Part 2

Chapter Ⅳ　Study Design, Approach and Sampling Framework

4.1　Study Inception Activities

4.1.1　Selection of Study Areas

A number of factors were considered in selecting suitable study areas. One such factor was that the selected infrastructure development projects should be the ones financed by JBIC. Another major consideration was that the selected areas should reflect sufficient variability in terms of irrigation infrastructure and related aspects. Other considerations, such as availability and ease of obtaining secondary data, transportation and logistical support, were also taken into account in the selection process.

Based on the above considerations, the Walawe Left Bank (WLB) irrigation system in Sri Lanka was selected as a case study. JBIC has provided a loan for the main construction component of the Walawe Left Bank Irrigation Upgrading and Extension Project. The project aimed to increase employment opportunities and income by improving agricultural productivity through improvement of irrigation system. The rehabilitation of the existing irrigation system of 2,900 ha in the irrigated area and the construction of irrigation systems in the rain-fed area of 1,400 ha were initiated in February 1997 with the general untied loan of 2,572 million yen, which was to end in October 2000.

The WLB system can be divided into areas with adequate access to irrigation water and into areas that are presently rain-fed but where irrigation is planned to be provided in the future. The area exhibits considerable variability in cropping patterns. Main crops grown in the area include paddy, sugarcane, banana and other upland crops. The type of farming in the study area varies from irrigated to rain-fed to Chena cultivation. Demographically, there is a mix of government allottees, encroachers and non-farm households in the area. Since the entire irrigation infrastructure in the WLB irrigation system has already been rehabilitated/upgraded/improved, an adjacent rainfed area and irrigation system with the same source of water but without any upgrading/improvement was selected as control sites for comparison purposes.

4.1.2 Field Visits by Team of Economists

Prior to the onset of the surveys, a team of economists undertook a field-visit to the selected study area to make a visual assessment of field conditions in the area. This visit also involved collection of more information on the study area, particularly information on the major characteristics of the study area needed to develop sampling framework and to identify specific study sites. Additionally, the team was able to meet with relevant officials to apprise them of this study and to obtain their consent and cooperation for the study. The team was also able to make most of the logistical arrangements for undertaking the household level surveys.

The team met with the Resident Project Manager (Uda Walawe) of the Mahaweli Authority (MA), and Plantation Manager of the Sevanagala Sugar Industries Ltd, who agreed to provide all the necessary assistance for the study. The team also met with other field officers of the MA and the Sevanagala Sugar Industries Ltd, who provided information on the rehabilitation status of the WLB area as well as maps of the Issue Tree for the WLB area and other relevant information required for sampling and surveys. Mahaweli Authority informed the team that several WLB areas did not receive irrigation water during the last Maha season due to water shortage in the reservoir and also due to infrastructure rehabilitation (construction) activities (in Sooriyaweva area).

The team members visited the entire left bank area, starting from the head of the left bank main canal (LBMC) of the system and proceeded to the end of the 31 km long canal on the canal bund-road. The team visited all the proposed sites (strata), starting with Sevanagala, and proceeding up to Kiri-ibbanwewa and Sooriyawewa blocks and lastly, the Extension Area. The team observed the main characteristics of the WLB area, noting the cropping patterns, current status of cultivation, type and condition of the structures and canals taking off from the LBMC, and the number and characteristics of other smaller tanks within the system supplied by the Udawalawe reservoir. In the Extension Area, the team met with some villagers cultivating under rain-fed conditions or under minor tanks.

The team also met with households and farm leaders to verify the status and quality of rehabilitation or upgrading currently under implementation. Discussions with farm leaders indicated that household lists were available with the Chairmen or Secretaries of Household Organizations. The household leaders were willing to provide the necessary household lists and were also willing to

assist in locating selected households during the surveys. The team was able to make some logistical arrangements regarding accommodation for enumerators at the Mahaweli Development Center at Sooriyawewa in the study area.

Based on observations and information gathered during field visits, it was decided to consider the following factors when selecting the specific study sites for comparison purposes.

1. Irrigation infrastructure and its rehabilitation status
2. Availability of irrigation water during last Maha season; and
3. Cropping patterns

Using the above criteria, the study area was classified into five strata, with each stratum representing a site of different characteristics. Before we go into details of the specific study site, let us discuss general characteristics of the study area.

4.2 Characteristics of Study Areas- General

The study sites are located in the command area of Uda Walawe reservoir. This reservoir is built across the Walawe Ganga, which is the fifth largest river in Sri Lanka. The river is 136 Km long and has a catchment area of 1200 square kilometers. It is located at a distance of about 200 km south east of Colombo. The Uda Walawe reservoir was constructed during the period 1963 – 1967, as part of a plan to develop irrigation infrastructure in 32,000 ha of land in the dry zone of southern Sri Lanka. It is an earth fill dam, with a live storage capacity of 240 MCM and a power generating capacity of 6 MW. There are two main canals, the Right Bank Main Canal (RBMC), which is 42 km long and the Left Bank Main Canal (LBMC), which is 31 km in length. The original plan was to develop 20,000 hectares of land for irrigation, under the project. The total area actually developed up to the end of 1997 was about 12,900 ha, comprising 8,500 ha under RBMC and 4,400 ha under LBMC. At present, the area irrigated has increased to 11,000 ha in the RBMC and 6400 ha in the LBMC.

4.2.1 Agro-climatics of Uda Walawe

The Uda Walawe reservoir is located on the boundary of the Wet and Dry Zones of Sri Lanka. Annual rainfall is around 1500 mm in the Uda Walawe dam area and 1000 mm near the coastal area. The Dry Zone is defined as an area receiving below 1900 mm of rainfall per annum or less than 500 mm of rainfall

during the southwest monsoon season. The location of Uda Walawe basin is such that, the rainfall pattern is more influenced by the northeast monsoon, than the southwest monsoon. Evaporation is 6 mm per day during the dry season and 4 mm per day in the wet season. The average relative humidity varies between 70 and 82, while the annual average temperature ranges between 27-28 ^{o}C. The annual and diurnal variations in temperature are small in the basin. Ten-year averages of annual rainfall in the Uda Walawe area, between 1960 and 2000 are provided in **Table 4.1**. The table shows that average rainfall has been declining over the last four decades.

Table 4.1. Total Annual Rainfall in Uda Walawe – ten year averages (mm / year)

Area/Year	1960-70	1970-80	1980-90	1990-2000
Right Bank	1560	1513	1289	1262
Left Bank	1518	1414	1344	1022
Catchment	2504	2410	2110	2033

Monthly rainfall varies, with the highest rainfall in the months of October to January and again from March to May. The monthly rainfall figures for the Uda Walawe Reservoir area for some selected years are shown in **Table 4.2**.

Table 4.2. Monthly Rainfall in Uda Walawe Reservoir Area (mm)

Month	1994	1995	1996	1997	1998	1999	Avg.
January	78	206	47	45	67	137	96.7
February	127	49	101	54	38	72	73.5
March	198	36	6	86	25	170	86.8
April	257	307	409	297	176	195	273.5
May	67	162	8	223	197	79	122.6
June	7	50	40	7	49	44	32.83
July	28	38	35	26	87	1	35.8
August	77	30	53	17	119	41	56.2
September	88	34	103	231	23	97	96.0
October	340	201	201	444	57	137	230.0
November	262	255	376	511	219	287	318.3
December	71	45	220	134	298	138	151.0
Total	1600	1413	1599	2075	1355	1398	1573.2

The Uda Walawe reservoir currently irrigates about 17,400 ha land in the left and right banks of the system. The major soil type in the area is the well-drained Reddish Brown Earth (RBE), which make up 47 percent of the total area

in the system, including the extension area. The poorly drained Low Humic Gley (LHG) soils in the valley bottoms is the next largest type, covering 34 percent of the total area. The remaining 19 percent are the moderately drained soils, which are a mix of both RBE, and LHG soils. **Table 4.3** provides details of soil types of the different areas within the system.

Table 4.3. Soil Type by Area in the Uda Walawe System

Area	Area under RBE soils in ha	Area under LHG soils in ha	Area under a mix of RBE & LHG soils in ha	Total Area
RB area	4470(39)	4057(35)	3045(26)	11572
LB area	3236(50)	2657(41)	552(9)	6444
Extension area	3148(61)	1114(22)	889(17)	5142
Total	10854(47)	7828(34)	4486(19)	23168

Figures in parenthesis show the percentage of total in each area

Data on cropping patterns in the irrigated areas in Uda Walawe over the last few years shows that about 52 percent of the land is under paddy cultivation, another 24 percent under bananas, 12 percent under sugarcane and remaining 12 percent of the area under OFC's. The total area cultivated under irrigated paddy ranged between 8,000-10,000 ha per season. Banana is cultivated on 3,500-4,500 ha of irrigated land annually. Sugar cane is cultivated on 1,500 ha of irrigated land and 2,100 ha of rainfed land. Cropping intensity in the system ranged between 174 percent and 192 percent during the years 1993-1998. In the irrigated areas, the average yield of paddy ranged between 4.5 to 5.5 metric tons per hectare, and that of sugarcane between 100-120 metric tons per hectare. Average yield of banana ranged between 15-20 metric tons per hectare per annum and that of OFC's about 1-1.5 metric tons per hectare.

A project titled, "Walawe Left Bank Upgrading and Extension Project" was launched in 1997 with assistance from JBIC, to further expand and upgrade the irrigation infrastructure in this area. The areas included for upgrading of existing irrigated areas were Kiri-ibbanwewa and Sooriyawewa blocks with a total irrigated area of 2,400 ha, occupying the northern half of the WLB and the Extension Area in the southern half of the WLB area. The existing irrigated sugarcane area of 2,000 ha in Sevanagala was not taken up for rehabilitation under this project. Phase I of this project has been completed recently, providing new irrigation facilities to an additional 1,600 ha of land and improved irrigation facilities (concrete lining of all canals) to about 2,400 ha of existing irrigated areas in the Kri-ibbanwewa and Sooriyawewa blocks under the LBMC. At present,

LBMC irrigates 6,000 ha of land (2,000 ha in Sevanagala and 4,000 ha in Kiribbanwewa and Sooriyawewa blocks).

Further development of the left bank is envisaged in Phase II of the project under which an additional 5,200 ha would be provided with irrigation facilities in an "Extension Area". This area, which is presently rainfed or under chena cultivation, occupying the southern half of the left bank, has similar climatic conditions as the irrigated areas in the northern half of the LBMC of the Uda Walawe system. This area was chosen as a control site for comparison purposes in this study. With the completion of the WLB extension project in 2004, the total area under irrigation would increase to 11,200 ha in the WLB

In addition, an area located downstream of the Uda Walawe reservoir, called Ridiyagama, was selected as an additional site for the study to represent an area where the irrigation infrastructure had not been upgraded/improved with concrete lining. This became necessary, since almost the entirety of the left bank irrigated area of the Uda Walawe system had already been upgraded with concrete lined canals. Such a site was needed as a second control site in order to assess the impact of infrastructure improved through concrete lining of canals. The Ridiyagama reservoir receives water via an anicut (Liyanagastota Anicut), across the Walawe river. The anicut diverts most of the drainage flows from the left bank irrigated areas of the Uda Walawe system for reuse in the Ridiyagama system.

4.2.2 Socio-economics of Uda Walawe

There are about 38,000 households (farm and non-farm) in the Uda Walawe area, of which slightly less than half are non-farm households. About 40 percent of the households are in the left bank. The population of the area is largely rural. The total estimated population of the area is 170,000. The total population of the selected study area in the WLB is estimated at 75,000 persons. There are three major urban centers close to the study area, namely Hambantota, Ambalantota and Embilipitiya. Embilipitiya is the closest town/city to the study area, with the right bank main canal of the reservoir passing through the city. Other infrastructure such as electricity, roads, schools and hospitals are reasonably well developed in parts of the area. There are 53 schools, 51 health centers, 27 post offices, and 46 cooperative societies in the Uda Walawe area. Piped water supply for drinking is generally limited to the urban centers or to adjacent areas. There are 25,000 houses, 21,000 latrines and 4500 wells in the area. Transport facilities in the study area are generally adequate. The annual average gross income is

estimated at Rs 105,000 per household. Real household gross income is estimated at Rs 30,000 per annum. Income from OFC cultivation accounts for over half of the total household gross income.

4.3 Characteristics of Specific Study Sites

The entire area was divided into five strata and five locations were selected for this study in the WLB area. About 11,400 farm households and about 5,200 non-farm households are settled in the WLB area. The total population of the area, based on an average household size of 4.5 persons per household, is estimated to be 75,000. In the Ridiyagama system, there are about 1800 farm households and 400 non farm households with a total population of about 10,000 persons. **Table 4.4** provides the breakdown of the number of households and population.

Table 4.4. Farm and Non-farm Households in the Selected Study Sites

Study site Households	No.of farm households	No.of non farm households	Total No. of households	Total Population
Sevanagala	3,520	900	4,420	19,890
Kiri-ibbanwewa	2,084	1,420	3,504	15,770
Sooriyawewa	3,983	2,860	6,843	30,794
Extension Area	1,800		1,800	8,100
Ridiyagama	1,800	400	2,200	9,900
Total	13,187	5,580	18,767	84,454

For administrative purposes, the entire WLB is divided into 4 main blocks namely;

1. Sevanagala
2. Kiri-ibbanwewa
3. Sooriyawewa
4. Mayurapura (Extension Area)

The following are the main characteristics of these areas

4.3.1 Sevanagala

The Sevanagala block is located upstream of the WLB canal. There are both rainfed and irrigated settlements in this block. The gross area under irrigated

agricultural settlements is 2,600 ha, of which 600 ha are allocated for homesteads. In the irrigated area, a total of approximately 2,300 farm households have been settled on 2,000 ha of irrigated land, with each household receiving an allotment of 0.75 ha for sugarcane and 0.25 ha for paddy. The settlements are concentrated in three villages, Sevanagala, Ginigalpelassa and Kowularagama. The total area under irrigated sugar cane and paddy is 1,495 ha and 505 ha, respectively. In the rainfed area about 1,200 farm households are settled on 2,100 ha of land. Each settler has been provided with 1.75 ha of land for the cultivation of sugar cane under rainfed conditions. In the Sevanagala block, canals were lined in the early 1980's in some distributaries and during the early 1990's in recently settled areas. No upgrading was undertaken in this area under the new rehabilitation project. Overall, the irrigation infrastructure in Sevanagala is well established, although the condition of infrastructure at some sites is poor.

4.3.2 Kiriibbanwewa and Sooriyawewa

The second block is Kiriibbanwewa, which is located in the middle of the WLB. About 2000 farm households are settled in the block, occupying 1700 ha of irrigated land. Since it is a settlement system, all households received an allotment equal to 1 ha of irrigated land and 0.25 ha of highland for homesteads. Some of the settlers have not received irrigated land, but only highland for homesteads. These settlers are encroachers, second-generation household members of settlers or part time households. Therefore the number of settler households exceeds the number of allotments provided on the basis of one ha of irrigated land per allotment. The main crop is paddy, followed by bananas and other OFC's

A similar situation prevails in the third block, namely Sooriyawewa, located downstream of the WLB, where there are more farm households than allotments. There are 3800 farm households resident in the Sooriyawewa block, having over 2300 ha of irrigated land. Some of the households may be provided irrigated allotments when the Extension Area is provided with irrigation facilities under the Walawe Upgrading and Extension project, now under implementation. Non-farm households have also been settled in the WLB area. These households have been provided with small plots of land for housing or business activities and are engaged in trading, or other service providing activities. Here too the main crop is paddy but relatively more bananas are grown here than in Kiri-ibbanwewa.

Upgrading was completed in all of the old existing irrigated areas in the Kir-ibbanwewa and Sooriyawewa Blocks, over a period of four years between 1998

and 2001. New irrigation facilities have been provided to about 300 ha of land in Kiri-ibbanwewa and 1300 ha of land in Sooriyawewa. Some of the new areas have started cultivation in Yala 2001. Although upgrading work has been completed, there appear to be many deficiencies in construction, as indicated by households. Most of the complaints relate to technical faults/problems i.e. poor levels in field canals, resulting in water not reaching households fields. These deficiencies need to be corrected if the full area is to be cultivated in the future.

4.3.3 Control Sites

(i) Mayurapura (Extension Area)

An Extension Area located further downstream of the WLB was chosen as a control site for comparison purposes. In this area, infrastructure development has not yet taken place. Residents are mostly encroachers from surrounding villages or permanent residents of small ancient villages that have evolved around small tanks. They either cultivate land under the command of existing small tanks in the area, or undertake rainfed cultivation in the Maha season. Many of those cultivating under small tanks do not reside there permanently. They migrate to the area during the cultivation season, living in temporarily built small huts till the end of the season. Those residing permanently in the area are clustered in eight villages, scattered across the Extension Area. Some have been resident in these villages for over 20 years. Currently, Land Kachcheris (process of allocating land to eligible persons for settlement in irrigation systems, including the regularisation of encroachers) are being held to select eligible persons to be settled in the Extension Area.

Table 4.5 provides information on number of villages and farming households in the Mayurapura Block (Extension Area).

Table 4.5. Villages in Mayurapura (Extension Area)

Name of Village		No. of Households
1.	Mahawelikada	260
2.	Summodaraya	380
3.	Nabodagaswewa	360
4.	Andarawewa	280
5.	Mahara	200
6.	Wediwewa	200
7.	Bolhinda	48
8.	Bellagaswewa	46
	Total	1774

(ii) Ridiyagama

Ridiyagama reservoir receives irrigation water via the Liyanagastota anicut across the Walawe river downstream of the Udawalawe reservoir. A single main canal branches into five branch canals, from which several distributary canals provide water to field canals. Distributary and field canals also take off from the main canal. There are a total of 30 distributary canals in this system, irrigating an area of approximately 3000 ha. Available information suggests that there are about 1800 farm households settled in 3000 ha of irrigated land in the Ridiyagama system. Since it is an old settlement with private lands, the size of holdings is not uniform. The majority of households cultivate private lands. The size of holding of private lands is usually higher than government allotments and may go up to 10 ha. Many owners have leased out their lands to Ande households on long-term lease contracts. Ridiyagama irrigation system is planned to be rehabilitated under Kuwait government funding.

4.4 Sampling Procedures

A multistage sampling procedure was adopted in selecting the sample for the study. Given the differences across various areas of the WLB, the study area was initially stratified based on the following criteria;

- availability or non-availability of irrigation infrastructure,
- improved or unimproved irrigation infrastructure,
- cropping pattern, and
- availability or non-availability of water for irrigation in Maha 2000.

At the second stage, one to two clusters representing each of the strata were selected. For the purpose of this study, a cluster is defined as a distributary canal in the case of irrigated areas and a village or division in the case of rainfed areas. While the clusters within a stratum may be more or less homogeneous in terms of the above criteria/characteristics, there could be variations in clusters within a stratum in terms of access to water (locational differences). These clusters were chosen to represent potential differential access to water within a stratum, if any. For example, in irrigated areas, a head, middle or tail end canal was selected to represent the variations due to the differences in access to irrigation water across locations within a stratum. In rainfed areas, criteria such as size of village or division, access to markets, period of residence of settlers, were used for the selection of representative clusters.

At the third stage, systematic random sampling procedure was adopted to select the sample within each selected cluster. The systematic random sample was drawn from a sampling frame of a complete list of all households within a cluster. The number of households selected within each cluster was based on the sample size adopted for the survey. It was decided to use a sample size of around 4.5 percent of total households for the study. Factors such as, adequate representation of the variations within the study area, adequacy of sample for statistical validity, cost and time frame for completion of surveys, were considered in selecting an appropriate sample size.

After visiting the field sites and discussing the characteristics of these sites it was decided to divide the sample into six strata as follows: Sevanagala Irrigated; Sevanagala Rainfed; Kiriibbanwewa; Sooriyawewa; Extension Area and Ridiyagama. These areas were different in the following characteristics;

- availability of irrigation infrastructure,
- level and timing of infrastructure development,
- cropping pattern and type of farming, and
- issue of water for cultivation in Maha 2000-2001.

Detailed characteristics of the selected strata or sub strata are described below.

4.4.1 Strata 1 and 2 - Sevanagala

Sevanagala area is located at the head end of the WLB main canal. This area can be demarcated into two distinct areas, according to the availability of irrigation infrastructure. The first area, which has a well established irrigation infrastructure including lined canals, is under irrigated sugar cane and paddy and has been selected as Stratum 1 for the purposes of this study. The second area, which has no irrigation infrastructure, is under rainfed sugar cane and has been selected as Stratum 2. Thus the two strata in this area can be named as Sevanagala Irrigated (Stratum 1) and Sevanagala Rainfed (Stratum 2). Settlers in Stratum 1, or the irrigated area of Sevanagala are provided with 0.75 ha for sugar cane and 0.25 ha for paddy cultivation. Settlers in Stratum 2 or the rainfed area are provided with 1.75 ha for sugar cane cultivation, to compensate for lower yields obtained under rainfed conditions. Canal lining of 75 percent of the irrigated areas in Stratum 1 was completed in the early 1980s while the remaining areas were lined in the early 1990's. Cultivation of sugar cane commenced in the early 1980's in the irrigated area and in the early 1990's in the

rainfed area. Unlike other irrigated areas in WLB, the irrigated area in Sevanagala received water for sugar cane and paddy cultivation in Maha 2000/2001.

4.4.2 Stratum 3 – Kiri-ibbanwewa

Stratum 3, comprises the Kiri-ibbanwewa area located immediately adjacent to the Sevanagala area. The cropping pattern is largely paddy and irrigated bananas with a small extent under other field crops (OFC's). During the field visit to Kiri-ibbanwewa, we were able to confirm that most work on irrigation infrastructure improvement was completed by May 1999. It was possible to identify clusters or areas within the block by date of completion of upgrading. Some of the distributaries received water for paddy cultivation in Maha 2000/2001, while others received water for bananas and OFC's only. This block is located midway of the WLB main canal and two medium sized reservoirs, Kiri-ibbanwewa and Mahagama, are located in this block. Both reservoirs receive water from the Walawe reservoir via the WLB main canal. The main characteristics of this block are, completion of upgrading / improvement of irrigation infrastructure two years prior to our study, water issue for paddy cultivation in some areas and for OFC's in the other areas, paddy cultivation more prevalent and located in the middle of the LBMC.

4.4.3 Stratum 4 - Sooriyawewa

Stratum 4 comprises the Sooriyawewa area, which is the last block irrigated by the WLB main canal. The cropping pattern is similar to the Kiri-ibbanwewa block, but a larger extent of bananas and OFC's are grown in this block. Demographically, this block has a larger number of households both farm and non-farm (landless households) in the WLB area. There was a larger number of both farm and non-farm households than the number of allotments. Upgrading of the infrastructure was undertaken over a period of two years between 1999 and 2001, with most work on irrigation infrastructure improvement / upgrading completed by mid 2001. It was possible to identify clusters or areas within the block by date of completion of upgrading. No water was issued for paddy cultivation in Maha 2000/2001 in this block. However, most distributaries received water for banana and OFC cultivation in this season. In this stratum, there are a much larger number of non-farm (landless) residents than in Kiri-ibbanwewa.

4.4.4 Stratum 5 – Extension Area

Stratum 5 comprises the Extension area, which is currently under chena/rainfed cultivation. This area is to be provided with irrigation facilities in the near future. The existing settlers in the area are mostly encroachers, who have settled in this area over the last 20-30 years. They cultivate mostly upland crops under rainfed conditions. Some undertake paddy cultivation under small tanks that are scattered in the area. It was decided to include this area as another stratum for the study to compare the differences between irrigated and rainfed farming.

4.4.5 Stratum 6 - Ridiyagama

Since the entire irrigated area in the WLB has already been rehabilitated / upgraded, no area within the WLB could be located with unimproved infrastructure. In order to assess the impact of irrigation infrastructure upgrading, it was necessary to include a sample from an area where no such infrastructure improvement/upgrading had taken place, and also where cultivation had taken place in the last season, since most areas did not receive water during last Maha due to water shortage. Having discussed the various options available, it was decided to include the adjacent system, Ridiyagama, within our study area. The Ridiyagama and the Udawalawe systems have many similarities. For example, the water source for both systems is the Walawe river and both systems are located on the left bank of the river. The main differences are that, Ridiyagama is a much older system being in existence for about 100 years, and about 50 percent of the irrigated lands are privately owned. The management system operated by the Irrigation Department, in Ridiyagama is different to that operated by the Mahaweli Authority. The cropping system in Ridiyagama is largely paddy with little diversification to upland crops. The irrigation infrastructure had not been upgraded in Ridiyagama, and there was a full cultivation of paddy in Maha 2000/2001. A new irrigation rehabilitation project funded by Kuwait government funds has been initiated in this system and is currently underway. It was felt that the differences between these two systems were minor, except for that irrigation infrastructure in Ridiyagama was unimproved and the impact study would benefit by including a sample from Ridiyagama. It was decided to select samples for the study from the non-rehabilitated areas of the Ridiyagama system in order to utilize this as a control stratum for poverty analysis of with and without improved infrastructure.

4.4.6 Sample Size

It was decided to select a sample around 4.5 percent of the total households in the selected study area. On this basis, the required sample size was 870 households. However, the sample actually selected was 858. **Table 4.6** provides information on selected strata and planned and actual sample size.

Table 4.6. Selected Strata and Sample Size

Study site	Total No.of Households	Planned Sample	Percentage of total	Actual Sample	Percentage of total
Sevanagala					
(a) Irrigated	3202	160	5.0	167	5.2
(b) Rainfed	1218	62	5.1	60	5.0
Kiri-ibbanwewa	3504	154	5.5	151	4.3
Sooriyawewa	6843	240	4.4	229	3.3
Extension Area	1800	100	3.5	105	5.8
Ridiyagama	2200	154	7.0	146	6.6
Total	18767	870	4.6	858	4.6

Table 4.7 provides a breakdown of the planned sample by stratum and by type of household i.e. farm or non-farm. Field level information and ground realities suggest that, most households categorized as non-farm, were in fact engaged in some form of agricultural activity. A large majority of these households were engaged in Chena cultivation, upland or home garden cultivation or were cultivating lands leased in from settlers who had been allotted land in the system. Only very few households were engaged purely in non-farm activities such as trading, small enterprise, or skilled work. A large number of the non-farm households were the second-generation of original settlers, who did not legally own land or had not been allotted any land within the system. A better classification of these households would be landless households rather than non-farm households.

Table 4.7. Selected Strata and Planned Sample Size (farm / non- farm households)

Study site	Total No.of FHH	Sample Size FHH	Percentage FHH	Total No.of NFHH	Sample Size NFHH	Percentage NFHH
Sevanagala						
(c) Irrigated	2392	120	5.0	810	40	5.0
(d) Rainfed	1128	54	5.0	90	6	6.6
Kiri-ibban wewa	2084	104	5.0	1420	50	3.5
Sooriyawewa	3983	140	3.7	2860	100	3.4
Extension Area	1800	100	5.0			
Ridiyagama	1800	126	7.0	400	28	7.0
Total	13187	646	5.0	5580	224	4.0

FHH – Farm Household: NFHH – Non Farm Household

A breakdown of actual sample size by stratum and by type of household i.e. farm or non-farm shows that the sample planned originally was 646 farm households and 224 non-farm households. The total sample actually selected was 660 farm households and 198 non-farm households/landless. The details of actual sample selected are given in **Table 4.8**.

Table 4.8. Selected Strata and Actual Sample Size (farm / non- farm households)

Study site	Total No.of FHH	Sample Size FHH	Percentage FHH	Total No. of NFHH	Sample Size NFHH	Percentage NFHH
Sevanagala						
(a) Irrigated	2392	126	5.3	810	41	5.4
(b) Rainfed	1128	54	4.8	90	6	6.7
Kiri-ibbanwewa	2084	114	5.5	1420	37	2.6
Sooriyawewa	3983	149	3.7	2860	80	2.8
Extension Area	1800	105	5.8			
Ridiyagama	1800	112	6.2	400	34	8.5
Total	13187	660	5.0	5580	198	3.5

FHH – Farm Household: NFHH – Non Farm Household

4.5 Sample Selection within Strata

4.5.1 Strata 1 and 2 - Sevanagala

Within the Sevanagala block, two distributaries in the irrigated sub-stratum (C 2 and C 8) and two divisions in the rainfed sub-stratum (D 1 and D 3) were selected as sample clusters. Irrigation facilities for the C 2 distributary, which are located at the head end of the stratum, were provided in 1995. Irrigation facilities for the C 8 distributary, which are located at the tail end of the stratum, were provided in 1983/84. It should be noted that the entire stratum is located at the head of the LBMC canal. Households were settled in these two clusters at the time of development of irrigation facilities. It is assumed that by selecting the C 2 and C 8 distributaries, the head-tail differences and variations due to the length of the period of establishment of settlements would be accounted for in the analysis. In the rainfed area too, settlements were established at different times. Households in division D 1 were settled in 1990, while those in D 3 were settled a few years later in 1993/94. By selecting these two divisions the variations due to the timing of settlements would be accounted for in the analysis. Details of clusters and sample selected within individual clusters in Sevanagala are provided in **Table 4.9**.

Table 4.9. Selected Sample in Sevanagala (farm/non- farm households)

Cluster/ Distributary	Total No.of FHH	Sample Size FHH	Total No. of NFHH	Sample Size NFHH	Sample Size Total
C 2 (Head)	226	37		26	63
C 8 (Tail)	470	89		15	104
Sub-total	696	126	363	41	167
Rainfed Div 1	266	28		3	31
Rainfed Div 3	399	26		3	29
Sub-total	665	54	40	6	60
Total	1361	180	403	47	227

FHH – Farm Household: NFHH – Non Farm Household

4.5.2 Stratum 3 - Kiri-ibbanwewa

In Stratum 3, the Kiri-ibbanwewa block, only part of the total area was cultivated under Paddy in Maha 2000-2001, due to shortage of water in the reservoir. The following distributaries were issued water for paddy and OFC cultivation in Maha 2000/2001; KRB, KLB, MD11 to MD14, and Mahagama

Branch Canal. All the other distributaries received water only for OFC cultivation in Maha 2000/2001. In this block, clusters were chosen on the basis of head-tail differences, availability of water for paddy cultivation in Maha 2000/2001, and the date of completion of irrigation upgrading. A total of seven clusters (distributary canals) were selected in this block. Two distributaries in this block, MD3 and MD 10 were selected, from those that were issued water for OFC cultivation only and not for paddy cultivation in Maha 2000/2001. The MD 3 is at the head end while MD 10 is at the tail end of the section of LBMC passing through this block. . Upgrading was completed in both canals in May 1998. The other five distributaries were selected from those that received water for both paddy and OFC cultivation in Maha 2000/2001. The upgrading of infrastructure of these distributaries was completed in May 1999. Distributaries selected from the latter category included MD11 from the head end and MD14 from the tail end of the section of LBMC passing through this block. MBD 2 from the head end and MBD 11 from the tail end of the Mahagama branch canal, and KLB, which is the left bank main canal of the Kiri-ibbanwewa reservoir. **Table 13** shows details of sample selected in the Kiri-ibbanwewa Stratum. It can be seen that there is a mix of large, medium and small sized distributaries among those selected for the survey.

Table 4.10. Selected Sample in Kiri-ibbanwewa (farm / non- farm households)

Cluster/ Distributary	Total No.of FHH	Sample Size FHH	Total No. of NFHH	Sample Size NFHH	Sample Size Total
KWLB	116	25	79	10	35
MBD 11	63	7	12	3	10
MBD 2	20	4	14	2	6
MD 11	34	12	3	2	14
MD 14	185	33	31	9	42
MD 3	82	15	21	5	20
MD 10	105	18	22	6	24
Total	605	114	182	37	151

FHH – Farm Household: NFHH – Non Farm Household

4.5.3 Stratum 4 - Sooriyawewa

In this Stratum, upgrading of the irrigation infrastructure of the existing irrigated area of approximately 1,400 ha, was completed during the period between May 1999 and May 2001. Additionally, 1,025 ha. of new lands in the Sooriyawewa block, were provided with new irrigation facilities under Phase I of

the upgrading project. In the entire block, no water was issued for paddy cultivation in Maha 2000/2001. However water was issued once every 10 days for OFC and banana cultivation in Maha 2000/2001, to all except the following distributaries; BBD 9, BBSB1, BBSB2/D2, BBSB2/D3, BBD 12, BBD 14, and BBD 15. The usual cropping pattern in this block is paddy, bananas and OFC's. There is a greater area under bananas in this block than in Kiri-ibbanwewa. In the Sooriyawewa block, a total of six distributaries (clusters) were selected for the survey. Two of the selected distributaries, MD15 (head end) and MD 18 (tail end) are off-takes from the head and tail ends of the LB main canal respectively. Three other selected distributaries BBD2, BBD5 and BBD7, arise from the head, middle and tail ends of the Beddewewa Branch Canal, which is the extension of the LB main canal. The last selected distributary, BBSB2 D2 is fed by BBSB2, one of the main sub branches of the Beddewewa Branch canal. This provides water to Tank 2, which is part of the new Extension Area, provided with water by the upgrading project. The left bank of this tank was selected, to represent an area, where there was no irrigated cultivation prior to this. Those currently settled in this area were undertaking rainfed upland cultivation, or chena cultivation prior to receiving irrigation water. In terms of size a mix of large, medium and small distributaries were selected as a representative sample of the block. Details of sample selected in this stratum are provided in **Table 4.11**.

Table 4.11. Selected Sample in Sooriyawewa (farm / non- farm households)

Cluster/ Distributary	Total No.of FHH	Sample Size FHH	Total No. of NFHH	Sample Size NFHH	Sample Size Total
MD 15	45	12	5	3	15
MD 18	99	25	60	13	38
BBD 2	85	21	33	11	32
BBD 5	246	52			52
BBD 7	149	39	26	9	48
BBSB2 D2			166	44	44
Total	790	149	124	80	229

FHH – Farm Household: NFHH – Non Farm Household

4.5.4 Stratum 5 – Extension Area

There were a total of eight villages in the Extension Area. The cropping system was similar in all of these villages. In some villages, where there were small village tanks, paddy is cultivated under partially irrigated conditions. Villages closer to the nearest town had greater access to facilities such as roads

and markets. **Table 4.13** provides details of the sample selected in the Extension Area.

Table 4.12. Selected Sample in Extension Area (farm / non-farm households)

Name of Cluster/Village	Total No. of FHH	Sample Size FHH	Sample Size Total
Andarawewa	248	47	47
Maha-ara	137	24	24
Wediwewa	79	19	19
Bolhinda	17	4	4
Bellagaswewa	37	11	11
Total	518	105	105

FHH – Farm Household: NFHH – Non Farm Household

Five villages were selected as clusters for the survey. These villages were selected on the basis of size and other differences, such as cropping pattern, availability of village tanks, access to towns and other services. Two large villages, two small villages and a medium sized village were selected for the study. Three of the villages selected, Maha-ara, Bolhinda, and Wediwewa, are situated close to the main road and have easy access to transport and markets. In four villages, Andarawewa, Wediwewa, Bolhinda and Bellagaswewa, paddy is cultivated under small tanks during Maha season. There are no small tanks in village of Mahaara, and cropping is limited to chena and rainfed crops.

4.5.5 Stratum 6 – Ridiyagama

The Ridiyagama system consists of two units, the Ridiyagama unit and the Bolana unit. The Ridiyagama unit has a command area of 760 ha and the Bolana unit a command area of 1800 ha. In this system, there is a single main canal – the left bank (LB) main canal, which divides into two branch canals North Central Branch (NCB) and North Right Branch (NRB) canals. All three canals feed the Ridiyagama unit. Further down the LB main canal, it branches into the (South Right Branch) SRB, South Central Branch (SCB) and South Left Branch (SLB) canals, which feed the Bolana unit. **Table 4.14** provides details of the sample selected in Ridiyagama.

Table 4.13. Selected Sample in Ridiyagama (farm / non- farm households)

Name of Cluster/ Distributary	Total No.of FHH	Sample Size FHH	Total No. of NFHH	Sample Size NFHH	Sample Size Total
LBMain Canal	72	12	26	8	20
RB 1	72	12	26	8	20
SRB Canal	149	25	44	9	34
LB 1	60				
LB 2	40				
LB 3	49				
SRB Canal	169	29	34	7	36
RB 5 Basnawa	57 74				
Mahawewa	38				
SCB Canal	257	46	40	10	56
Canal 19	72				
Canal 11	50				
Canal 18	82				
SCB 2	20				
SCB 3	33				
Total	647	112	144	34	146

FHH – Farm Household: NFHH – Non Farm Household

The clusters were chosen on the basis of access to irrigation water- one cluster at the head end, one at the middle and two clusters at the tail end. The first cluster, the RB 1 distributary canal, is at the head end of the system and takes off from the LB main canal itself. The second cluster comprises of distributaries LB 1, LB 2, and LB3, which are at the middle of the system and take off from the SRB canal. The third cluster, which comprises RB 5 and drainage canals Basnawa, and Mahawewa, are at the tail end of the system, and arise from the tail end of the SRB canal. The fourth cluster comprises canals 19, 18, 11, SCB 2 and SCB 3, which is also at the tail end of the system and take-off from the tail end of the SCB canal.

The tail end clusters receive relatively less water, and have poorer soils, while the head and middle end clusters receive relatively adequate water and have good soils. Paddy is the main crop in all four clusters, very little OFC's are grown in this system. Households in all clusters cultivated paddy during the Maha 2000/2001 season.

Chapter V Survey Administration and Data Collection

5.1 Questionnaire Development and Pre-testing

A common questionnaire was developed for both Pakistan and Sri Lanka. The questionnaire consisted of six modules arranged as follows; Basic information, Infrastructure, Agricultural production, Expenditure, Credit and Retrospective questions.

- Basic Information Module:
  This module is designed to gather basic information about the household, such as household members, their ages, schooling, employment, non-farm income, housing, land ownership, and housing characteristics.

- Infrastructure Module:
  This module gathers information on the operating environment of the household, including information on sources of water, irrigation infrastructure, cultivated area, operation and maintenance of infrastructure and health facilities.

- Agricultural Production Module:
  This module attempts to obtain information on the farming situation, farm assets, cost and value of agricultural production, household organizations, and marketing of inputs and produce.

- Expenditure Module:
  This module gathers information on household expenditure, including food, clothing, medical care, transportation, education and other living expenses.

- Credit Module:
  This module obtains information on loans obtained, sources, repayment and problems in obtaining credit.

- Retrospective Questions Module:
  This module is designed to obtain historical information over the last ten years on crop yields, and production of the main crops and related problems.

The questionnaire was carefully edited to frame the questions to suit the local context, in so far as units of measurement, local connotations, or other

common usage of phrases or words etc., were concerned. This made the questionnaire easier to understand by both the enumerators and the respondents as well as easier to administer and process. All local team members, as well as mission members of JBIC, took part in the revision process. The enumerators also participated in the process as a part of their training program. The revision of the questionnaire continued after pre-testing of the questionnaire and feedback from such pre-testing.

Pre-testing was undertaken in each stratum, but avoiding the selected clusters within each strata. Information such as the clarity of the questions, length of time required to complete a questionnaire, quality of the answers, relevancy of the questions, logistical requirements, etc. was gathered during the pre-test. Such information was reviewed and discussed in detail with the participation of the enumerators, and if deemed necessary, the questionnaire revised appropriately to incorporate the information gathered. This procedure was applied after each pre-test and a final revised questionnaire developed. This was then translated into the local language (Sinhala) prior to final administration. Details of the schedule of pre-testing, including the number of sample pre-tests and other information is provided below the questionnaire was pre-tested during the training program. The enumerators were divided into two groups for pre-testing and covered all the selected strata, except some clusters, as follows.

May 29 –	Group A –	Nebadagaswewa (Extension Area)
	Group B –	Sooriyawewa
May 30 -	Group A –	Kiriibbanwewa
	Group B –	Ridiyagama
May 31 -	Group A –	Sevanagala (Rainfed)
	Group B –	Sevanagala (Irrigated)

5.2 Enumerators Training

The enumerators' training was designed to provide an overview of the study including its background and objectives. The ethics and code of conduct of surveys was dealt with in some detail in order to inculcate a sense of discipline among the enumerators and to stress the importance of upholding the standards of the institution. A general review of the questionnaire was conducted in order to introduce the contents of the questionnaire, to discuss the methods or processes to be adopted in filling the questionnaire, and what was expected of the enumerators in this information collection process. This was followed by a detailed review of the questionnaire in both languages (English & Sinhala). Each question in the

questionnaire was discussed and explained in detail to the enumerators and any doubts cleared. A further period was set aside to allow the enumerators to discuss their individual problems in relation to the questionnaire.

This training session was followed by a field visit by the enumerators and a subsequent one to one discussion between pairs of enumerators. This included a hypothetical role-play among the enumerators to fill up the questionnaires. This was followed by several pre-tests and if needed, further revisions to the questionnaire, based on field observations. The enumerators were requested to carefully go through the revised questionnaire and bring up any problems or clarifications before going to the field. The training program, including the pre-testing and review of questionnaires was conducted over a period of six days prior to the start of the surveys.

A short training was provided to the enumerators and data entry operators to familiarize them with the requirements of the second and third surveys. The revised questionnaires for the second and third surveys were discussed in detail, and any doubts, problems or ambiguities arising from the questionnaires cleared by the supervisors. Problems that were encountered in the first survey were also discussed and suggestions were made to resolve such problems, taking into account the views of the enumerators, in order to improve the quality of the data collected. The need for adhering to the ethics and code of conduct of the Surveys was repeatedly emphasized in order to inculcate a sense of discipline among the enumerators. A procedure for evaluating the performance of enumerators, data entry operators, and those assigned to check filled questionnaires and supervisors was established for both the second and third surveys. Details of this evaluation procedure are provided below.

Those assigned for checking the questionnaires were required to evaluate the quality of data gathered by the enumerators, using a grading system. The checkers were required to look for errors in the filling out of questionnaires such as missing or illegibly entered values or responses, very high, low or improbable values, faulty coding or numbering, not entering the responses logically or in the proper sequence. The checkers were trained to discuss these types of possible errors with the enumerators and give an initial warning not to repeat such errors. Those enumerators who repeatedly made such errors were given black stars, with penalties imposed. The performance of those checking the questionnaires was evaluated by the data entry persons and given black stars according to the number of mistakes made. The performance of data entry persons was evaluated in turn by the supervisors using criteria such as accuracy, completeness and reliability of data entry. Log books were maintained and daily records kept of

attendance of all staff, the number of questionnaires completed, number of questionnaires checked, the number of questionnaires entered in the data base, and the performance evaluation and grading of enumerators, checkers, data entry persons and supervisors. With all of these measures put in place by the project leader, the quality of data collection was maintained at high levels in all the three surveys.

5.3 Planning and Implementation of First Survey

Table 5.1 provides a summary of implementation schedule of the three surveys. A total of 25 enumerators were recruited to conduct the field survey. They were given a week's training prior to the beginning of the survey. The first field survey was conducted during the period 2 to 27 June, 2001. The study area was divided into five strata and surveys were conducted stratum by stratum. In each stratum, except Sevanagala, a farm leader from the selected distributary or cluster (chairman, secretary, any current or former office bearer of the relevant household organization) was recruited as a field-guide, for the surveys. The field guides were recruited to assist the supervisors in locating the residences of selected households (based on household lists) and to make prior appointments with the respondents. In the case of Sevanagala, officers of the Sevanagala Sugar Industries Ltd. assisted the supervisors in locating the farm households and in making appointments. The sampling was completed prior to the start of the survey, using household lists obtained either from the farm leader or in the case of Sevanagala, from officials. A list of the names of selected households in each stratum was prepared and a copy was handed over to the field guide or official. One or two days prior to the date of survey of a particular cluster or distributary area, the supervisors along with the field guide or official, visited the selected farm households and made an appointment with the respondents for the survey. On the date of the survey, the field guide or official accompanied the supervisor and enumerators to show the location of the selected farm households. The enumerators were dropped off one by one in each selected household and picked up upon completion of the survey questionnaire. The procedure followed in implementation of the survey was to complete one stratum before moving into the next one. The survey was completed in the following order; Extension Area, Sevanagala, Kiri-ibbanwewa, Sooriyawewa, and Ridiyagama. There were a few cases in some strata, where the questionnaires could not be completed. These were completed on a subsequent day and towards the end of the survey.

Each enumerator was required to fill at least two questionnaires per day. This target was achieved in most cases, with only a few exceptions. On an average,

about 35 questionnaires were completed per day. At the beginning, all 25 enumerators were sent to the field to administer the questionnaires. From the second day of the survey onwards, two to four of the enumerators were assigned the job of checking the completed questionnaires in the field. In order to increase the accuracy of the data gathered and enhance the quality of the survey, it was decided that all questionnaires should be checked for minor errors, missing information or other shortcomings. This was done immediately after filling out the questionnaires, while the data gathered was still fresh in the minds of the enumerators. All errors were corrected in the field itself or immediately afterwards. If necessary, the enumerators were required to go back to the household to correct any shortcomings in the collected information. Six to seven of the enumerators were identified for this work and rotated for administering and checking of the questionnaires. Checking of the questionnaires was slow at the start, with only 3-4 questionnaires completed per person per day. Since there was a backlog of unchecked questionnaires building up, it was decided to eliminate the backlog by putting all the enumerators on the job of checking for one day. Subsequently, it was decided to assign an adequate number of persons for checking (varying from two to six per day) depending on the number of questionnaires filled on the previous day, in order to complete all checking by the following day. However, those assigned for checking had to work late hours in order to complete all questionnaires filled on the previous day.

There were four supervisors assigned for the survey and at least two of them were in the field through out the survey. Supervisors took turns accompanying the enumerators, and observing how they were conducting the surveys. They corrected any errors that they observed during the interview process and advised the enumerators on the correct procedures to be adopted in the conduct of the survey. As far as possible, a few of the completed questionnaires were randomly checked by the supervisors while in the field and during lunch breaks. If errors were noticed, the enumerators were sent back to the households for correcting such errors or missing information. Supervisors also spent some time with those assigned for checking to discuss any problems that they faced in reviewing the questionnaires. While in the field, the supervisors also gathered information about the specific sites selected for the survey, by talking to the people of the area and to local officials. At the end of each day, discussions were held after dinner, to discuss the problems in questionnaire filling, checking of questionnaires, and any other problems encountered during the day. These problems were usually resolved satisfactorily during these sessions. Data entry of corrected questionnaires started on 07 June, and continued until the end of the surveys. Initially two persons were assigned for data entry. Subsequently more

enumerators were assigned to this task. Prior to this, the questionnaire was coded and variable names assigned.

Table 5.1. Summary of Survey Implementation Schedule

Stratum	**Extension area**	Sevanagala Irrigated	Sevanagala Rainfed	Kiriibban wewa	Sooriya wewa	Ridiyagama	Total*
No of samples	105	167	60	151	229	146	858
Dates of first survey	Jun 2,3,4,18	Jun. 6,7,8,10.11	Jun 9, 10	Jun 11,12,13,14 ,20,25	Jun 15,16,17, 18,19, 20,26,27	Jun 21,22, 23, 24	25 days
Number interviewed	105	167	60	151	229	146	858
Dates of second survey	Aug 24, 25	Aug 26, 27	Aug 28	Aug 29, 30	Aug 31, Sept 01	Sept 02, 03	11 days
Number interviewed	102	165	53	146	217	142	825
Dates of third survey	Oct 11, 12, 13	Oct 18, 19, 20	Oct 21, 22	Oct 23, 24, 25, 26	Oct. 27, 28 28,29,30, 31	Oct 14,15,16, 17	22 days
Number interviewed	104	163	59	145	221	145	839

* Total number of days for surveys does not include the additional days in the field for undertaking interviews and measuring heights and weights of those households that were not available during the first visits by enumerators.

5.4 Planning and Implementation of Second and Third surveys

Although the common questionnaire for the second and third surveys remained basically the same as the first survey, some modifications were made to incorporate the changes in the calendar months (March to mid-August for the second survey and mid-August to September for the third survey). For the second survey, the questionnaire was considerably shortened, as sections relating to infrastructure, agriculture, and retrospective information, and part of the section on basic information were not included. The basic module was adjusted to obtain only the weights and heights of household members, and labor utilization during the period of March to mid-August of each household member. The expenditure and credit modules were adjusted only to obtain information during March to mid-August. For the third survey, the questionnaire was almost the same as that for the first survey, except that sections on housing, electricity, and retrospective information were not included.

Thus the initial period of preparation for the surveys involved making the required changes to the questionnaire and translating the modified questionnaire to Sinhala. The templates in the computer program (Excel) were adjusted to

accommodate data entry for the second and third surveys. In order to facilitate data entry, all questions in the questionnaire were serially numbered, and the numbers incorporated in the templates of the second, as well as the third, survey. The first two pages of the filled questionnaire from the first survey were photocopied and attached to the questionnaire of the second and third survey, to avoid re-entering of previously obtained basic data, and to reduce the chances of errors in filling out the questionnaires. The respondent ID and code number of each respondent was written on every page of the questionnaire so as to reduce errors resulting from torn pages, mix-up or faulty entering.

The enumerator assigned for checking the completed questionnaires was expected to check all the questionnaires completed the previous day. He was also required to maintain a log-book to keep track of the number of questionnaires filled daily by each enumerator. One of the supervisors would cross check a random sample of about 10-15 percent of the checked questionnaires to ensure that the checking was being done properly. Three persons were assigned for data entry. They were required to complete data entry of all the questionnaires completed and checked on the previous day. Log-books were also required to be maintained by the data entry persons as well as the supervisors, to monitor the progress and quality of the survey.

A total of 23 enumerators were hired for the second survey. Three of the enumerators were assigned to data entry, after a few days in the field. The actual field time taken for completion of the second survey was 18 days compared to the planned 11 days. For the first eleven days all 20 enumerators undertook field interviews, using two vehicles. During the last seven days of the second survey, only seven enumerators were utilized for the survey, using one vehicle for field travel. This was mainly to complete the interviews with respondents not available at the time of the visit of the enumerators earlier and to enter the weights and heights of household members not present at the time of interview.

A total of 23 enumerators were recruited for the third survey. The three enumerators who undertook data entry for the second survey were assigned for data entry for the third survey as well, because of their previous experience in data entry and familiarity with the questionnaire. However, for the first seven days, the data entry persons were engaged in field interviews in order to complete a sufficient number of filled and checked questionnaires to begin data entry at IWMI head office in Colombo. The actual field time taken to complete the survey was 29 days, as compared to the planned 22 days. As for the second survey the extra time was required to complete the interviews of respondents not available

during the first visit and to complete the weights and heights of householders not present at the time of interview. The last eight days of the field survey were utilized for the above, using only 8 enumerators and one vehicle.

5.5 Logistical Arrangements for Surveys

Considerable effort went into planning the logistics of the study in order to keep the deadlines specified by the terms of reference. A major problem of finding suitable accommodation for the field enumerators and supervisors was resolved prior to the surveys. The Mahaweli Authority agreed to provide accommodation in their newly constructed Mahaweli Development Centre, located within the project area. The survey team was also able to make use of copying, computer, training and other facilities available at the center during the enumerators' training program as well as during pre-testing and revision of the questionnaire, although some problems were encountered in operating some of the equipment. Two vehicles (vans) were hired to take the enumerators and supervisors to the field during data collection. Four computers were set up in the Development Centre (DC) to begin data entry as soon as the questionnaires had been filled and checked. Four persons were assigned for data entry work a week after the start of the surveys. Two additional data entry persons were hired from outside to speed up the data entry process.

Logistical arrangements for the second survey were similar to the arrangements made for the first survey. Accommodation for the enumerators, date entry persons and supervisors was provided at the Mahaweli Development Center in Sooriyawewa. Two vans were hired for field travel and three desk-top computers provided for data entry at the site. At least one supervisor accompanied the enumerators in the vans to locate farmers, and to ensure the proper conduct of the survey. The second supervisor accompanied the enumerators to the field when possible, while supervising data checking and entry in the Mahaweli Center. The enumerators were requested to report for work on the evening of the day prior to the start of the survey to enable them to participate in the refresher training program in the morning and to begin the surveys in the afternoon on the following day. The required number of questionnaires was copied and the ID and code numbers entered on every page of the questionnaire by the enumerators, to ensure that there were no mix-ups.

The logistical arrangements for the third survey differed somewhat due to the unavailability of the Mahaweli Center during the third survey. Although it was indicated by the Mahaweli officials that the Center would be available for the

latter half of the third survey period, the lack of water facilities at the Center precluded the use of this Center for the survey. Accommodation for the enumerators and supervisors for the first eight days of the third survey (Oct 10 to Oct.18) was provided at the Vihara Maha Devi Women's Development Center at Mirijjawela. The enumerators were accommodated in a rented house in Sooriyawewa for the rest of the 22 days survey period (Oct. 19 to Nov. 8). The full complement of 20 enumerators and checkers worked up to the end of October, while only 8 enumerators were hired for the balance period of 9 days to complete the surveys of those respondents not available earlier and to measure weights and heights of household members not present at the time of interview. Here too, two vans were hired for field travel within the project area. For the third survey it was decided to undertake data entry at the IWMI Head office in Colombo, as there were better facilities in Colombo, and data entry could be closely supervised. Prior to starting data entry work in Colombo, the data entry operators undertook household interviews along with the other enumerators. Data entry started a week after the beginning of the surveys with an initial set of completed questionnaires. From time to time, completed questionnaires were brought to Colombo for data entry.

5.6 Survey Team

The survey team for the three surveys comprised the following members:

Dr. Intizar Hussain	-	Project Team Leader
Dr. Fuard Marikar	-	Supervisor
Mr. Sunil Thrikawala	-	Supervisor
Mr. J.K. Somasiri	-	Field Supervisor
Enumerators	-	20
Data entry persons	-	03

While Dr Hussain and Dr. Marikar were present during the start up of the surveys and made visits to the field during the surveys, Mr. Thrikawala and Mr. Somasiri, remained with the enumerators throughout the field surveys. Field problems were referred to the supervisors, who discussed these problems and tried to resolve them as quickly as possible.

5.7 Data Collection Procedures

Primary data collection was undertaken by a formal one-to-one interview process, using a structured questionnaire. A sample 4.5 percent of the population

(858 households) was selected for the interviews. The weights and heights of all household members were also measured and recorded during the interview. The enumerators were provided with a weighing scale and a tape measure to obtain the weights and heights of all household members. The problem faced in taking weights and heights was that not all members of the household were present at the time of interview. The weights and heights of those members not present at the time of the interview were obtained subsequently. A small team of enumerators, together with a supervisor, visited all of the incompletely measured households in the weeks following completion of the main survey to complete these measurements. Primary data was also collected through discussions with household leaders, and local officials. Additionally, the supervisors collected secondary data from published and unpublished literature. Other data relating to the project area, available in government and other offices, was also collected. In addition to household level surveys, participatory poverty assessments (PPAs) were done in each of the selected blocks, as a separate activity (see chapter 11 for more details on PPAs) .

The first survey was completed by the end of June 2001. As per schedule, the second of the series of three surveys commenced during the third week of August 2001. The first survey was designed to obtain data for the previous Maha cultivation season beginning October 2000, up to the end of May 2001.The second survey was expected to obtain data from June to August, 2001. Since the second cultivation season, Yala (Apr.-Sept.), would not be completed during this period, it was decided to exclude the section relating to agricultural production from this survey. Other basic data gathered during the first survey was also excluded from this survey. Therefore the questionnaire was shortened considerably, and limited to income and expenditure data, heights and weights, time spent on household and other income generating activities as well as credit data. The third survey was a complete survey, designed to obtain data on Yala cultivation, as well as on expenditures, incomes, weights and heights, infrastructure and credit. The sections left out of the third survey were information pertaining to family details, housing and retrospective information. The second survey was conducted over a period of two and a half weeks beginning August 23, 2001. The third survey began on October 10, 2001 and was completed on November 8, 2001. Details of the process and conduct of the second and third surveys are provided in the sections below.

Twenty-three out of 25 enumerators recruited for the first survey participated in the second and third surveys. Three of the enumerators, who were computer literate, and considered above average in terms of their knowledge and

understanding of the surveys and familiarity with the questionnaire, were assigned for data entry work. The first two pages of the completed questionnaire of the first survey was photocopied and attached to the new questionnaires for the second and third surveys, to prevent mix-ups of family members as well as to avoid entering the same information again. All questionnaires were then arranged according to the strata and by DC canal or village. Enumerators were advised to write down the sample and identification numbers and the names of the household members in the same order as in the first survey. They were also advised to check whether the ID number marked in each of the sample household premises during the first survey coincided with the sample ID number in the questionnaire, prior to commencing the interviews for the second and third surveys.

The same procedure adopted in the first survey of completing one stratum before moving to the next stratum was followed in the second and third surveys. For the second survey, each enumerator was required to fill at least four questionnaires per day. The enumerators were assigned at least two nearby households for completion in the morning session and two more in the afternoon session. However, if no one was available in one of the assigned households at the time of interview, the enumerator was usually reassigned to another household after completion of one interview. The supervisor would try to reassign the missed households to one of the other days that the survey team planned to be in the area or stratum. If such reassignment was not feasible, the household that was missed would be taken up later by a smaller team of enumerators, after completing the survey in all the strata. A similar procedure was adopted for the third survey, excepting that the enumerators were expected to complete at least two interviews per day.

Initially, all 23 enumerators were sent to the field for the second and third surveys. From the second day onwards, one enumerator was assigned for checking questionnaires. Although working longer hours, only 30-40 questionnaires on average could be checked per day, per person. From time to time, an additional person was assigned for checking to reduce the backlog. Since data entry for the second survey was undertaken in the field office, the three data entry operators started entering data within two days of the start of the survey, when a sufficient number of questionnaires had been filled and checked. In the case of the third survey, data entry started a week after the beginning of the survey, since a sufficient number of questionnaires had to be filled, checked and brought to Colombo, prior to entry. There were three supervisors assigned for the surveys and at least two of them were in the field throughout the survey period.

As in the previous survey, supervisors took turns accompanying the enumerators, to observe and advise the enumerators on the correct procedures to be adopted in conducting the survey. The supervisors also made a random assessment of the quality of the checking and data entry process by reviewing checked questionnaires and examining the data entry files.

5.8 Household Income and Expenditure Diaries

In addition to questionnaire survey, the households were provided with a diary (notebook) to record their daily expenditures and income for the three months following the survey. The premise was that data from daily records of income and expenditure would be more reliable than recall data obtained from the questionnaire survey. Furthermore, such data would help in assessing the quality of the data gathered using the structured questionnaire. Information on all expenditures, including expenditure on agricultural production activities was requested to be recorded by a literate person in the household. The households were also requested to include the quantity of produce consumed from home garden or from their agricultural lands. This diary was developed from the expenditure module of the questionnaire. The households were requested to list all income received and expenditure incurred on each day on a page in the diary or notebook. The enumerator selected a suitable person in the household to keep the diary. He would then instruct the selected person, on how to fill up the diary, including examples of what should be included. For example, expenses on food, such as vegetables, fish, milk powder, etc. were included in this category. Other expenses such as, for health, education, transport, entertainment, payment of bills, hiring of labor, agricultural inputs were also included. All income, including salaries from permanent employment, wage labor, sale of produce, gifts, subsidies, interest payment etc were included in the income category. Thirdly, the quantity of produce used for home consumption was also included in the diary. This included such items as rice, bananas, vegetables and fruits, and livestock products.

Although most households had made an honest attempt to fill out the diaries as requested by the enumerators, there were some shortcomings that we observed. Some households had filled out the diaries for a month or so and then stopped, for various reasons such as an impending examination in the case of a student, no time to fill out in the case of a female or male spouse, due to field or household work commitments. Most households appear to have filled up the diaries on a daily basis at the beginning, but had then progressively increased the interval between filling up, to a week, fortnight or month, due to lack of motivation or

other causes. The accuracy and reliability of the information would decline in such cases. There were some who, filled up the diaries initially and then stopped, and restarted at the time of the second and third surveys, when the enumerators went back to the households for interviews. A few households had lost the notebooks, but at least 80 percent of the diaries have been returned. Overall, at least one month of income and expenditure data entered on a daily basis could be gleaned from the notebooks, from a majority of the households.

5.9 Field Problems

The survey team faced several problems during the field surveys. Some of the problems faced during the second surveys include the following:

1. Events such as weekly markets (*pola*) and farmer organization meetings caused some delays in the survey schedules on several occasions.
2. Due to severe drought in the area, individual household members in several households or in some cases entire households, in some cases, had temporarily moved out of the area. Consequently, it was not possible to make appointments for interviews for all of the selected households. Some households were re-visited several times, before an interview was possible, while few could not be interviewed at all.
3. Due to school vacations, some families had left their residence to visit their home-towns or relatives, gone on a pilgrimage, excursion or similar activity. Whenever possible, interviews of such cases were completed on a later date.
4. In a few cases, encroachers who were part of the sample, had been evicted from their residences by the Authorities, and hence could not be contacted.

As for the second survey, field problems faced during the third survey include the following

1. In the Sevanagala area, there were delays in contacting some respondents as they were involved in sugarcane harvesting, either in their own fields or in other farmers' fields.

2. Delays were also encountered due to roads being affected by the heavy rains, particularly in Sevanagala, where many of the dirt roads became slippery after rains, thus hindering travel in the area.

3. Many of the respondents were involved in chena cultivation, particularly in the Extension, Sooriyawewa and Kiriibbanwewa areas. These farmers were

sometimes not available for days if the chena plot was located at some distance to their homes. This also caused delays in contacting the farmers.

4. In the third survey, too, we encountered the problem of not being able to contact some of the sample encroachers who had been evicted from their homes by the Authorities. Some could not be contacted at all, because they had moved out of the area, while a few others who were residing elsewhere in the area were contacted and interviewed.

5. A few respondents had begun preparatory work for Maha cultivation and were in the field. Enumerators had to make several visits before they were able to interview these farmers.

6. Due to prevailing drought in most of the areas covered by the survey, several farmer associations had called frequent meetings to distribute drought relief to residents of the area. Thus it was difficult to contact some of the residents who were actively involved in such activities, and repeated visits had to be made.

The above problems were resolved to a large extent by retaining a smaller team of enumerators in the field for an extended period of time to undertake a second round of surveys for interviews as well as for measuring heights and weights of those households members, who were not available during the first round of surveys.

5.10 Data Entry

The procedure followed in data entry required each data entry operator to complete all modules of the filled questionnaire, before moving on to the next questionnaire. Individual data entry operators divided the completed questionnaires equally among them, and entered all data from the questionnaire. They were also required to convert data recorded in different units in the questionnaire to standard units, prior to entering in the database. The templates used in the first survey were adjusted to facilitate data entry for the shortened second survey data, while retaining the framework for comprehensive analysis of all three surveys. Initially, operators were able to enter only 21 - 27 questionnaires per day, but this eventually increased to 35 questionnaires per day. The Excel program was used for data entry. After initial cleaning, data were transferred to the SPSS program for further cleaning and analysis

The data entry process was modified in the third survey to improve efficiency. Each data entry operator was required to specialize in data entry from a particular section or module of the questionnaire, rather than complete the entire questionnaire, as was done previously. The questionnaire was broken up into three sections with approximately equal work load as follows: modules 1 & 2, module 3 and modules 4 & 5, and distributed among the three data entry operators, with each entering one section only. This reduced errors in the entering process, facilitated and improved accuracy when data conversion was required prior to entry, increased familiarity with the data so that obvious errors, outliers or unusually large or small figures could be detected. The data entry operators were also required to double check the entered data after completing each page or section.

5.11 Data Cleaning Process and Quality Control

The primary data collected through the surveys was subject to a five-stage process for quality improvement. At the first stage, the enumerators who filled the questionnaires were required to carefully go through their own questionnaires to check for errors, missing values or other problems and correct such problems before handing it over for checking. At the second stage, those assigned for checking questionnaires are required to carefully check all the filled questionnaires for accuracy, clarity, completion of entries, and other errors and correct these errors in consultation with the enumerator who filled the questionnaire. At the third stage, a random sample of the checked questionnaires, were again checked by one of the supervisors. At the fourth stage, the date entry person was required to look for errors, mistakes or missing values and correct the errors, prior to data entry. Conversions to standard units were also undertaken by the data entry person prior to entering the data. At the fifth stage, the supervisor responsible for cleaning the data prior to analysis, also examined the data for errors or bad entry, missing values, etc. and corrected any mistakes in consultation with the data entry person or the enumerator, if necessary.

The supervisors also randomly checked completed questionnaires in the field, immediately after it had been filled. At the initial stages, the supervisors accompanied the enumerators to the household, to determine how the enumerators were performing with respect to the interviewing procedure adopted, the phrasing of the questions to the household, coverage of entire questionnaire, and proper filling of the questionnaire. Errors identified by the supervisor were immediately corrected in the field itself. Apart from this, the supervisors held discussions with the enumerators almost on a daily basis after dinner, to sort out

any problems relating to the questionnaire or to the conduct of field surveys. Thus a fairly rigorous procedure for quality control was implemented to improve the quality as well as the reliability of data collected.

The data cleaning process for the surveys began even prior to the interviews, through an exhaustive and thorough training program offered to the enumerators and supervisors, in order to minimize the errors that could be potentially made during the survey. The second step began upon completion of the interviews, when a thorough check of the completed questionnaires was undertaken by a group of trained enumerators and supervisors. Checks were made for errors in recording data, outliers, conversion errors, missing values or other obvious mistakes. Errors detected during this initial screening process were corrected in consultation with the enumerator concerned. If these errors could not be corrected in consultation with the enumerator, the enumerator was sent back to verify the data.

Similar procedures were used for data cleaning for all three surveys. After data entry, the data was cleaned first in the Excel Program, into which the data was initially entered. Specifically, the missing values, zeros, and not applicable values were identified and classified. The minimum and maximum values were determined and outliers identified for verification or correction. The coding was completed for open ended questions and appropriate codes entered. The data was also examined cell by cell to detect any errors. The data base in Excel was converted into SPSS format and further cleaning undertaken. Frequency tables were generated for all variables and these tables examined for outliers, errors in coding, as well as other errors. Variables with such errors were sorted and the case number identified and doubtful cases were verified by checking back with the questionnaire. Subsequently, the each data file was examined by individual row or column to detect any errors across variables or within a variable.

Chapter VI Analytical Framework

The major objective of this study is to assess the impact of irrigation infrastructure development on poverty. The study employs a 'with' and 'without' approach by comparing sample areas representing various states of infrastructure development: well developed/improved, less developed/unimproved, with no infrastructure, and without irrigation in order to establish irrigation accessibility. Like other types of infrastructure, development of irrigation infrastructure can be expected to generate positive outcomes for the poor in terms of overall increased productivity and production, improved incomes, increased consumption and employment, reduced vulnerability and food in-security, and enhanced overall welfare through both direct and indirect positive impacts. All these factors can be assumed to reduce not only the incidence of chronic poverty but also to positively influence temporary poverty. The overall framework for this study is based on three key hypotheses as stated below.

1.The incidence, depth and severity of poverty are lower in agricultural areas with irrigation infrastructure than in areas without infrastructure.

The dynamic aspect of poverty to be examined in this study is to determine whether irrigation infrastructure can reduce the variability in incomes and expenditures in rural households. The second hypothesis to be tested can be stated as follows:

2. The variability in incomes and expenditures is less in agricultural areas with irrigation infrastructure than in areas without infrastructure or in other words irrigation infrastructure help smoothens incomes and expenditures.

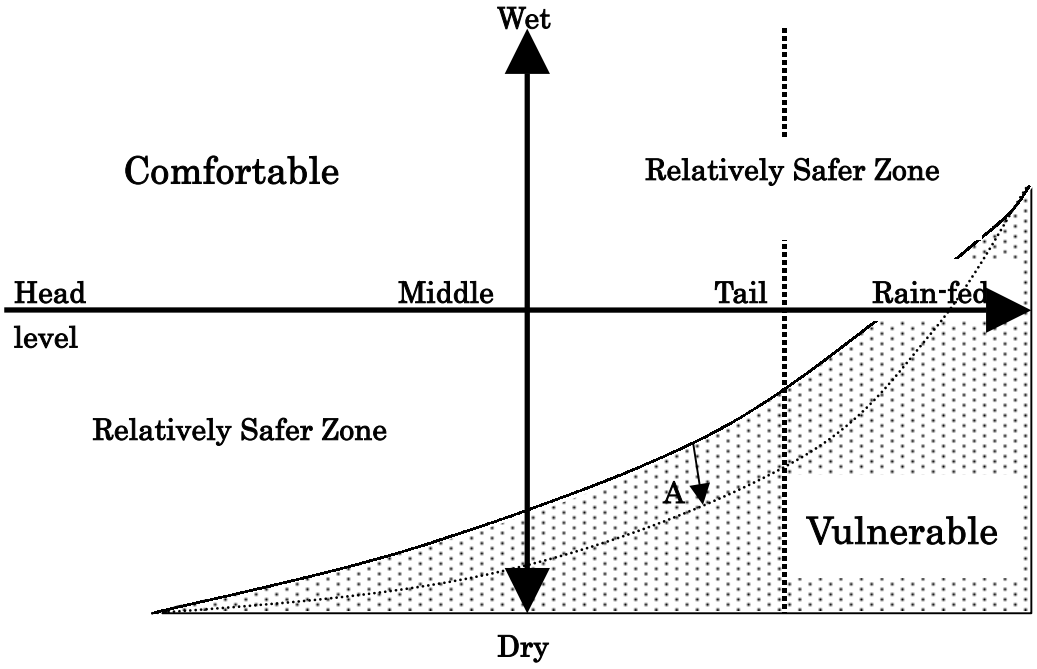
The relationship between consumption smoothing and irrigation infrastructure, specifically the question of whether households with access to irrigation infrastructure receive higher incomes and thus able to smooth consumption, is another dynamic poverty aspect that will be addressed in this study. The third hypothesis can be stated as follows;

3. If incomes in agricultural areas with irrigation infrastructure are higher (than in areas without infrastructure), consumption expenditure may not track incomes during the year. Or if incomes in agricultural areas without irrigation infrastructure are lower (than in areas with infrastructure), consumption expenditure may track incomes during the year.

In assessing the impact of irrigation infrastructure on poverty, it is important to understand that irrigation water and infrastructure are complementary to each other. Access to irrigation water becomes possible only if infrastructure for conveyance and distribution of water is available. However, while availability of physical irrigation infrastructure alone may not be a sufficient condition for access to water, it is surely a necessary condition. Adequate water may be available, but without infrastructure, people may not be able to access it. The access to water depends upon availability of both water and infrastructure. However, there may be variations in availability of water and the degree of infrastructure development, with varying impacts on poverty.

The hypothesized spatial and temporal relationships between infrastructure development and poverty are depicted in Figure 1. The horizontal axis represents the irrigation system with the arrow illustrating the flow of water from the head down to the tail reach. The rainfed area relies on rain as its primary source of water. The vertical axis represents the time dimension and is characterized as either the wet or dry season. Based on the location and season/ timing each area is classified by the state of infrastructure development and relative security of access to adequate irrigation water supplies.

Figure 6.1. Spatial and Temporal Dimensions of Irrigation and Poverty



Near the head of the irrigation system, where infrastructure is most likely to be well developed (compared to, for example, tail reaches, a farmer is most likely to be guaranteed an adequate supply of water during the rainy season. This is because during the wet season surface water flows will be at their highest and because head-end farmers will have first opportunity to take water. Farms located further down the irrigation system will experience diminished relative security of their access to irrigation water. The diagram presented illustrates that there are seasonal vulnerability patterns for access to irrigation water, as well as distinct spatial patterns. Policy interventions to alleviate the vulnerability, should attempt to reduce the vulnerability zone both in time and location, illustrated by the lower dashed curve.

6.1 Analytical Methods

There is no single indicator or method for testing the above hypotheses. In this study, we use the following approach to comprehensively assess the impacts of irrigation infrastructure on poverty covering both its spatial and temporal aspects.

1. Compare various strata representing the state of infrastructure development – quantify the difference in the value of relevant variables by developing a socio-economic profile for each stratum.

2. Develop and quantify key indicators of poverty – covering both income / expenditure and qualitative dimensions of poverty.

3. Estimate household income/ consumption smoothing effects of irrigation infrastructure development through econometric analysis, and

4. Identify and quantify key determinants of household incomes/expenditures/poverty including quantifying the impact of irrigation infrastructure development on these variables through econometric analysis.

Details on indicators of poverty and econometric framework are provided in the following section.

6.2 Defining the Poor and Measuring Poverty

A basic problem in any work on poverty is how to define the poor and how to measure poverty. There could be as many definitions of poverty as the number of

poor themselves, or at least as many as the number of people who have attempted to define poverty. Traditional approaches to measure poverty have centered on the concepts of incomes and consumption levels, with poverty generally perceived in two distinct ways: absolute poverty and relative poverty. Absolute poverty is defined in terms of minimum consumption needs without reference to income or consumption levels of the general population. A relative poverty situation, on the other hand, is generally defined in relation to mean income or consumption of a population as a whole. A person is considered poor, in absolute terms, if his/her income or consumption level falls below some minimum level necessary to meet basic needs – this minimum level is called the poverty line.

However, it has been argued that income is a narrow concept and is not an adequate measure of poverty and well-being. In recent years, it has been increasingly recognized that poverty is a multidimensional concept, extending from low levels of incomes and consumption to lack of education and poor health, and includes other social dimensions such as powerlessness, insecurity, vulnerability, isolation, social exclusion and gender disparities. Similarly, the concepts of livelihoods, basic capabilities and entitlements have broadened the concepts of poverty. While looking at poverty from both economic and non-economic dimensions provide a comprehensive and holistic approach for understanding poverty, analytical and measurement problems pose difficulties in the application of most of the above concepts. Consequently much of the empirical work in poverty relies on traditional income and consumption measures – estimating poverty lines using a basic needs approach. As the basic needs vary across time and space, poverty lines also vary over time and across societies – depending upon the level of socio-economic development, social norms and values within regions in a country or across countries.

For the purpose of this study, we will measure poverty in terms of the following two major dimensions:

1. Income / Expenditure Dimensions of Poverty – Income Poverty
2. Qualitative Dimensions of Poverty

6.3 Income / Expenditure Measures of Poverty

6.3.1 Income Poverty – Concepts of Chronic and Transient Poverty

There are two basic concepts of income poverty, static and dynamic. Static concepts relate to measurement of poverty at a point in time. Dynamic poverty

relates to changes in poverty over time. The concept of dynamic poverty is further categorized as chronic poverty and transient poverty. Chronic poverty is defined as a state where a household's income (consumption) is constantly below the poverty line. Transient poverty, on the other hand, is a state where a household's average income (consumption) is above the poverty line, but the household is confronted with the possibility of temporarily falling below the poverty line. Transient poverty is also called stochastic poverty.

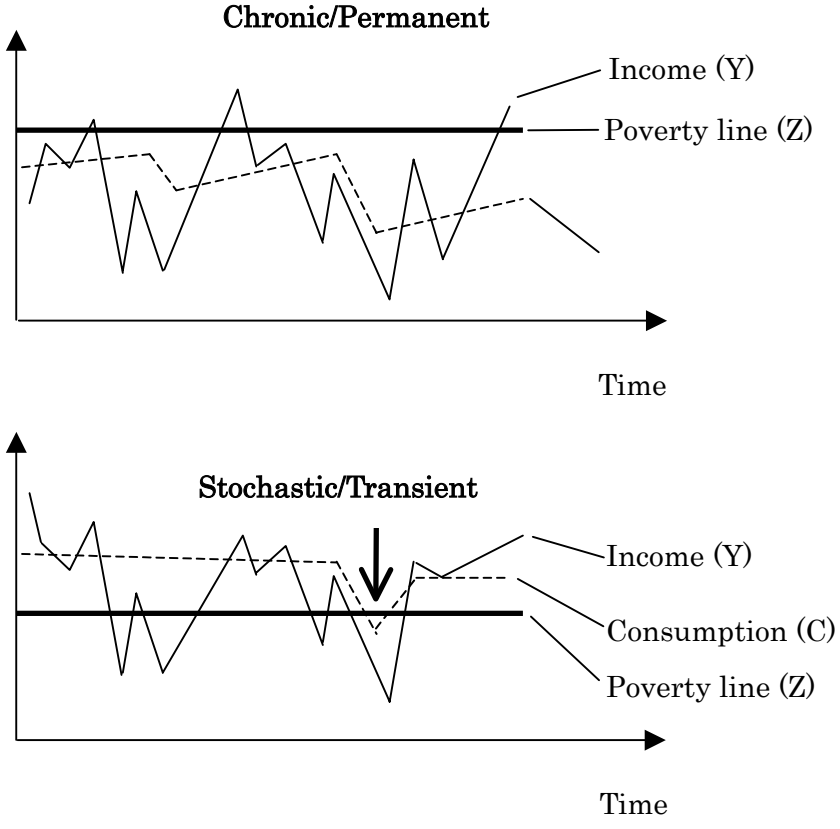
Chronic poverty = a situation where $Y^P < Z$

Transient poverty = a state where $C < Z < Y^P$,

where Y^P= a household's permanent income

C = a household's current consumption level

Z = poverty line



In the figures above, solid and dotted lines indicate income and consumption respectively.

There are distinct policy implications underlying the two dynamic concepts of poverty. For example, when chronic poverty is dominant, continuous long-term

policy interventions are necessary. Such policies may include agricultural research and extension, land reforms, income re-distribution and price support policies. When transient poverty is more prevalent, some form of insurance provision policies are more appropriate. For example, policies such as micro-credit, crop insurance, employment guarantee, or price stabilization policies may be needed. Recent literature from the Asian region suggests that transient poverty is more prevalent, with 50-70 percent of the population identified as living in transient poverty (Sawada, 2000).

Some of the income / expenditure indicators of income poverty include:

1) Average income per month
2) Average farm income per month
3) Average non-farm income per month
4) Average expenditure per month
5) Ratio of food expenditure to total expenditure

The relationship between income and consumption is embodied in the Engel's law, put forward by a German statistician Ernst Engel, who concluded that as incomes increase with a small amount that amount is spent on food. In general, the function denoting the relationship between income and consumption, keeping prices constant is called the Engel curve. As incomes increase, the quantity demanded increases for a normal good, like food, a necessity. As incomes increase further, the quantity of necessities consumed does not increase in proportion to income increases. Consumption does not cease altogether, because they are necessities. For luxury goods, there is little or no consumption at low levels of income, but consumption increases as income increases. For inferior goods, consumption declines with increases in incomes. A good cannot be inferior at all levels of income, at zero income there are no purchases, as income increases a little, consumption increases a little, and eventually as income gets high enough, the consumer ceases to purchase it altogether. Thus at high poverty levels one may observe a high proportion of income being spent on food, and as poverty levels decline, the proportion spent on food declines while the proportion spent on luxury and other normal goods increases.

6.3.2 Income / Expenditure Measures of Poverty

The measurement of income poverty involves: 1) specification of an indicator of well-being such as income or expenditure, 2) specification of an income level or threshold below which a person or household is considered poor – the poverty line,

and 3) construction of poverty measures. Foster-Greer-Thorbecke (FGT) class of measures is the most commonly used measure of poverty, which captures three aspects of poverty: incidence, depth/intensity and severity of poverty. These measures are the Headcount Index, the Poverty Gap Index and the Squared Poverty Gap Index.

1. Headcount Index is defined as the share or proportion of the population which is poor or whose income is below the specified poverty line. This is a measure of incidence of poverty. Suppose in a population of size n, there are q number of poor people whose income y is less than the poverty line z, then head count index can be defined as:

$$\text{Head Count Index} \quad HC = q/n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6.1)$$

2. Poverty Gap Index is defined as the mean distance separating the population from the poverty line. This can be interpreted as a measure of depth of poverty. Non-poor is given a distance of zero. This measure can be mathematically represented as follows:

$$\text{Poverty Gap} \quad PG = 1/n \sum_{i=1}^{n} \left[\frac{z - y_i}{z} \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6.2)$$

where z is the poverty line, y_i is the income of the individual i or household i, and the sum is taken only on those individuals who are considered poor (below poverty line).

The poverty gap can also be defined as the product of the income gap and the Head Count Index ratio, represented as follows:

PG = I*HC, where I is the income gap

Where $I = \frac{z - y_q}{z}$ and $y_q = 1/q \sum_{i=1}^{q} y_i$ is the average income of the poor.

Squared Poverty Gap Index is a measure of the severity of poverty. The poverty gap takes into account the distance separating the poor from the poverty line, while the squared poverty gap $[PG]^2$ takes into account the square of the distance. The squared poverty gap index gives more weight to the poor, by taking

into account the inequality among the poor—greater weights are given to larger gaps and the weights are simply the poverty gaps. It is represented as follows:

$$\text{Squared Poverty Gap} \qquad [PG]^2 = 1/n \sum_{i=1}^{n} \left[\frac{z - y_i}{z}\right]^2 \quad \text{.....(6.3)}$$

Both Poverty Gap Index and the Squared Poverty Gap Index put more emphasis on those who are further away from the poverty line. The general formula for all three measures is given below, which depends on parameter α which takes a value of zero for the Head Count Index, one for the Poverty Gap Index and two for the Squared Poverty Gap Index

$$P(\alpha) = 1/n \sum_{i=1}^{q} \left(\frac{z - y_i}{z}\right)^{\alpha} \quad \text{.....(6.4)}$$

The above measures can be analyzed for various socio-economic groups and for different geographic locations (within irrigation systems).

The above general income/consumption measures of poverty can be used to estimate the incidence of chronic poverty and transient poverty. The households can be divided into three groups: a. non-poor b. chronic poor, and c. transient poor.

a. households that never experienced income at levels below the poverty line
b. households whose income sometimes fell below the poverty line during the study period
c. households with income levels that are always below the poverty line

$$I_t = \frac{1}{n}\sum_{i=1}^{Pt}\left(\frac{Z - y_{it}}{Z}\right)^{\alpha} \quad \text{.....(6.5)}$$

$$C_t = \frac{1}{n}\sum_{i=1}^{P^*}\left(\frac{Z - \overline{y_i}}{Z}\right)^{\alpha} \quad \text{..... (6.6)}$$

$$T_t = I_t - C_t \quad \text{.....(6.7)}$$

I_t	poverty index
C_t	chronic poverty index
T_t	transient poverty index
Z	poverty line
y	monthly income of household
$\bar{y}$	average monthly income of household
n	population

In this report, poverty indices are calculated as per the following categories, with $\alpha = 0 or 2$.

First category

1. both average monthly income and highest monthly income are less than the poverty line (i.e. chronic poverty)
3. average monthly income>poverty line, lowest monthly income<poverty line (i.e. transient poverty)
4. average monthly income>poverty line, lowest monthly income>poverty line (i.e. the case of non-poor)

Second category

1. average monthly income≤0.5*poverty line
2. 0.5*poverty line<average monthly income≤0.75*poverty line
3. 0.75*poverty line<average monthly income≤poverty line
4. poverty line<average monthly income≤1.25*poverty line
5. 1.25*poverty line<average income

In addition to the above measures, we also undertake income distribution analysis both spatially and temporally and estimate welfare impact of income/expenditure fluctuations/variability using the following measures.

1. Gini-coefficient and Lorenz Curve
2. Cofficient of Variation
3. Standard Certainty Equivalence Measure—measure of welfare impact of income variability

The first two measures are self-explanatory. The third measure is described below.

6.3.3 Standard Certainty Equivalence Measure

Suppose a household's expected income and expected utility are denoted as follows:

$$E(y) = Y,$$
$$U(Y\text{-}m) = E[U(y)], \quad \text{.....6.8)}$$

where y is stochastic income, Y is the expected value of income, and m is the certainty equivalent compensation of income risks. Then, the fraction of income which households would be willing to give up to eliminate risks will be approximately:[12]

$$\frac{m}{Y} = \frac{RRA(\sigma / Y)^2}{2} \quad \text{..... (6.9)}$$

where RRA is the degree of relative risk aversion and σ is the standard deviation of household income. Note that m/Y represents the negative welfare effects of the existence of income fluctuations. When there is no income risk, i.e., σ=0, then there is no negative welfare impact. The certainty equivalent measure quantifies the amount that household would be willing to give-up to achieve perfect smoothing in incomes/expenditures, and measures the welfare cost of income/expenditure fluctuations (for more details see Morduch, 1995).

Empirically, the value of the standard deviation σ and the average monthly income Y are easily obtained from the data set. However, RRA is more difficult to estimate. Estimates obtained from South Asian data sets suggest that a value of R = 2 to 4 can be used to calculate the welfare impact, m/Y of each household.

6.3.4 Defining the Poverty Line

As mentioned above, specification of a poverty line is an important step in estimating the above measures. There are three commonly used approaches used for estimating poverty line: a) based on calories intake, b) income /expenditure needed for required food energy intake (only food) and c) cost of basic needs (food and non-food). For the purpose of this study, we use secondary estimates of national/regional poverty line available from the national statistical agencies for

[12] We can employ a second-order Taylor expansion around Y.

that country/region.

As stated earlier, there is no official definition of poverty line in Sri Lanka. Several studies have used a poverty line that has been estimated based on the value of a food basket that provides the required minimum calorie and protein intake, and allows for a certain empirically determined proportion of expenditure on non-food items. Nanayakkara and Premaratne (1987) estimated a poverty line using the 1985/86 Labor Force and Socio-Economic Survey (LFSS) data of the Department of Census and Statistics, at a monthly per capita food expenditure of Rs 202 at 1985/86 prices. This corresponded to the expenditure required for a daily calorific intake of 2500 calories and 53 grams of protein per adult male (age 20-39) equivalent. An additional amount of Rs 40 was allowed for basic non-food expenditure estimated from national Engel functions for 1985/86, bringing the total poverty line to Rs 242 per capita per month (excluding consumer durables) at 1985/86 prices. This was updated to Rs 471 at 1990/91 prices using the Greater Colombo Consumer Price Index (GCCPI) to adjust for price inflation (World Bank, Poverty assessment Study, 1995). A higher poverty line of Rs 565 was also estimated on the basis of expenditures of 20 percent above the reference poverty line. The reference and higher poverty lines are used as the basis for this study, updating the figures at 2000 prices using the same GCCPI to account for inflation. This works out to Rs 952[13] per person per month for the reference poverty line and Rs 1142 for the higher poverty line. The poverty line of US$1 per day used by the World Bank (1990), estimated at Rs 252 per person per month, adjusted for purchasing power parity at 1985 prices, can also be used for comparison purposes. This poverty line works out to Rs 991 per person per month at 2000 prices, when adjusted for domestic price inflation using the GCCPI.

[13] The Greater Colombo Consumer Price Index has a base January to June 1989=100, and weights for different components of expenditure are based on the Labor Force and Socio Economic Survey 1985/86 of the Department of census and Statistics, revalued at January to June 1989 prices. This index measures consumer price inflation in the Greater Colombo area based on the expenditure on a typical basket of goods and services of an average urban family (Statistical Abstracts, Department of Census and Statistics, 2000). The basic poverty line of Rs. 242 at 1985/86 prices was updated using the GCCPI to Rs 471 at 1990/1991 prices. For our study, we have updated the poverty line based on 1991 prices and estimated a new poverty line based on 2000 prices using the GCCPI. Therefore, the basis for the poverty line (estimated by Nanayakkara and Premaratne , 1987 as consumption of 2500 Kcals of energy and 53 grams of protein and an additional amount for basic needs) remains the same for this poverty line except that it is now valued at 2000 prices. {GCCPI for 1990 = 124.6 and for 2000 = 252.0 Poverty Line 2000 = (471/124.6)*252=952.6}. The international poverty line of US$ 1 per day (at 1985 purchasing power parity) works out to Rs 252 per capita per month expenditure at 1985/86 prices (Datt G. & Gunawardena D, 1997). This value of prices works out to Rs 490 per capita per month updated at 1990/91 prices and Rs 991 per capita per month updated at 2000 prices, on the basis of the GCCPI.

6.3.5 Defining Household Income —Sources of Rural Income

The concept of rural income, as used in methodological discussions above, is defined as the total income received in both cash and kind in a given season/year. Income received in kind is imputed in monetary value using the prevailing prices. The total income used is net of all cash expenses but exclude the imputed value of all resources owned by the household (family labor, draft animals etc)
Total income may be disaggregated by its source of origin as follows.

1. Income from crop production – includes incomes from the sale of all crop outputs (including grains, vegetables and fruits), imputed value of all crop outputs retained for household consumption, and imputed value of crop by-products. The income is calculated net of all cash expenditures on material inputs (seeds, fertilizers, chemicals), hired labor, rental payments for farm machinery.
2. Income from non-crop agriculture – includes incomes from livestock, fisheries and forest products and their by-products. This includes the imputed value of the produce retained for household consumption.
3. Income from agricultural wages – includes incomes from working in agricultural activities on others' farms.
4. Incomes from trade, services and other non-agricultural sources – includes incomes from shop-keeping, petty trade, business and market intermediation, self-employment, salaried services, earnings from manual labor employed in rural processing and industrial activities, transport operations, housing and road construction and other similar activities.

6.3.6 Definition Household Expenditures and Assets

Household expenditure is first divided into durable and non-durable expenditures. Non-durable expenditure is divided into three categories. Category I comprised rice, both purchased and consumed from own farm, cereals other than rice, pulses, cassava and sweet potato, vegetables, fruits, sea fish, tank fish, canned fish, dried fish, meat, flour, bread, eggs and milk. Category II comprised tea, coffee, milk powder, yoghurt, soft drinks, liquor, cooking oil, coconut, sugar, salt, and spices. Category III comprised, of tobacco, cigarettes, soap, shampoo, electricity charges, expenses for firewood, cooking fuel, LP gas, and lighting fuel. Other category of expenditure included expenses for house repairs and maintenance, clothing and shoes, medical care, education, recreation, ceremonies, transport and communication, remittances for family/relatives, rent, loan

repayment, taxes, bank deposits, weddings, and other miscellaneous expenditures. Non-durable expenditures included food expenditure, which included all items in Categories I and II and non food expenditure, which included all other expenditure included in Category III and Other Category (i.e. non-durable expenditures other than those in the above three categories). Since wedding expenditure, was considered to be one time expense it was excluded from the non-food category of expenditure. Household expenditure data was obtained on a monthly basis from October 2000 to September 2001.

Durable expenditure included expenditure on agricultural assets and household assets. Agricultural assets included two and four wheel tractors, plow and harrow, water pump, sprinkler systems, motorized and hand threshers, winnows, rice mills, mechanized livestock feed processors, hand and mechanized sprayers, ox and hand carts, and other farm equipment. Other items included in agricultural assets are the ownership and amount spent on purchases of livestock such as cattle, buffalo, milk cows, pigs, goats, chicken and other animals on a seasonal basis. Household assets include assets such as bicycles, motor cycles, television, radio, cassette recorder, sewing machine, refrigerator, petromax lamps, electric fans, telephone, clocks, gas cookers, electric cookers, trucks and pick up trucks, cars, land and buildings, and any other assets.

In the case of agricultural assets, data were obtained on the ownership of assets and the market value of such assets and not on expenditure or the date of purchase of such assets. Data on the value of sales of assets such as livestock during the season was also obtained. Household assets included the number owned, and if purchased, the price and the year of acquisition of such assets. Since monthly data on expenditure on assets was not obtained, it was not possible to analyze monthly movements on such expenditure. The only durable item for which monthly data were collected was the expenditure on repairs and maintenance of house. This was included under the other category expenditure in the analysis. Data on durable expenditure was obtained on a yearly basis.

6.4 Other Qualitative Indicators of Poverty

Frequently used qualitative indicators of poverty can be grouped into the following categories.

1) Health related indicators: under 5 mortality rate, life expectancy, number of days absent from work due to illness, prevalence of child malnutrition, access to sanitation, access to hospitals, access to drinking water, type/housing

condition, per capita calorie intake;

2) Education related indicators: Adult literacy rates, number of years of schooling, school drop out rate, distance to school;
3) Infrastructure indicators: Distance to nearest bus station, market, post office, telephone, availability of electricity, access to gas cooking, access to irrigation, access to upgraded lined irrigation;
4) Asset ownership: per capita land, per capita irrigated land, ownership of houses, household assets;
5) Household, Labor and Employment: Primary and secondary occupation, percent unemployed, dependency ratio, labor force participation rate.

For this study the following key qualitative indicators have been selected, on the basis of information collected in the survey. These indicators will be estimated for each stratum.

1. *Dependency ratio:* This is defined as the ratio of the number of children and elderly persons to total potentially employable persons. This indicator can be calculated on the basis of a household, stratum, group or sector of the population. One would expect the dependency ratio to decline with the decline in poverty.

2. *Educational level:* The rationale for this indicator is that, higher levels of educational attainments open up economic opportunities, including ability to absorb new technology, make better use of available services such as extension, credit, marketing and venture into new enterprises or self-employment. The indicator is measured as the number of years of schooling of household head. It is assumed that higher levels educational attainments would reduce poverty.

3. *School drop out rate:* Traditionally, it has been assumed that high drop out rates of children of school going age were mainly due to the household not being able to afford schooling due to poverty. It could also be a result of schools being far away, and/or lack of transport facilities. On the other hand, high drop out rates may be due to the availability of employment opportunities for children within the locality. The parents may prefer to send their children to work than to school in order to earn an additional income.
4. *Under-five mortality rate:* Poverty can result in higher mortality of children under five years old, as they are the most vulnerable group. Thus, one would expect a higher mortality rate of this group within poor

households. A measure of mortality of children under five would be a good indicator of poverty.

5. *Housing Index:* This index evaluates the quality of housing based on the materials used for the walls, roof and floor, the number of rooms in the house and the type of toilet. The maximum points for each component of housing are three points as follows; wall (palm-1, mud-2, brick-3, other-2); roof (palm leaf-1, tin-2, tile-3, other-2) and floor (mud-1, cement-2, tile-3, other-2) and maximum points for the number of rooms are four, estimated as the average number of rooms per household. The water seal type of toilet was allocated 2 points and all other types 1 point. The maximum score possible is 15 points, which translate to an index of 100 percent.

6. *Ownership of household assets:* One would expect households owning greater amounts of assets to be less poor than those having little or no such assets. Data has been collected on the current value of household assets owned by households. Value of household assets per household or per capita would be good indicators of poverty (household assets here include only non-agricultural assets).

7. *Average land holding – irrigated and non irrigated:* This estimates the average land holding ownership by type of water source. It is assumed that households owning larger irrigated holdings are less poor than those not having irrigation facilities.

8. *Access to irrigation water:* This is similar to the indicator on irrigated land holding described earlier. The difference here is that lands, officially classified as rainfed or un-irrigable, may be receiving irrigation water from some source, such as agrowell, illegal diversion of canal, seepage water, tube well, drainage water, etc. and would fall into this category. This indicator and would capture the true irrigated extent and provide a more precise categorization of land by irrigation.

9. *Cropping intensity:* This is the ratio of the area cropped to the area actually owned, per season. The higher the cropping intensity, the less poor the household.

10. *Agricultural productivity per hectare:* The average productivity per unit of land (total output / total land owned) and average productivity per unit of land cropped (total output / total area cropped) will provide a measure of

the potential versus actual productivity. The difference may be due to various causes such as lack of irrigation facilities, poor water management, climate, input supply problems, lack of credit or finances, marketing problems, poor soils, drainage problems or other problems.

11. *Total agricultural assets:* Agricultural asset ownership provides a measure of wealth and would be a good indicator of poverty in rural areas. Data has been collected on the current value of agricultural assets owned by the household. Thus the value of agricultural assets per household or per capita would be a good indicator of the level of poverty of the household. Agricultural assets would include, all equipment used in agricultural production, e.g. tractors, plows, threshers, trailers, sprayers etc.

12. *Access to electricity:* The proportion of households with access to electricity is another indicator of poverty. However, it is also possible that the household does not have electricity because of non-availability of electricity supply to the locality by the authorities and not due to poverty. These factors should be considered when interpreting the results of this indicator.

13. *Access to piped water supply:* This indicator can be estimated as the proportion of households having access to piped supplies of water, which can be used as a measure of poverty.

14. *Access to credit:* The assumption here is that the poor have less access to credit than non-poor households.

6.5 Econometric Analysis

6.5.1 Seasonality in Incomes and Expenditures

The third hypothesis on the issue of income and expenditure smoothing is tested using the model developed by Paxson (1993). Paxson suggests that in addition to constraints to borrowing there are other reasons that can cause consumption fluctuations. She tested the hypothesis that seasonal taste and price variations, as opposed to variations in incomes, are a major determinant of observed consumption variation in Thailand. Assuming two seasons, she develops a model of perfect smoothing, i.e. individuals do not have credit market constraints. It implies that seasonal consumption patterns are unaffected by the timing of income inflows. The model is extended to allow for imperfect smoothing, and actual expenditure in any season, which is a weighted average of income in

that season and desired expenditure that is given a perfect ability to smooth. This is expressed as follows:

$$E_{ji} \;=\; E_{ji}^{*}(1- \pi) \;+\; Y_{ji}\pi, \quad j = 0,1 \text{ ....(6.10)}$$

where $0 \leq \pi \leq 1$. This yields the following equation for expenditure in each period.

$$E_{ji} \;=\; Y_i\,[\beta_j\,(1 - \pi) + A_{ji}\pi]\;,\ j = 0,1 \text{ ....(6.11)}$$

where A_{ji} is the fraction of annual income earned by individual i, in season j (so that A_{ji} sums to one across seasons for any individual). As π increases, the effects of prices and preferences (measured by β_j) receive less weight in determining seasonal expenditure, and seasonal incomes receive more weight. If $\pi = 1$, then seasonal expenditure tracks seasonal income. Y_i is defined as total annual income divided by the number of seasons (12 months), or the average monthly income level of person i. The above equation yields the following log expenditure equation:

$$\ln (E_{ji}) \;= \ln (Y_i) + (1 - \pi)\beta_j \;+\; \pi A_{ji} - 1$$

where E_{ji} is the expenditure of individual i, for season j.
Y_i is the total annual income divided by the number of seasons.
A_{ji} is the fraction of annual income earned by individual i, for season j.
β_j is the effect of prices and preferences and
π is the smoothing coefficient

In the above equation, perfect smoothing ($\pi = 0$), implies seasonal expenditure is determined only by income, preferences and prices. Imperfect smoothing ($\pi>0$), implies that the timing of income flows A_{ji} is also a determinant of seasonal expenditure. The above equation can be estimated using OLS. For more details on the framework see Paxon (1993).

Separate OLS estimates for the six strata can be obtained for each season, in order to test the hypothesis that seasonal expenditure is dependant only on permanent income, prices and preferences and not on timing of income flows. A regression analysis based on the above framework using consumption as the dependent variable and dummy variables for seasons/months as independent variables is undertaken. Regional differences and the differences in irrigation infrastructure development are also taken into account in this analysis. A graphical analysis of the outcome is produced to illustrate the differences (see chapter 10).

6.5.2 Estimation of the Determinants of Incomes/Expenditures – Quantification of Impacts

Quantification of key determinants of household incomes and expenditures is undertaken by estimating a multivariate econometric model with annual household level data. It is hypothesized that household incomes/expenditures depend upon:

a) Household endowment of natural resources, particularly land;
b) Household productivity of natural resources, such as land productivity;
c) Household human resources and their characteristics, such as number of non-dependent working family members, education levels of family members, occupation;
d) Household capital resources, such as household non-land productive assets such as agricultural machinery, livestock;
e) Household access to irrigation/infrastructure.

Irrigation infrastructure and its state of development can be expected to contribute positively to household incomes through increased overall productivity and production, through enhanced employment and income earning opportunities associated with infrastructure induced improved economic activities in both farm and non-farm rural sectors.