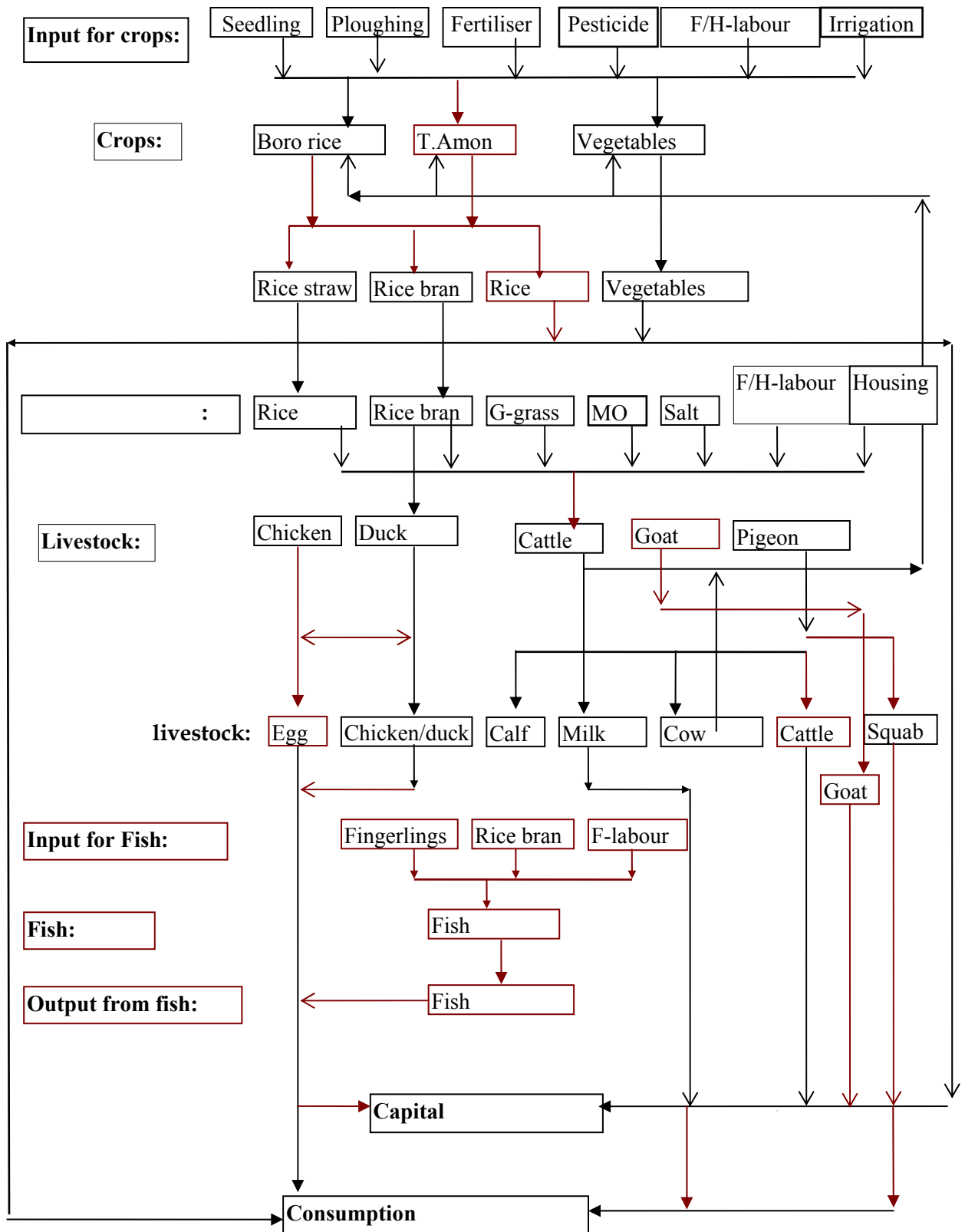**Figure 1.3 Cluster of rural, peri-urban and urban *Mauzas* of Sylhet.**

Input for crops: | Seedling | Ploughing | Fertiliser | Pesticide | F/H-labour | Irrigation

Crops: | Boro rice | T.Amon | Vegetables

Rice straw | Rice bran | Rice | Vegetables

: | Rice | Rice bran | G-grass | MO | Salt | F/H-labour | Housing

Livestock: | Chicken | Duck | Cattle | Goat | Pigeon

livestock: | Egg | Chicken/duck | Calf | Milk | Cow | Cattle | Squab | Goat

Input for Fish: | Fingerlings | Rice bran | F-labour

Fish: | Fish

Output from fish: | Fish

Capital

Consumption

Figure 2.1   General product flow in the Farming systems of traditional farm at the peri-urban area of Mymensingh throughout the year

Input for crops: | Seedling | Ploughing | Fertiliser | Pesticide | F/H-labour | Irrigation

Crops: | Aus rice | T.Amon | Vegetables | Boro rice

Output from crops: | Rice straw | Rice bran | Rice | Vegetables

Input for livestock: | Rice straw | Rice bran | G-grass | Labour | Salt | Treatment | Housing

Livestock: | Chicken | Duck | Cattle | Goat | Pigeon

Output from livestock: | Egg | Chicken/duck | Calf | Milk | Cow dung | Cattle | Goat

Input for Fish: | Fingerlings | Rice bran | F-labour

Fish: | Fish

Output from fish: | Fish

Capital

Consumption

Figure 2.2   **General product flow in the Farming systems of traditional farm at the peri-urban area of *Sylhet* throughout the year**

Figure 3.1

Egg Marketing Channel, Mymensingh.

Peri-urban to Urban
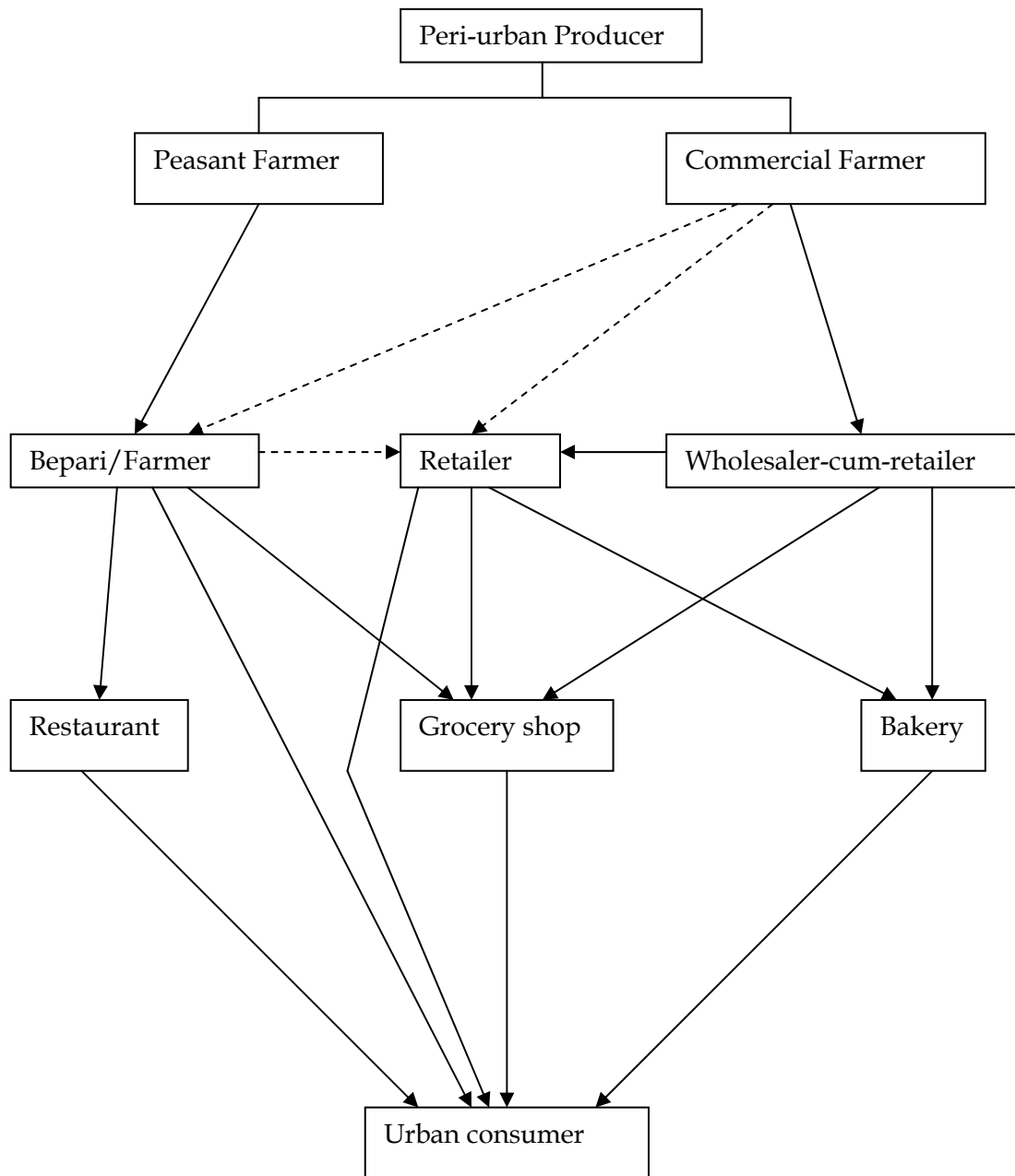
Figure 3.2

Classification of producer-sellers by livestock and livestock products
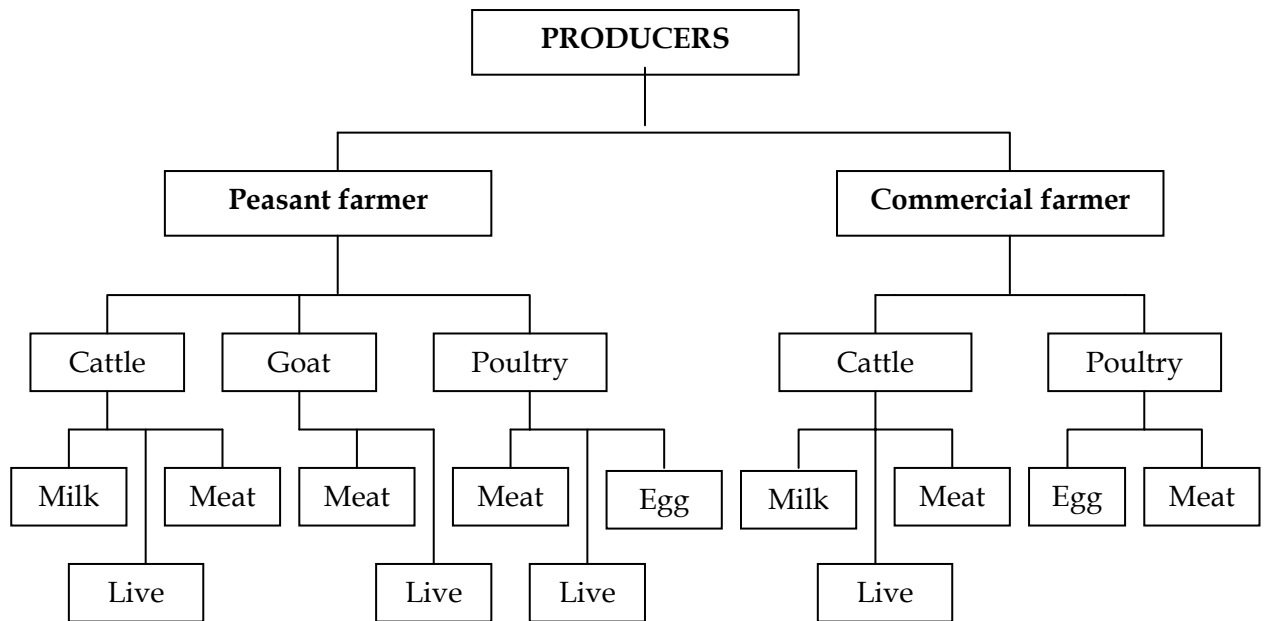
Figure 3.3

Classification of intermediaries by livestock and livestock product

INTERMEDIARIES

Producer cum retailer | Retailer | Wholesaler cum retailer | Commission agent

Milk | Egg | Goat
Cattle | Chicken

Butcher | Grocery | Restaurant

Beef | Mutton | Processors | Egg | Chicken

Meat | Milk | Egg | Egg | Beef | Chicken | Mutton

Ghee | Yoghurt | Card milk | Sweetmeat

Faria | Bepari
Goala
Milk

Egg | Chicken | Goat
Cattle

Arathdar | Dalal
Chicken | Cattle

68
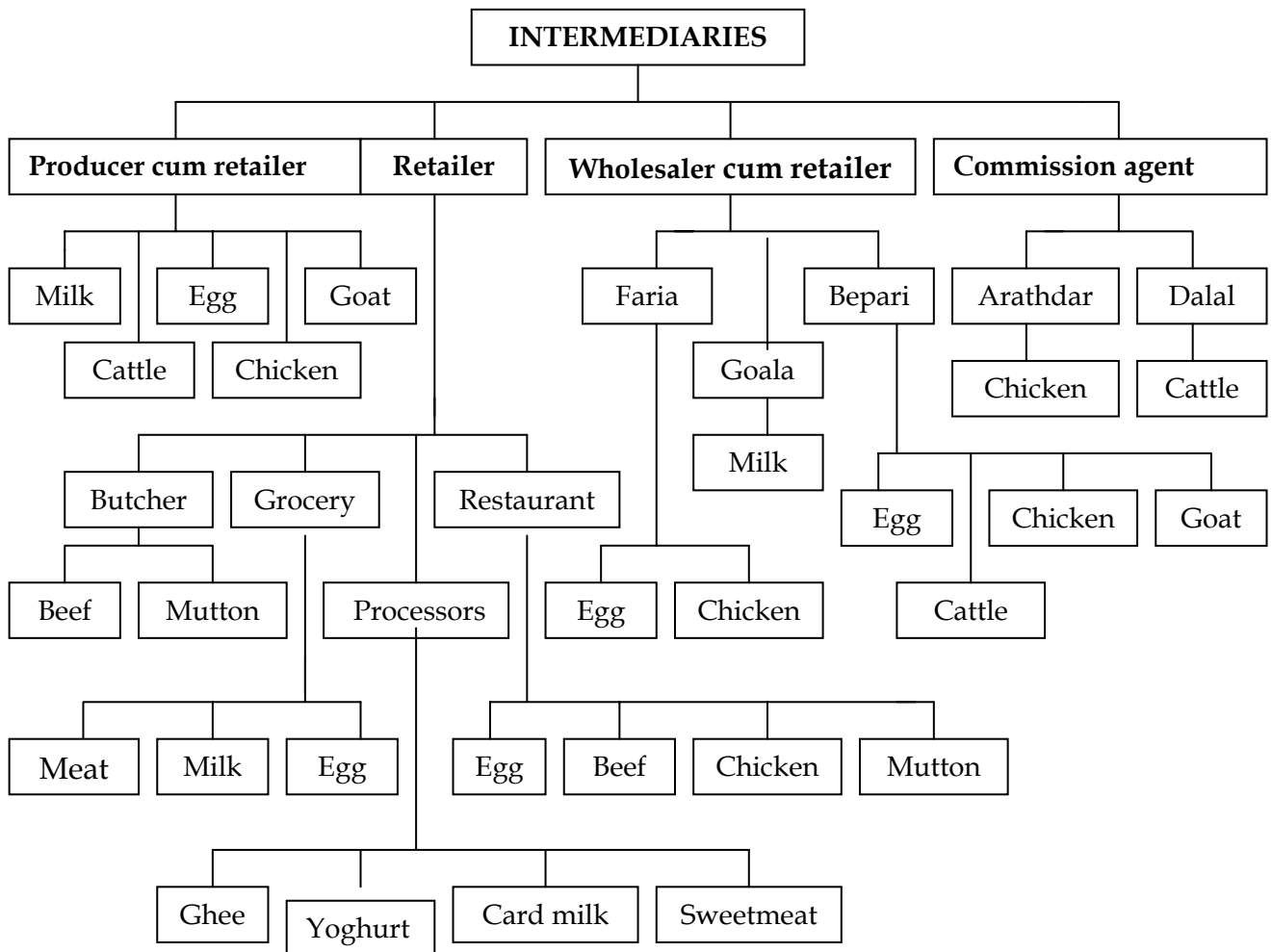
Figure 3.4

Classification of consumers by livestock and livestock products
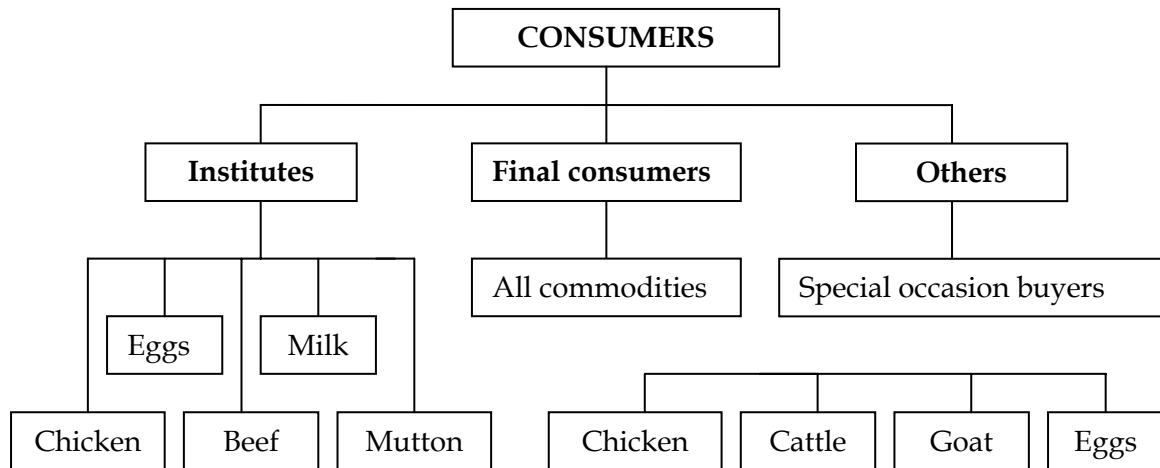
Figure 4

Map of Mymensingh showing Urban, Peri-urban and Rural areas as determined by mauza classification
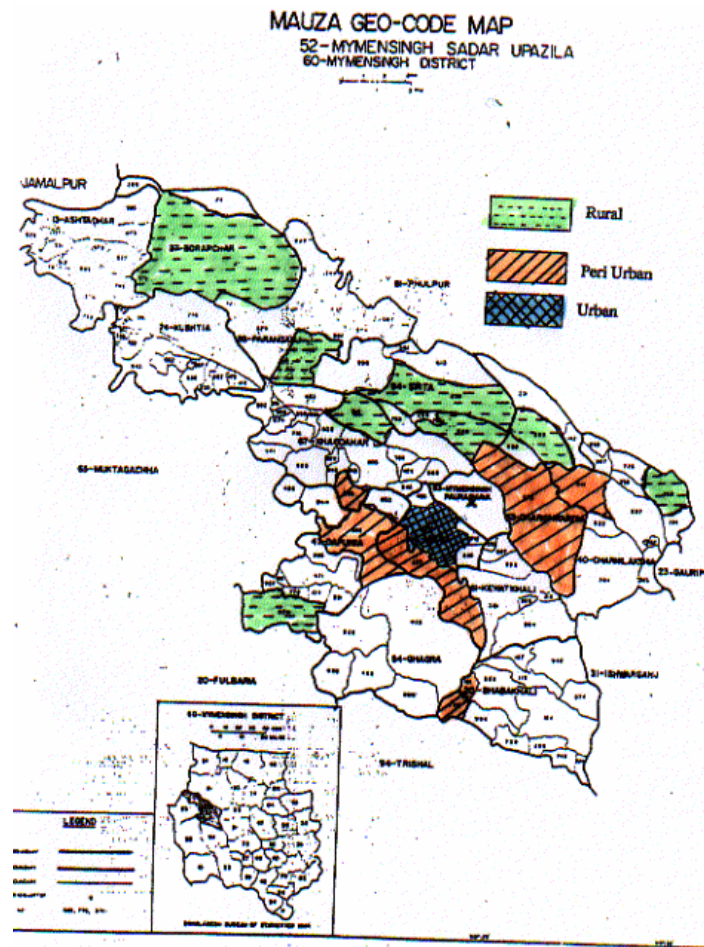
Map 2

Mymensingh Sadar Thana
(Showing Union Mauza Bounderies)

Figure 5a and 5b

Graphs showing breakdown of costs and returns for cattle and chickens respectively. Net returns on cattle and their products are restricted by high costs and/or low production whereas returns for chicken are restricted by losses (deaths through diseases and other miscellaneous causes
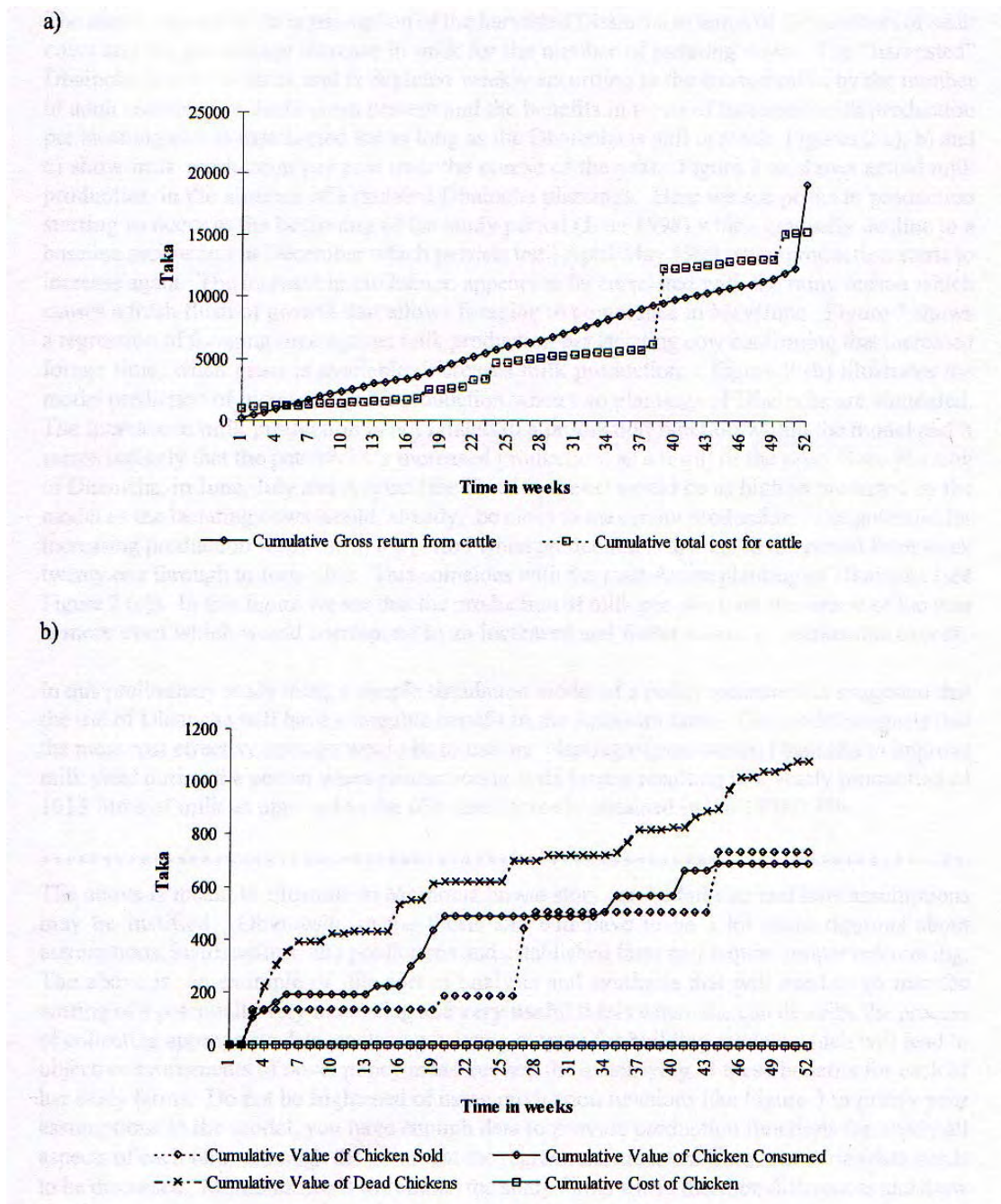
Figure 6a, b and c

Graphs showing the milk production per cow over the course of the study year. Figure 6a shows actual milk production ie no simulated Dhaincha use. Figure 6b shows potential milk production when two plantings of Dhaincha are simulated and Figure 6c shows potential milk production when a single planting is made after the Amon rice has been harvested
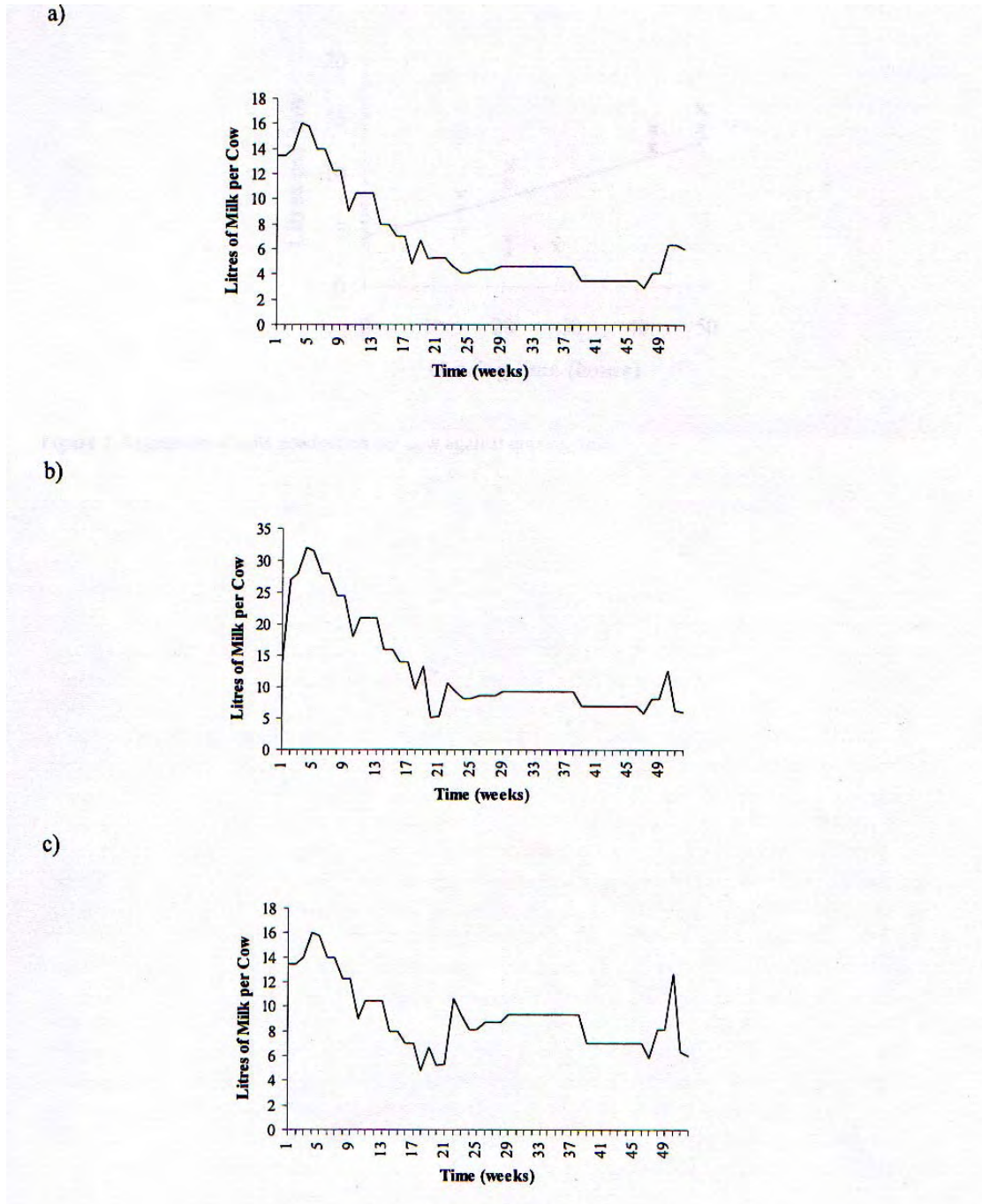
a)

b)

c)

Figure 7

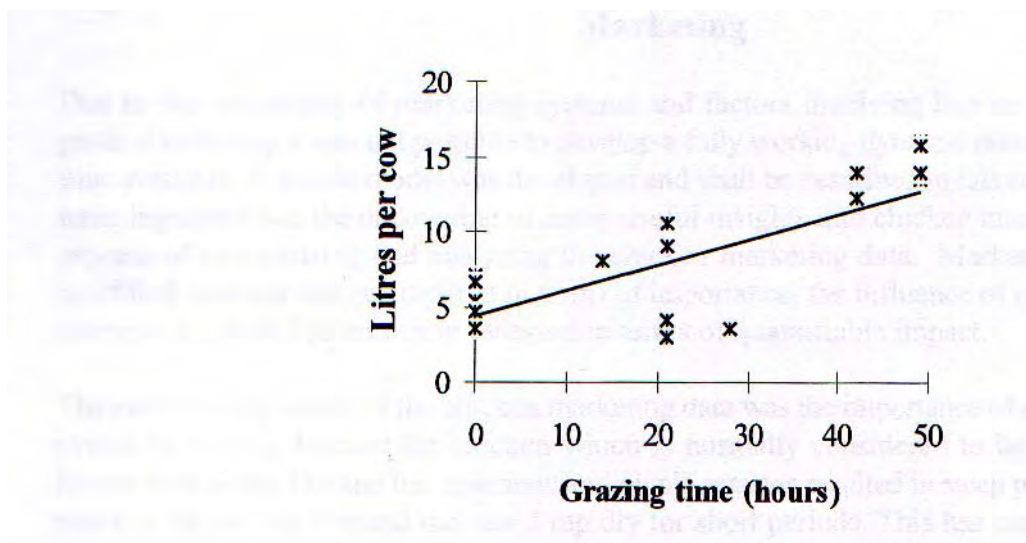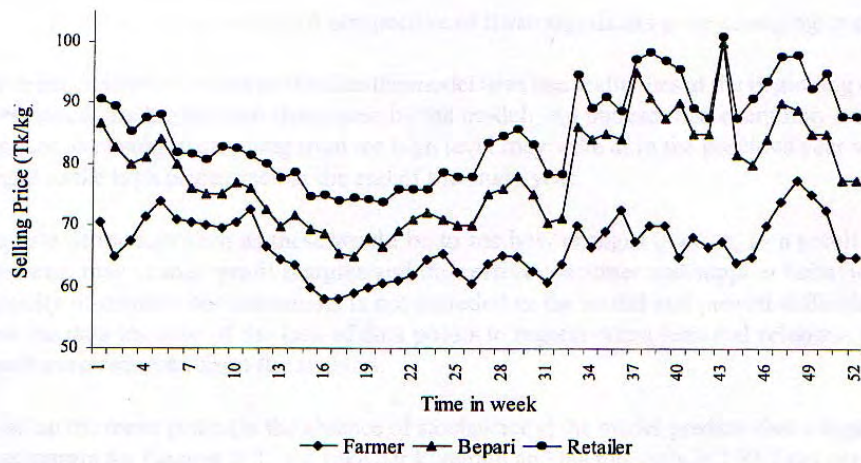Regression of milk production per cow against grazing time

Figure 8

Graphs showing the change in price of chicken per kilogram for three types of trader. Figure 8a shows the actual data and figure 8b shows the user defined means of chicken price
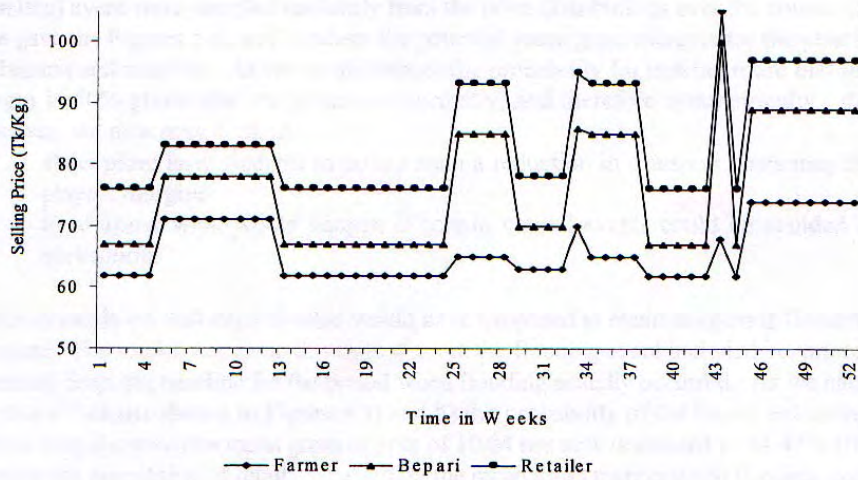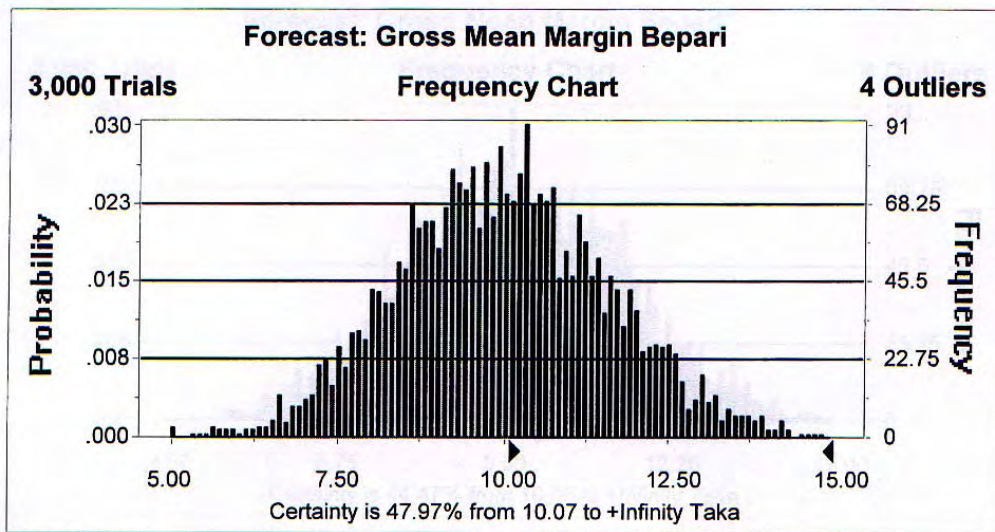
a)

b)

Figure 9a and b

Model outputs of frequency distribution of potential mean gross margins for the 1998/1999 season with no policy simulation

a)

Forecast: Gross Mean Margin Bepari

3,000 Trials — Frequency Chart — 4 Outliers

Certainty is 47.97% from 10.07 to +Infinity Taka

b)

Forecast: Gross Mean Margin Retailer

3,000 Trials — Frequency Chart — 1 Outlier

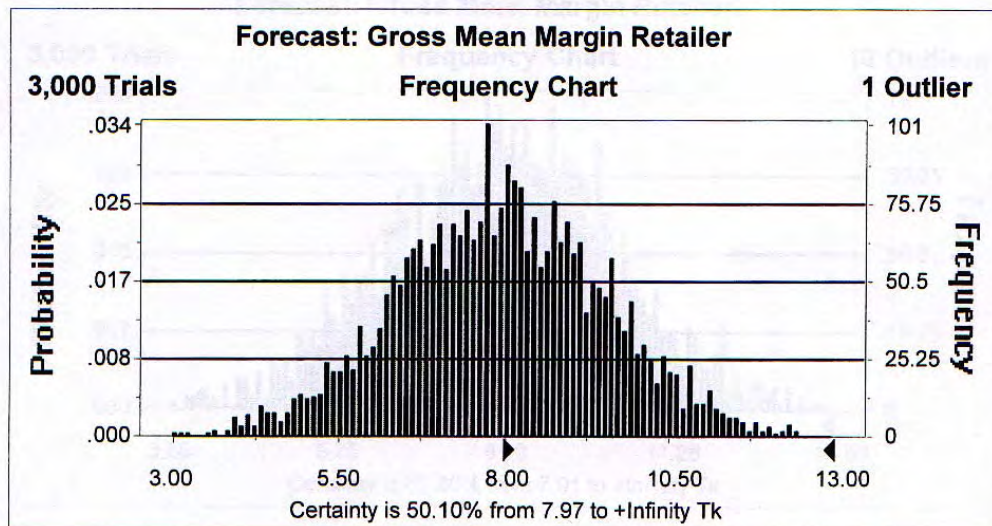Certainty is 50.10% from 7.97 to +Infinity Tk

Figure 10 a and b

Model outputs of frequency distribution of potential mean gross margins for the 1889/1999 season if flooding had not occurred

a)

Forecast: Gross Mean Margin Bepari

Frequency Chart

3,000 Trials   6 Outliers

Certainty is 44.47% from 10.05 to +Infinity Taka

b)

Forecast: Gross Mean Margin Retailer

Frequency Chart

3,000 Trials   10 Outliers

Certainty is 62.80% from 7.91 to +Infinity Tk