## Malaysian Case Study I: The Irrigation Scheme Information Scheme

*M.N. Mohd Adnan*[18]

## INTRODUCTION

In 1989, a study on crop diversification and small irrigation schemes was undertaken under a technical cooperation program between the Governments of Japan and Malaysia. A major outcome of this study was a management information system (MIS) for the 924 irrigation schemes totalling 130,122 ha. The data are stored into two files (S-INFO and S-AREA) using dBASE IV software. S-INFO is comprised of 102 items of data primarily pertaining to the physical aspects of the irrigation scheme while S-AREA stores data on the planted areas. For the information retrieval system, 52 programs were prepared. This system has assisted in determining crop diversification potential for each scheme and is also used as a source of information for planning and management as well as a base to develop other information systems such as water resource planning. The same format could be used to develop an MIS for Farmer-Managed Irrigation Systems (FMIS). Although not a new concept, FMIS have yet to be positively developed in Malaysia. The current economic situation and policies such as industrialization, crop diversification, group farming, commercial orientation and privatization indicate that FMIS will be an important feature of future irrigation development. In developing FMIS, a suitable MIS is necessary both for agencies such as the Department of Irrigation and Drainage (DID) for monitoring and evaluation and to improve their performance.

Irrigation in Malaysia has developed almost exclusively for paddy. The DID, a technical department within the Ministry of Agriculture (MOA), is responsible for the planning, design, construction and management of irrigation systems.

Of over 600,000 hectares (ha) of paddy lands in the country, 52% or 342,650 ha have been provided with irrigation facilities while the remainder remain as rainfed areas.

The irrigated areas comprise eight large schemes totalling 212,528 ha and 924 small irrigation schemes scattered over the country and totalling 130,122 ha (Figure 1). All these schemes were developed and continue to be managed by the Government.

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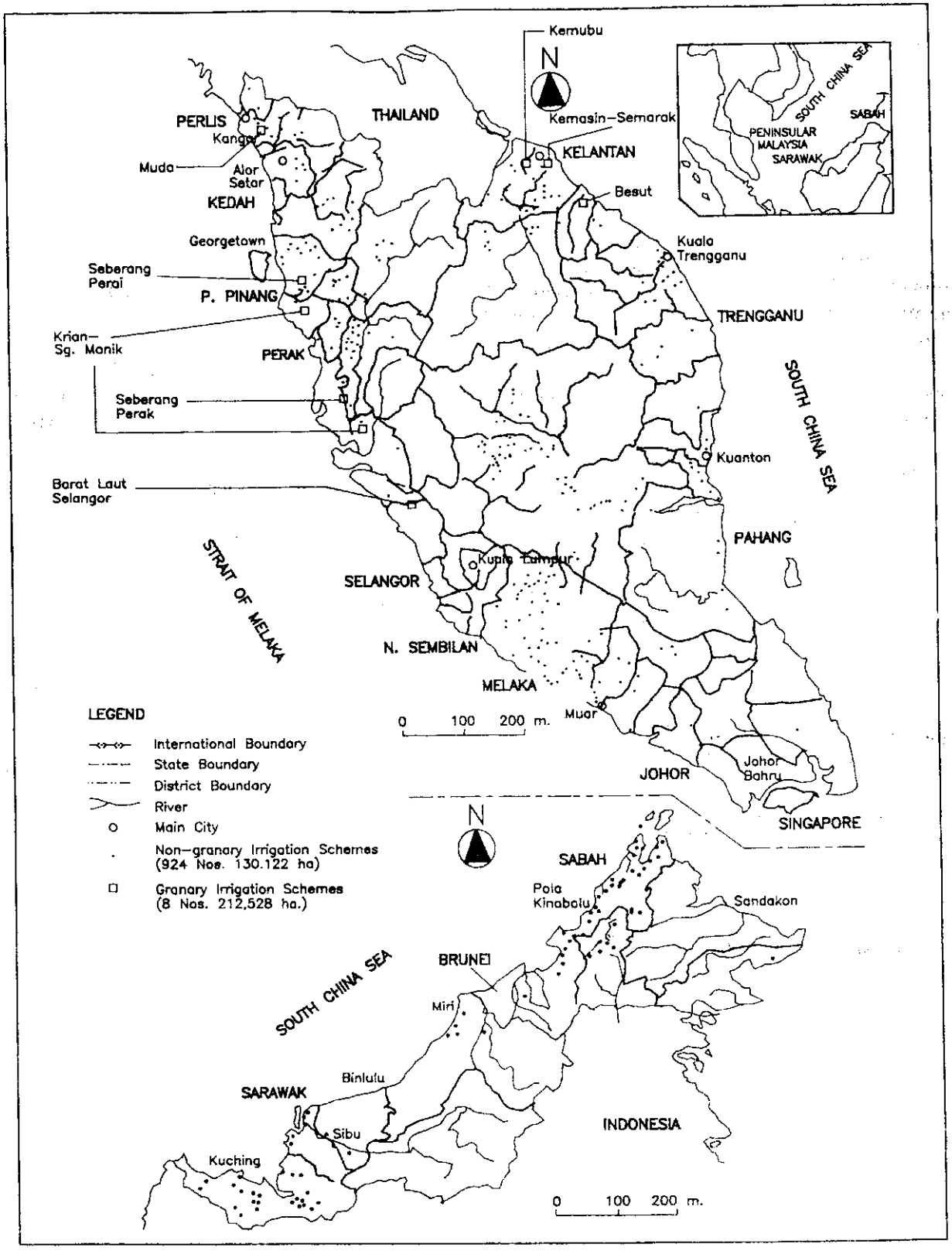
[18] Senior Engineer, Irrigation Branch, The Department of Irrigation and Drainage, Jalan Sultan Salahuddin, 50626 Kuala Lumpur, Malaysia. The author wishes to thank the Director General of DID and the workshop organizers, IIMI and DSE/ZEL, for giving the opportunity to write this paper, the staff of Irrigation Branch, DID for their assistance in its preparation and Mr. M. Ansor for presenting it at the workshop.

*Figure 1. Irrigation schemes in Malaysia*



Agriculture development (including irrigation) in Malaysia is guided by the National Agriculture Policy (NAP) which was enunciated in 1984 and is currently under the final stages of review. The policy stipulates that paddy production shall be focussed in the eight large irrigation schemes, also known as the Granaries, and that these areas be capable of producing at least 65% of the country's needs. The rest of the paddy areas, the rainfed and non-granary irrigated areas, shall be converted in phases into diversified crops. In-situ development is emphasized and farmers will be encouraged towards commercially oriented farming systems.

This means that while efforts will be to increase paddy productivity in the Granaries to meet the demands of the increasing population, special programs need to be developed for the non-granaries. Focussing initially on the non-granary irrigation schemes, a rationalization and crop diversification study (the Study) was carried out under a Technical Cooperation Program between the Governments of Japan (JICA) and Malaysia (GOM) in 1989. The 20-month Study included an inventory survey of the 924 schemes, a socio-economic survey and the identification of the potential (diversified) land use of each of the scheme (JICA, GOM 1990a, 1990b).

This paper focusses on the Management Information System (MIS) of the irrigation schemes which developed out of the inventory survey. The potential of developing Farmer Managed Irrigation Systems (FMIS) and expanding the MIS to support FMIS is also discussed.

## THE INVENTORY SURVEY

The inventory survey for each scheme was carried out by distributing questionnaires to all DID offices throughout the country. The questionnaire was divided into two parts. Part I refers to the physical aspects of the scheme while Part II focusses on annual area planted. Information on irrigation systems were supplied by the DID and information pertaining to agriculture, socio-economy and marketing were obtained from the Department of Agriculture (DOA), the office of the District Officer, Farmer's Organization Authority (FOA) and from the Federal Agriculture Marketing Authority (FAMA). The list of information requested for in the inventory survey is shown in Appendix A.

The exercise was carried out over a 2-month period at the end of which nearly 90% of the information required was to be collected. The remaining information, not critical to the outcome of the study but nevertheless important, is expected to be furnished during the process of updating the database.

## THE INFORMATION SYSTEM

All the information collected was checked, verified and stored using dBASE IV software. The computer used was a 386k IBM compatible computer with 40MB hard disk memory.

Two database files were created namely the "S-INFO.DBF" containing the information collected in Part I of the questionnaire and the "S-AREA.DBF" containing information of Part II (JICA, GOM 1990c).

A complete list of the data stored in the S-INFO.DBF file and S-AREA.DBF file is shown in Appendices B and C respectively.

Using these data, an MIS was developed using 52 programs (Appendix D). Sample output of these programs is shown in Appendix E.

## USES OF THE MIS

The MIS was developed under this Study primarily to assist the DID in understanding in detail the existing condition of each irrigation scheme in technical and performance aspects. Using this MIS and results of a separate socio-economic survey involving 6,037 farm leaders and farmers to gauge the farmer's intention towards crop diversification in their schemes, a step-wise procedure for categorization of each scheme into eight potential landuses was developed under the Study. The categories of landuse identified are shown in Table 1 below.

*Table 1. Diversification categories for non-granary irrigation schemes*

| CATEGORY | LANDUSE |
|---|---|
| 1 | Conversion to high value crops (e.g. vegetables, tobacco) |
| 2 | Conversion to tree crops (e.g. oil palm, fruits) |
| 3 | Paddy-upland crop rotation |
| 4 | Grazing/livestock rearing |
| 5 | Aquaculture |
| 6 | Maintained for paddy (secondary granary areas) |
| 7 | Maintains present situation for social reasons until pre-determined period for review |
| 8 | Converted to housing, industry |

The step-wise procedure looked into seven key factors, namely: water resources availability, farmers' intention towards paddy cultivation and diversification, land suitability, soil suitability, crop profitability, crop marketability and investment performance. This led to the determination of the best option of landuse for each of the 924 schemes and their alternatives based on the above categories. Table 2 summarizes the number of schemes and total area identified for each of the category.

*Table 2. Number of schemes and total area for each category of landuse*

| CATEGORY | NOS. OF SCHEMES | TOTAL AREA (Ha) |
|---|---|---|
| 1 | 144 | 9,930 |
| 2 | 334 | 32,384 |
| 3 | 46 | 4,619 |
| 4 | - | - |
| 5 | - | - |
| 6 | 74 | 28,441 |
| 7 | 172 | 47,653 |
| 8 | 154 | 7,095 |

Under the Sixth Malaysia Development Plan, MR$5 million (US$1.9 million) has been allocated for the implementation of the crop diversification program.

Apart from the use of the MIS in the categorization procedure, it is currently serving managers and planners of agriculture and irrigation projects not just within the DID but in other agencies as well.

The MIS is currently being revised to suit the need of the national paddy production statistic committee chaired by the DOA with the Statistics Department, DID, National Paddy Board, (LPN), Malaysian Agriculture Research and Development Institute (MARDI), FOA, FAMA and representatives of the eight granaries as members. During each planting season, the committee conducts crop cutting surveys (CCS) in randomly selected plots of the paddy areas to estimate yields, collates and verifies reports of planted areas, fertilizer utilization as well as the paddy varieties planted. The DID reports primarily on the planted areas of all the non-granary irrigation schemes. The committee publishes a report for each of the planting season. In order to monitor diversification trends in the irrigation schemes, a pilot study on the data collection of non-paddy crops planted in these schemes is being planned and expected to be launched early next year. The MIS will then be expanded to include these details.

Another major use of this MIS is in monitoring investment and operation and maintenance (O&M) costs. The updating of these data is expected to start at the end of this year (1992). It is envisaged that the subsequent analysis of results gathered should indicate the cost of O&M in relation to the size of schemes and the type of system (gravity, pumping, controlled drainage etc.) as well as assisting in identification of sources of problems and formulation of strategies to overcome them.

For regional and national water resource planning and development, the MIS is used as a base for developing a new information system which will aid in the monitoring of present and forecasting future water supply and demand (domestic, industry and irrigation).

Perhaps one of the major potentials of this MIS is the possibility of using the same format to develop a comprehensive information system for farm managers in each of the irrigation schemes.

## TOWARDS FARMER MANAGED IRRIGATION SYSTEMS (FMIS)

Although FMIS is not a new concept in Malaysia, it has yet to be recognized as a specific aspect of irrigation development program. The DID over the years has assisted various government and farmer organizations in the design and construction of small irrigation systems. However, these were undertaken as providing a special service and depends on the workload of the DID office at the time the request is made. It does not form part of the Department's annual work program. The Department's contribution is in terms of technical advice, expertise in design, or in the preparation of specifications and estimation of costs and in some cases, construction supervision. The Department does not allocate any funds for construction nor involved in O&M. This is left entirely to the clients and the DID only responds if further advice or input is sought.

Current trends and government policies however indicate that there is a need to develop FMIS in the country.

The present opportunity cost of labor favoring the manufacturing sector instead of agriculture has resulted in dwindling farm labour and increased occurrences of idle paddy lands in various parts of the country. The granaries have adjusted to this situation through mechanization of labour intensive activities such as land preparation and harvesting as well as adoption of direct seeding in place of transplanting. The non-granaries however, due primarily to economies of scale and their dispersed locations, could not fully adjust to the situation. To overcome this problem, the government is encouraging farmers or organize group farming under a single management. Farming objectives should be commercially oriented (as opposed to subsistence).

The expected impact this has on agriculture is that larger areas will be managed by a single entity (farm management) as opposed to the traditional system of many farmers operating small individual farms. The other impact is that although rainfall is generally adequate and that severe drought conditions are rare, irrigation using sprinklers and micro-systems for non-paddy crops such as fruits is on the increase. This is because commercial farms need to ensure continuity of supply and increase and maintain production to meet contractual commitments as well as to maintain quality farm products for competitive prices. Under such a system, the farm managers may prefer to have more control of the irrigation facilities rather than depend entirely on the DID.

Apart from the above, developing FMIS will be necessary as one of the strategies to meet the government's policies to reduce the size of the civil service, reduce farmer's dependence of government support and develop and increase the private sector's role in the national economy.

The implementation of the crop diversification program provides an opportunity to introduce FMIS. Under this program, the initial approach is to implement a pilot or demonstration project of about 20 ha in a selected scheme in each of the 14 states in the country. The farmers involved will be organized to form a single management group which will be responsible for the everyday running of the farm and will include choice of crops, cultivation activities and marketing. The group will also be responsible for irrigation scheduling and on-farm water management. This is where the need for MIS comes in. Being small, the probability is that the area will be located in one part of the scheme commanded by one or two irrigation lines. Since this is now commanding a larger area under one management, it seems feasible that the

adjacent irrigation facilities or part of the system is managed and maintained by the project management group. Depending on the system layout and characteristics, the DID's role would be to manage the main system only.

Being a commercial entity, the O & M costs may be borne by the farmers for that section of the system. Alternatively, the DID may assist management in initial years until the farm achieves profitable returns. Even if the government continues to provide financial assistance indefinitely, there may be some advantages in terms of reduced staff size, emolument and pension funds.

While at the onset these advantages may be marginal since the size and number of FMIS is small, if successful, over time the entire scheme could be composed of several FMISs. In that situation, the DID's role would be supervisory and mainly to coordinate overall irrigation systems management.

However, an in-depth study need to be carried out prior to large-scale implementation of FMIS. The existing FMIS which appear to be successful could provide bases for developing appropriate models. Many of the existing FMISs are for orchards developed under a special program of the MOA to promote the commercial production of selected high value crops and those with export potentials such as carambola. Under this program, 21 pilot projects totalling 370 ha are in various phases of implementation. All these projects will be with irrigation. The Government will provide financial assistance in the form of grants or soft loans to develop water resources and install on-farm irrigation facilities. Technical advice for water resources development, irrigation systems design and installation are provided by the DID, DOA and MARDI. Construction works, supply and installation of system components are by private contractors. Basic training on system O&M is provided by the Departments involved during the commissioning period.

In paddy areas, the number of FMIS are few. Usually, the systems are very basic, comprising of either a single mobile pump or a structure to back-up flow in the drain for irrigation in adjacent areas. These are mostly installed in response to requests by farmers in rainfed areas where water resource are limited and not technically nor economically viable for total irrigation development.

One interesting FMIS developed is the Kampung Kekabu Scheme in the State of Kelantan (Wong et al. 1990). Here, the farmers' group, organized by the National Tobacco Board (NTB), plants tobacco in the dry season and paddy in the wet season. The NTB approached the DID to design and construct an irrigation system using groundwater as the water resource. Although the initial investment cost was borne by the NTB, farmers operate and maintain the systems themselves and the running cost of the electric pumps are paid (based on area operated by the individual farmer) by the farmers through deductions from proceeds of the sale of tobacco. A similar system is also in operation in the Bendang Pauh Scheme, Kelantan. Here, farmers are organized by the Area Farmers' Organization and paddy-tobacco-vegetable rotation is practiced.

## MIS FOR FMIS

For the successful implementation of FMIS and as in other projects, monitoring and evaluation (M&E) of each system is an important process. Especially at the initial stages, government input will be necessary. Using the same format as the one developed by the Study, some of the parameters that will need to be included will be the infrastructure cost, the physical characteristics of the system, water demand and supply including water quality and O&M costs.

Apart from the technical parameters, additional data pertaining to crop cultivation practices and marketing will need to be included such as crop choice, fertilizer input, farm labour, production costs, yield, total produce, quality, farmgate price and market prices, types of services provided, their frequency and problems faced by the system managers. Such an MIS should in the long term assist in determining the degree of success or failure of the FMIS, identify problem areas and provide a more quantitative approach towards refining policies and strategies to promote FMIS programs.

At the on-farm level, the MIS developed should not only be designed to assist general management of the farm organization but should also be useful as a reporting format for the FMIS monitoring and evaluation system. Differences between the two would perhaps be in the degree of details to be monitored. At the on-farm level, the MIS should perhaps be designed to assist managers in determining areas where cost can be reduced without affecting the productivity. The system should also assist managers in improving their management approach and practices. For example, keeping records of rainfall and irrigation frequency, amount and duration and comparing this with the yields and fertilizer input should in the long term indicate the most appropriate management approach in their particular farms. The MIS could also act as a checklist for periodic maintenance of the system component in order to reduce/avoid major repair costs.

The list of parameters to be monitored can be endless and considering that farm managers have to tend to the various aspects of production, very little time can be spared for extensive data collection. The system should therefore be such that it does not become a burden but instead be simple and useful.

## CONCLUSION

The MIS developed for the non-granary irrigation schemes, although relatively new, has shown usefulness in monitoring the performance of each of the irrigation schemes in terms of planted area, yield, production and O&M costs. Apart from that, the MIS is also used as a source of information by systems managers and planners. Using the MIS established as a base, various other information system can be developed. An example is the development of an MIS for water resource planning and development.

The MIS can also be reformatted and expanded for FMIS. Although not a new concept, the numbers of FMIS in Malaysia are few. There are at present no specific programs to develop FMIS. However, the current economic situation in the country, government policies in

encouraging group farming and the new commercial orientation and privatization efforts indicate that FMIS will have to be the characteristic of future irrigation development. Current efforts to diversify non-granary irrigation schemes into non-paddy crops provide an opportunity to further develop FMIS.

In-depth studies of existing FMIS in the country and exchange of information with other countries should be carried out in order to formulate an appropriate FMIS program. For implementation, suitable MIS will be useful for monitoring and evaluation by agencies such as the DID and this must be complemented by an MIS for farm management.

## REFERENCES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*Appendix A. List of information requested during the inventory survey*

| Main Item | Item | Sub Item |
|---|---|---|
| Overall | General | Scheme code number, name of scheme, location, type of scheme, year of completion, area of scheme, major towns nearby accessibility. |
| | Socio-economy | Name, population, household number and farm household number of Mukin in which scheme is located; total number and land holding size of beneficiary farm households; land holding and tenure situations. |
| | Topography and land series | Topography, elevation, ground slope, soil survey previously done, soil conditions, typical land use around scheme. |
| | Agricultural development project | Existence of on-going rural and agricultural development projects covering scheme; name, responsible agency and sponsoring of project. |
| Facility | Water source | Name of water source river, river gauging station, diversion discharge, catchment area at diversion point, representative rainfall and meteorological station, quality of irrigation water. |
| | Irrigation water demand requirement | Designed discharge value, actual diverted discharge, situation and affected area of water shortage in normal year, main reasons of water shortage. |
| | Irrigation facilities | Type of diversion structures, headworks, pumphouse, intake structure at diversion site, total length of irrigation canal, canal structures, specific problems. |

| | | |
|---|---|---|
| | Drainage and flood control facilities | Total length of drainage channels, drainage structures, drainage conditions, main reasons of poor drainage, area affected by floods, estimated flood damage, measures for flood mitigation with estimated costs. |
| | Farm road | Length and width of farm roads, surface pavement, specific problems, trunk road connected. |
| | Operation and maintenance | Responsible office, supervisory staff, O&M field staff and annual O&M costs. |
| | Investment cost | Initial investment cost, major rehabilitation cost. |
| | Water charge | Basic rate, situation of collection, main reason of difficulty to collect water charge. |
| Cropping | Land use | Land use changes and actual cultivated area for the previous five years, situation of idle land. |
| | Farming system | Farm operating system, cropping pattern, farm plot condition, use, possession and rental fee of agricultural machinery. |
| | Crop production | Crop yield and total crop production for the previous five years. |
| | Crop budget | Farm gate prices and production costs of crops, specific problems against increasing crop production. |
| Supporting services | Post harvest facilities | Rice mill facilities, storage facilities, processing facilities other than tree crops. |
| | Agricultural services association | Farmers' association, farmers' cooperatives, extension services, available credit services, farm input supply, selling of crops, specific problems concerning supporting services. |

*Appendix B. List of data stored in S_INFO.DBF file (1/ 4)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 1 | CODE | Code number of the scheme | |
| 2 | NAME | Name of the scheme | |
| 3 | STATE | Name of the state in the scheme area | |
| 4 | DISTRICT | District name in the scheme area | |
| 5 | MUKIM | Mukim name in the scheme area | |
| 6 | TYPE | Type of the scheme<br>G : Gravity<br>P : Pump<br>CD : Controlled drainage<br>I : Inundation<br>O : Others | |
| 7 | C_YEAR | Year of completion | |
| 8 | KM_S_CAP | Distance from state capital | km |
| 9 | KM_D_CAP | Distance from district capital | km |
| 10 | NO_HOUSE | Number of households | |
| 11 | L_HOLD_AVE | Average land holding size | ha |
| 12 | L_HOLD_MAX | Maximum holding size | ha |
| 13 | L_HOLD_MIN | Minimum land holding size | ha |
| 14 | L_OPE_O | Area of owner operator | ha |
| 15 | L_OPE_TO | Area of tenant /owner operator | ha |
| 16 | L_OEP_T | Area of tenant operator | ha |
| 17 | L_GOV | Area of governmental land | ha |
| 18 | L_NON_GOV | Area of non-governmental land | ha |
| 19 | TOPO | Topographic condition<br>a : Alluvial flat<br>b : Valley bottom<br>c : Terrace<br>d : Hilly | |
| 20 | EL_AVE | Average elevation in the area | m |
| 21 | EL_HIGH | Highest elevation in the area | m |
| 22 | EL_LOW | Lowest elevation in the area | m |
| 23 | SLOPE | Land slope in the area | 1 : X |
| 24 | SOIL | Name of soil series in the project area<br>C : Clay<br>HC : Heavy clay<br>L : Loam<br>S : Silt<br>O : Others | |

*Appendix B. List of data stored in S_INFO.DBF file (2/ 4)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 25 | OUTSIDE_LU | Land use outside the scheme area<br>a : Village<br>b : Paddy field<br>c : Oil palm<br>d : Rubber<br>e : Cocoa/Coconut<br>f : Upland crops<br>g : Grass land<br>h : Forest<br>i : Others | |
| 26 | RIVER_NAME | River name at diversion site | |
| 27 | R_SYSTEM | Name of river system | |
| 28 | RIVER_STA | Name of river gauging station | |
| 29 | LOW_FLOW | Annual low flow | $m^3/s$ |
| 30 | LOWEST_LF | Annual lowest low flow | $m^3/s$ |
| 31 | LOW_MONTH | Month of lowest low flow occurs | |
| 32 | CATCH_AREA | Catchment area at diversion site | $km^2$ |
| 33 | RAIN_STA | Name of rainfall station | |
| 34 | METEO_STA | Name of meteorological station | |
| 35 | W_QUALITY | Irrigation water quality<br>a : Not polluted<br>b : Polluted by swamp water<br>c : Polluted by effluent from rubber processing<br>d : Polluted by effluent from oil processing<br>e : Polluted by tin mine effluent<br>f : Polluted by industrial effluent<br>g : Polluted by piggery waste<br>h : Others | |
| 36 | DESIGN_Q | Design diversion requirement | $m^3/s$ |
| 37 | Q_MEASURE | Availability of discharge measurement at intake<br>Y : Available<br>N : Not available | |
| 38 | W_SHORTAGE | Water shortage situation<br>a : No water shortage<br>b : Occasional water shortage happen<br>c : Frequent water shortage happen | |
| 39 | OCCASIONAL | Area under occasional water shortage | ha |
| 40 | FREQUENT | Area under frequent water shortage | ha |
| 41 | SERIOUS | Area under serious water shortage | ha |

*Appendix B. List of data stored in S_INFO.DBF file (3/ 4)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 42 | WS_REASON | Reasons of water shortage<br>a : Shortage of river discharge<br>b : Less flow capacity of canals by poor maintenance<br>c : Malfunction of irrigation facilities<br>d : Improper design of facilities<br>e : Excessive use of water by farmer<br>f : Others | |
| 43 | DIV_TYPE | Type of diversion structure<br>a : Headworks<br>b : Pumphouse<br>c : Run-of-the river<br>d : Others | |
| 44 | HW_YEAR | Year of completion of headworks | |
| 45 | NO_BAY | Number of gates at intake | |
| 46 | GATE_SIZE | Size of gate at intake weir | m |
| 47 | FLOOD_Q | Design flood discharge of headworks | $m^3/s$ |
| 48 | OPE_CNDTN | Operation condition of headworks<br>G : Good P : Poor B : Broken | |
| 49 | PUMP_YEAR | Year of completion of pump station | |
| 50 | NO_PUMP | Number of pump | |
| 51 | UNIT_CAPA | Unit capacity of pump | m3/s |
| 52 | PUMP_CAPA | Total capacity of pump | m3/s |
| 53 | PUMP_HEAD | Actual pumping head | m |
| 54 | D_POWER | Driven system of pump<br>D : Diesel engine<br>E : Electric motor | |
| 55 | P_OPE_CON | Operation condition of pump<br>G : Good P : Poor B : Broken | |
| 56 | NO_IN_GATE | Number of intake gates | |
| 57 | IN_G_SIZE | Size of intake gate | m |
| 58 | G_MATERIAL | Material of gate<br>S : Steel<br>W : Wood | |
| 59 | I_OPE_CON | Operation condition of intake gate<br>G : Good<br>P : Poor | |
| 60 | M_CANAL_TL | Total length of main canal | km |
| 61 | M_CANAL_LL | Total lining length of main canal | km |
| 62 | M_CANAL_RL | Length to be rehabilitated of main canal | km |
| 63 | S_CANAL_TL | Total length of secondary canal | km |
| 64 | S_CANAL_LL | Total lining length of secondary canal | km |
| 65 | S_CANAL_RL | Length to be rehabilitated of second. canal | km |

*Appendix B. List of data stored in S_INFO.DBF file (4/ 4)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 66 | T_CANAL_TL | Total length of tertiary canal | km |
| 67 | T_CANAL_LL | Total lining length of tertiary canal | km |
| | T_CANAL_RL | Length to be rehabilitated of tertiary canal | km |
| 68 | NO_C_ST | Number of canal structures | |
| 69 | NO_C_GATE | Number of canal structures with gate | |
| 70 | CS_OPE_CON | Operation condition of canal structure<br>G : Good P : Poor B : Broken | |
| 71 | DRAIN_TL | Total length of drainage canal | km |
| 72 | DRAIN_RL | Length to be rehabilitated of drainage canal | km |
| 73 | BUND_TL | Total length of dike | km |
| 74 | NO_D_ST | Number of drainage structure | |
| 75 | DS_OPE_CON | Operation condition of drainage structures<br>G : Good P : Poor B : Broken | |
| 76 | DRAIN_GOOD | Area with good drainage condition | ha |
| 77 | DRAIN_POOR | Area with poor drainage condition | ha |
| 78 | DRAIN_DIFF | Area under difficult to drain for crop | ha |
| 79 | FLOOD_CON | Situation of flood<br>Y : Flood<br>N : No flood | |
| 80 | F_AREA_1Y | Area affected by annual flood | ha |
| 81 | F_AREA_5Y | Area affected by every five years | ha |
| 82 | F_AREA_MAX | Area affected by recorded maximum flood | ha |
| 83 | MAX_F_YEAR | Year of recorded maximum flood | |
| 84 | M_ROAD_TL | Total length of main road | km |
| 85 | M_ROAD_RL | Length to be rehabilitated of main road | km |
| 86 | S_ROAD_TL | Total length of secondary road | km |
| 87 | S_ROAD_RL | Length of secondary road to be rehabilitated | km |
| 88 | T_ROAD_TL | Total length of tertiary road | km |
| 89 | T_ROAD_RL | Length of tertiary road to be rehabilitated | km |
| 90 | OM_COST83 | Annual O & M cost (1983) | M$ |
| 91 | OM_COST84 | Annual O & M cost (1984) | M$ |
| 92 | OM_COST85 | Annual O & M cost (1985) | M$ |
| 93 | OM_COST86 | Annual O & M cost (1986) | M$ |
| 94 | OM_COST87 | Annual O & M cost (1987) | M$ |
| 95 | OM_COST88 | Annual O & M cost (1988) | M$ |
| 96 | OM_COST89 | Annual O & M cost (1989) | M$ |
| 97 | OM_COST90 | Annual O & M cost (1990) | M$ |
| 98 | OM_COST91 | Annual O & M cost (1991) | M$ |
| 99 | OM_COST91 | Annual O & M cost (1991) | M$ |
| 101 | C_COST | Initial investment cost | M$ |
| 102 | R_COST | Major rehabilitation cost | M$ |

*Appendix C. List of data stored in S_AREA.DBF file (1/ 3)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 1 | CODE | Code number of the scheme | |
| 2 | NAME | Name of the scheme | |
| 3 | STATE | Name of the state in the scheme area | |
| 4 | DISTRICT | District name in the scheme area | |
| 5 | TYPE | Type of the scheme<br>G : Gravity<br>P : Pump<br>CD : Controlled drainage<br>I : Inundation<br>O : Others | |
| 6 | GROSS_AREA | Gross irrigable area | ha |
| 7 | I_AREA_MS | Irrigable area in main season | ha |
| 8 | I_AREA_OS | Irrigable area in off season | ha |
| 9 | PMS83 | Paddy planted area. 1983 main season | ha |
| 10 | POS83 | -do- 1983 off season | ha |
| 11 | PMS84 | -do- 1984 main season | ha |
| 12 | POS84 | -do- 1984 off season | ha |
| 13 | PMS85 | -do- 1985 main season | ha |
| 14 | POS85 | -do- 1985 off season | ha |
| 15 | PMS86 | -do- 1986 main season | ha |
| 16 | POS86 | -do- 1986 off season | ha |
| 17 | PMS87 | -do- 1987 main season | ha |
| 18 | POS87 | -do- 1987 off season | ha |
| 19 | PMS88 | -do- 1988 main season | ha |
| 20 | POS88 | -do- 1988 off season | ha |
| 21 | PMS89 | -do- 1989 main season | ha |
| 22 | POS89 | -do- 1989 off season | ha |
| 23 | PMS90 | -do- 1990 main season | ha |
| 24 | POS90 | -do- 1990 off season | ha |
| 25 | PMS91 | -do- 1991 main season | ha |
| 26 | POS91 | -do- 1991 off season | ha |
| 27 | PMS92 | -do- 1992 main season | ha |
| 28 | POS92 | -do- 1992 off season | ha |
| 29 | T_CROP83 | Tree crop planted area. 1983 | ha |
| 30 | T_CROP84 | -do- 1984 | ha |
| 31 | T_CROP85 | -do- 1985 | ha |
| 32 | T_CROP86 | -do- 1986 | ha |
| 33 | T_CROP87 | -do- 1987 | ha |
| 34 | T_CROP88 | -do- 1988 | ha |
| 35 | T_CROP89 | -do- 1989 | ha |
| 36 | T_CROP90 | -do- 1990 | ha |
| 37 | T_CROP91 | -do- 1991 | ha |
| 38 | T_CROP92 | -do- 1992 | ha |

*Appendix C. List of data stored in S_AREA.DBF file (2/ 3)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 39 | A_CROP83 | Annual crop planted area, 1983 | ha |
| 40 | A_CROP84 | -do- 1984 | ha |
| 41 | A_CROP85 | -do- 1985 | ha |
| 42 | A_CROP86 | -do- 1986 | ha |
| 43 | A_CROP87 | -do- 1987 | ha |
| 44 | A_CROP88 | -do- 1988 | ha |
| 45 | A_CROP89 | -do- 1989 | ha |
| 46 | A_CROP90 | -do- 1990 | ha |
| 47 | A_CROP91 | -do- 1991 | ha |
| 48 | A_CROP92 | -do- 1992 | ha |
| 49 | FRUIT83 | Fruit crop planted area, 1983 | ha |
| 50 | FRUIT84 | -do- 1984 | ha |
| 51 | FRUIT85 | -do- 1985 | ha |
| 52 | FRUIT86 | -do- 1986 | ha |
| 53 | FRUIT87 | -do- 1987 | ha |
| 54 | FRUIT88 | -do- 1988 | ha |
| 55 | FRUIT89 | -do- 1989 | ha |
| 56 | FRUIT90 | -do 1990 | ha |
| 57 | FRUIT91 | -do- 1991 | ha |
| 58 | FRUIT92 | -do- 1992 | ha |
| 59 | OTHER83 | Other land use, 1983 | ha |
| 60 | OTHER84 | -do- 1984 | ha |
| 61 | OTHER85 | -do- 1985 | ha |
| 62 | OTHER86 | -do- 1986 | ha |
| 63 | OTHER87 | -do- 1987 | ha |
| 64 | OTHER88 | -do- 1988 | ha |
| 65 | OTHER89 | -do- 1989 | ha |
| 66 | OTHER90 | -do- 1990 | ha |
| 67 | OTHER91 | -do- 1991 | ha |
| 68 | OTHER92 | -do- 1992 | ha |
| 69 | IDLE_YEAR | Year of first occurrence of idle land | |
| 70 | CAUSE_IDLE | Reason of occurrence of idle land | |
| 71 | F_SYSTEM | Type of farming system<br>a : Individual farmers<br>b : Farmers unit<br>c : Group farming<br>d : Farmers association<br>e : Others | |
| 72 | PLOT_SIZE | Standard plot size | ha |
| 73 | F_MACHIN | Type of farm machineries presently used<br>a : Land preparation<br>b : Transplanting<br>c : Weeding<br>d : Spraying<br>e : Harvesting<br>f : No use in any form | |

*Appendix C. List of data stored in S_AREA.DBF file (3/ 3)*

| | Item | Content of Data | Remarks |
|---|---|---|---|
| 74 | PMSY83 | Unit yield, main season paddy in 1983 | t/ha |
| 75 | POSY83 | -do- off season paddy in 1983 | t/ha |
| 76 | PMSY84 | -do- main season paddy in 1984 | t/ha |
| 77 | POSY84 | -do- off season paddy in 1984 | t/ha |
| 78 | PMSY85 | -do- main season paddy in 1985 | t/ha |
| 79 | POSY85 | -do- off season paddy in 1985 | t/ha |
| 80 | PMSY86 | -do- main season paddy in 1986 | t/ha |
| 81 | POSY86 | -do- off season paddy in 1986 | t/ha |
| 82 | PMSY87 | -do- main season paddy in 1987 | t/ha |
| 83 | POSY87 | -do- off season paddy in 1987 | t/ha |
| 84 | PMSY88 | -do- main season paddy in 1988 | t/ha |
| 85 | POSY88 | -do- off season paddy in 1988 | t/ha |
| 86 | PMSY89 | -do main season paddy in 1989 | t/ha |
| 87 | POSY89 | -do- off season paddy in 1989 | t/ha |
| 88 | PMSY90 | -do- main season paddy in 1990 | t/ha |
| 89 | POSY90 | -do- off season paddy in 1990 | t/ha |
| 90 | PMSY91 | -do- main season paddy in 1991 | t/ha |
| 91 | POSY91 | -do- off season paddy in 1991 | t/ha |
| 92 | PMSY92 | -do- main season paddy in 1992 | t/ha |
| 93 | POSY92 | -do- off season paddy in 1992 | t/ha |
| 94 | F_ASSO | Existence of farmers' association<br>Y : Yes<br>N : No | |
| 95 | NO_F_ASSO | Number of farmers' association | |
| 96 | F_COOP | Existence of farmers' cooperatives<br>Y : Yes<br>N : No | |
| 97 | NO_F_COOP | Number of farmers' cooperatives | |

*Appendix D. List of programmes (1/ 2)*

| Name of Program. | Information and Data Retrieved | |
|---|---|---|
| **Summary state by state** | | |
| Nation01 | Irrigable Area by State | |
| Nation02 | Paddy planted area, | 1983 - 1987 |
| Nation03 | -do- | 1988 - 1992 |
| Nation04 | Tree crop area, | 1983 - 1987 |
| Nation05 | -do- 1988 - 1992 | |
| Naition06 | Annual crop area, | 1983 - 1987 |
| Nation07 | -do- | 1988 - 1992 |
| Nation08 | Fruits planted area, | 1983 - 1987 |
| Nation09 | -do- | 1988 - 1987 |
| Nation10 | Other crop area, | 1983 - 1987 |
| Naiton11 | -do- 1988 - 1992 | |
| Naiton12 | Size of scheme | |
| Nation13 | Type of scheme | |
| Nation14 | Unit yield of paddy, | 1983 - 1987 |
| Nation15 | -do- | 1988 - 1992 |
| Naiton16 | Paddy production by state, | 1983 - 1987 |
| Naiton17 | -do- | 1988 - 1992 |

**Part-1 Data (Physical conditions of the scheme)**

| | |
|---|---|
| Inf1 | Location of Irrigation Schemes |
| Inf2 | Land Operation Situation by Scheme |
| Inf3 | Physical Condition of Schemes |
| Inf4 | Hydrological Information of Schemes |
| Inf5 | Hydrological Condition of Schemes |
| Inf6 | Water Shortage of Schemes |
| Inf7 | Type of Schemes and Facilities by Schemes |
| Inf8 | Situation of Existing Headworks |
| Inf9 | Situation of Existing Pumping Stations |
| Inf10 | Situation of Existing Intake Facilities |
| Inf11 | Situation of Existing Irrigation Canals |
| Inf12 | Farmers Association and Cooperatives by Scheme |
| Inf13 | Situation of Existing Drainage Canals |
| Inf14 | Situation of Flood |
| Inf15 | Situation of Existing Farm Roads |
| Inf16 | Construction, Major Rehabilitation and Annual O&M Cost, 1983 - 1987 |
| Inf17 | -do- 1988 - 1992 |

*Appendix D. List of programmes (2/ 2)*

| Name of Program. | Information and Data Retrieved | |
|---|---|---|
| Part-2 Data | | |
| Area1 | Irrigable Area by Scheme | |
| Area2 | Paddy planted area, | 1983 - 1987 |
| Area3 | -do- | 1988 - 1992 |
| Area4 | Tree crop area, | 1983 - 1987 |
| Area5 | -do- 1988 - 1992 | |
| Area6 | Annual crop area, | 1983 - 1987 |
| Area7 | -do- | 1988 - 1992 |
| Area8 | Fruit planted area, | 1983 - 1987 |
| Area9 | -do- | 1988 - 1992 |
| Area10 | Other crop area, | 1983 - 1987 |
| Area11 | -do- 1988 - 1992 | |
| Area12 | Condition of mechanized farming | |
| Area13 | Unit yield of paddy, | 1983 - 1987 |
| Area14 | -do- | 1988 - 1992 |
| Area15 | Condition of farmers' association | |

*Appendix E. Sample output of the MIS for non-granary irrigation schemes*

Table 1 Irrigable Area by State

(ha)

| State | Gross Area | Irrigable Area Main Paddy | Off Paddy |
|---|---|---|---|
| Perlis | 4,911 | 4,215 | 475 |
| Kedah | 20,995 | 17,133 | 13,510 |
| P.Pinang | 17,639 | 3,541 | 3,525 |
| Perak | 15,249 | 12,722 | 12,236 |
| Selangor | 2,238 | 939 | 486 |
| N.Sembilan | 12,031 | 10,934 | 5,285 |
| Melaka | 12,100 | 7,149 | 2,279 |
| Johor | 4,791 | 4,010 | 3,924 |
| Pahang | 24,287 | 17,430 | 4,503 |
| Terengganu | 20,382 | 9,083 | 5,543 |
| Kelantan | 15,418 | 10,667 | 3,185 |
| Sabah | 27,279 | 17,163 | 7,774 |
| Sarawak | 20,688 | 15,136 | 2,387 |
| Total | 198,008 | 130,122 | 65,112 |

Table 2 Trend of Irrigated Paddy Area by State (1983 - 1987)

| State | Main Season Paddy 1983 (ha) | 1984 (ha) | 1985 (ha) | 1986 (ha) | 1987 (ha) | 1987/1983 | Off Season Paddy 1983 (ha) | 1984 (ha) | 1985 (ha) | 1986 (ha) | 1987 (ha) | 1987/1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Perlis | 4,086 | 4,086 | 4,061 | 4,084 | 4,084 | 1.00 | 0 | 0 | 0 | 0 | 0 | **.** |
| Kedah | 10,022 | 11,683 | 11,544 | 11,934 | 12,455 | 1.24 | 7,778 | 8,447 | 7,900 | 8,380 | 9,172 | 1.18 |
| P.Pinang | 3,598 | 3,617 | 3,267 | 3,358 | 3,518 | 0.98 | 3,370 | 3,754 | 3,257 | 3,308 | 3,504 | 1.04 |
| Perak | 6,061 | 6,159 | 7,438 | 7,181 | 7,113 | 0.88 | 6,517 | 5,584 | 4,042 | 5,020 | 6,833 | 1.05 |
| Selangor | 300 | 281 | 252 | 236 | 170 | 0.57 | 151 | 65 | 248 | 52 | 153 | 1.01 |
| N.Sembilan | 2,994 | 2,989 | 2,513 | 2,417 | 1,996 | 0.67 | 610 | 719 | 968 | 703 | 906 | 1.49 |
| Melaka | 2,936 | 2,909 | 2,165 | 1,781 | 2,003 | 0.68 | 553 | 473 | 596 | 545 | 552 | 1.00 |
| Johor | 1,579 | 1,780 | 1,435 | 1,572 | 1,109 | 0.70 | 1,381 | 1,483 | 868 | 1,385 | 1,177 | 0.85 |
| Pahang | 1,378 | 1,648 | 1,557 | 1,570 | 1,631 | 1.18 | 352 | 276 | 483 | 497 | 735 | 2.09 |
| Terengganu | 6,455 | 6,338 | 6,362 | 6,479 | 6,417 | 0.99 | 2,023 | 2,293 | 1,595 | 1,831 | 2,967 | 1.46 |
| Kelantan | 6,158 | 6,703 | 6,133 | 6,983 | 7,452 | 1.21 | 1,101 | 1,574 | 1,617 | 1,769 | 1,791 | 1.63 |
| Sabah | 11,400 | 12,004 | 11,926 | 12,942 | 12,486 | 1.10 | 1,377 | 2,198 | 2,092 | 2,967 | 2,748 | 2.00 |
| Sarawak | 2,770 | 3,999 | 5,880 | 5,731 | 5,477 | 1.98 | 380 | 296 | 322 | 109 | 159 | 0.41 |
| Total | 61,737 | 64,196 | 64,533 | 66,270 | 65,911 | | 25,593 | 27,162 | 23,988 | 26,566 | 30,675 | |