Attachment

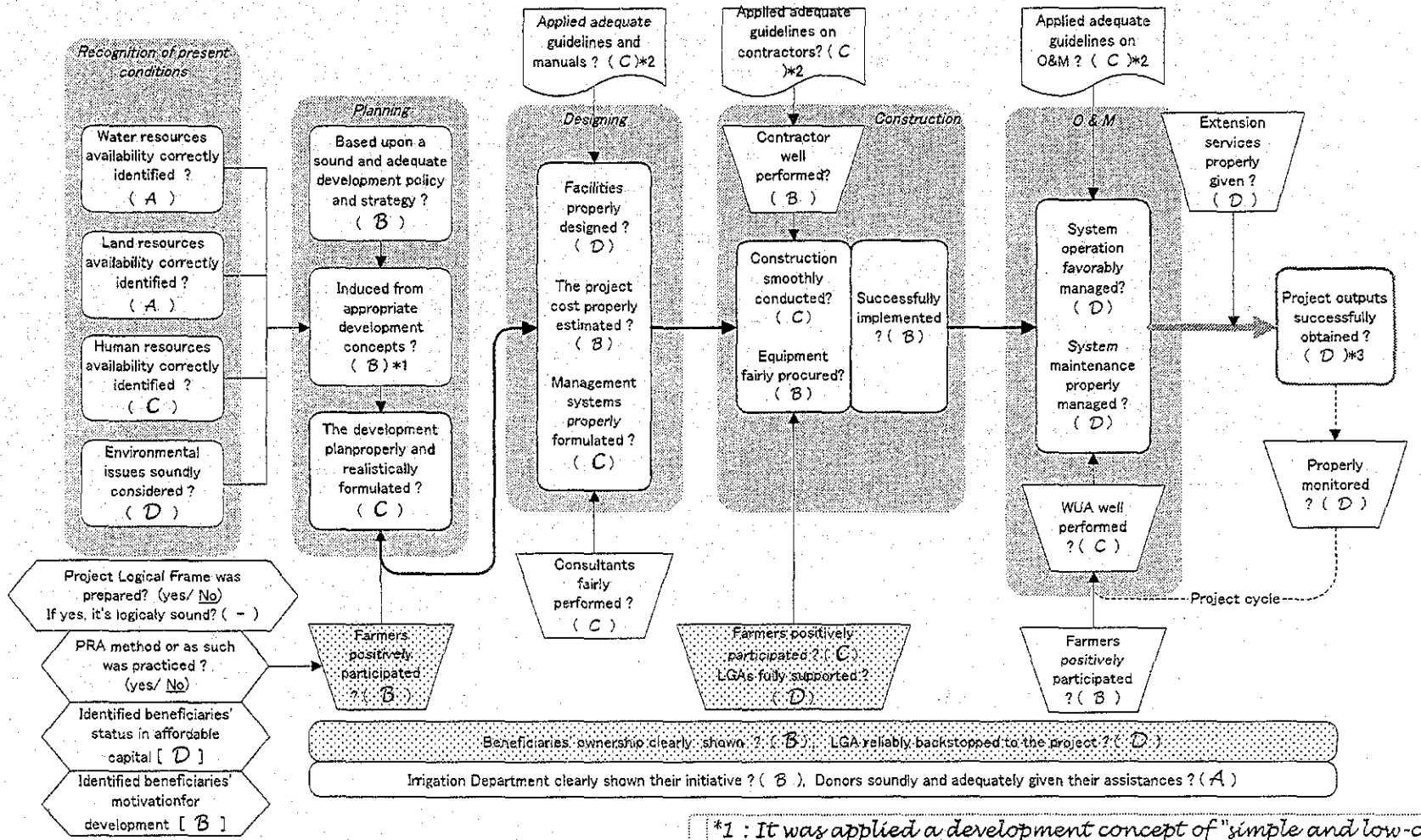
Attachment 1

Results of Problem Analysis

Project Sheet for the Problem Analysis Project title: *Pawaga Irrigation Project* Name of Scheme: – surveyed in Nov. 27,2001

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)

DAT - 1



Note; ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

[ ]: Put down the level of A to E

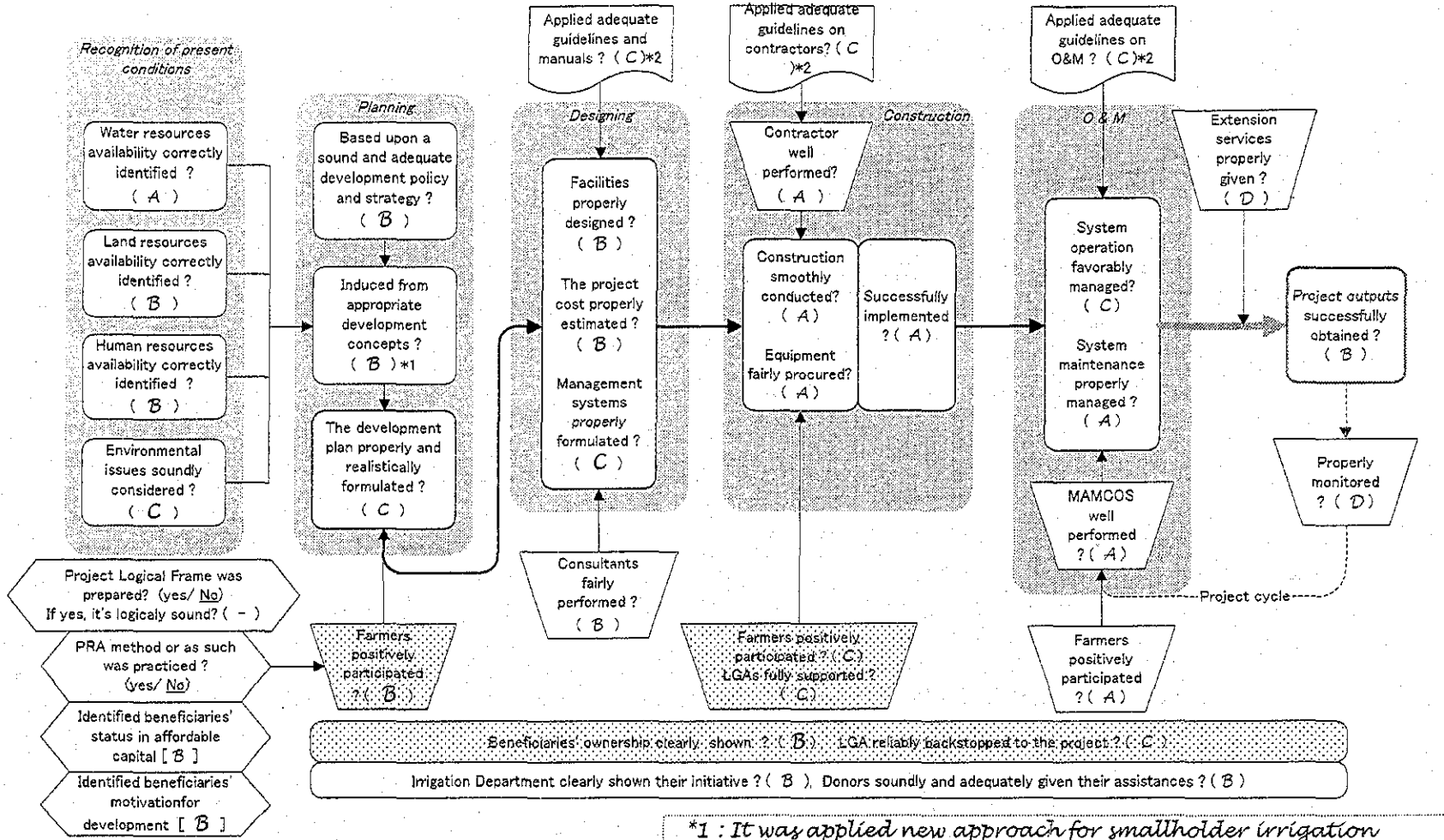
*1 : It was applied a development concept of "simple and low-cost technology".
*2 : No authorized guidelines and manuals have been prepared in the Irrigation Section.
*3 : F/S of the project proposed 3phased development. However, 1st phase which had been proposed to majorly implement weir structure, was implemented.

DAT - 2

Project Sheet for the Problem Analysis Project title: *Madibira Smallholder Agricultural Development Project* Name of Scheme: -

surveyed in Jan. 17,2002

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)



Note: ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

[ ]: Put down the level of A to E

*1 : It was applied new approach for smallholder irrigation development in large slale scheme.

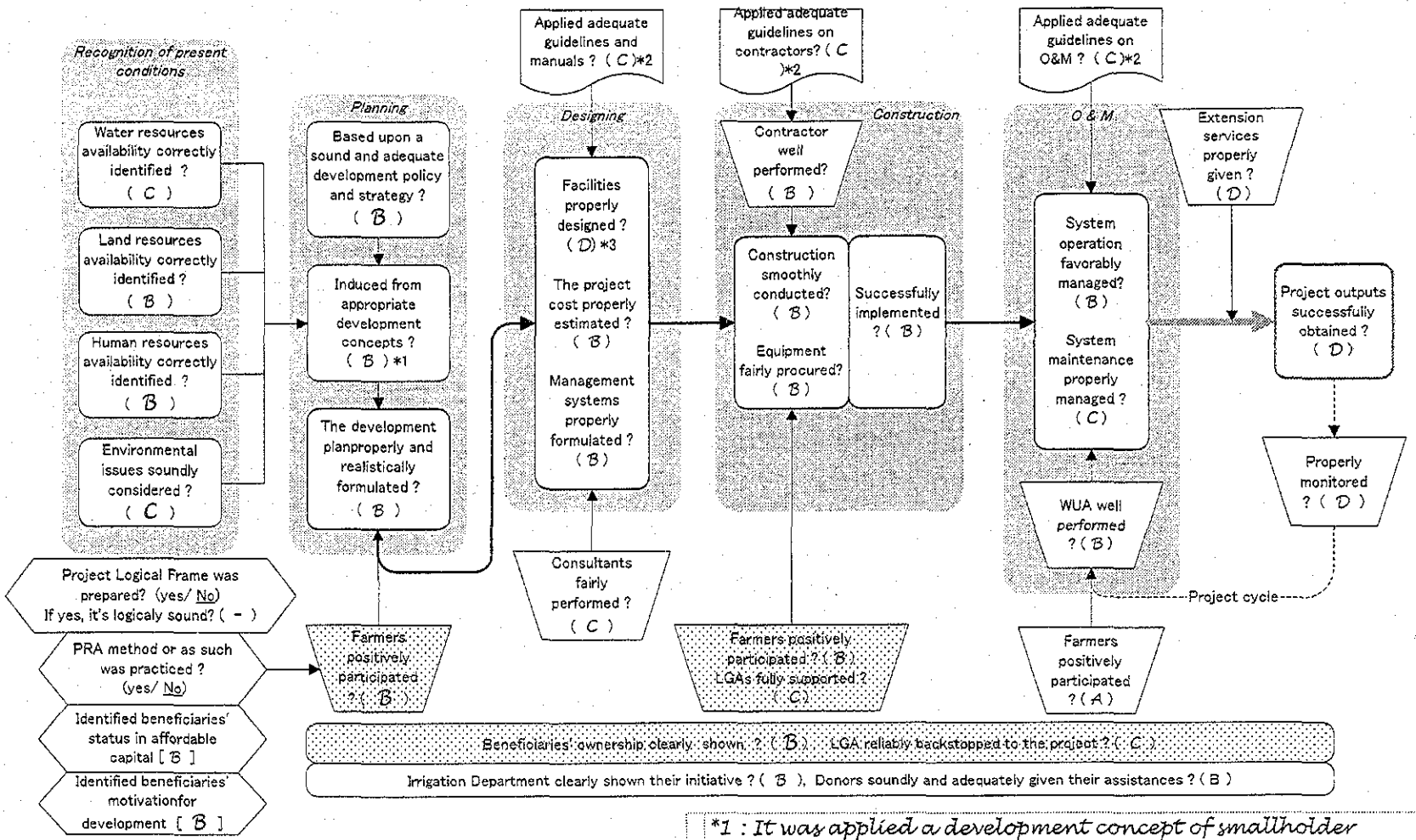
*2 : No authorized guidelines and manuals have been prepared in the Irrigation Section.

Performance of the project could not assess due to only short term passing after completion of the project.

Project Sheet for the Problem Analysis

Project title: *SDPMA Project* Name of Scheme: Bahi scheme surveyed in Nov. 28,2001

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)



Note; ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

[ ]: Put down the level of A to E

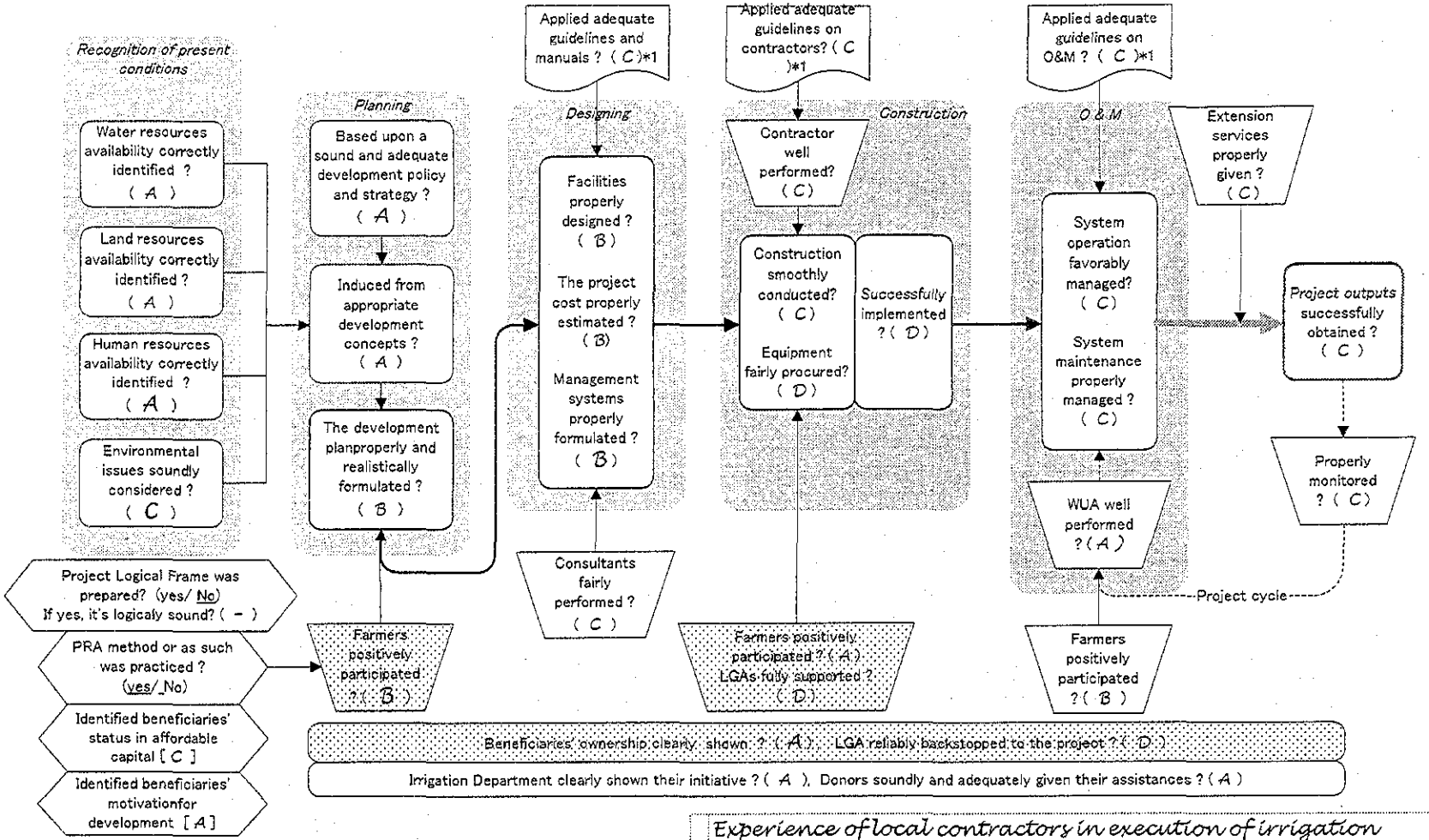
*1 : It was applied a development concept of smallholder irrigation development with simple water harvesting technology.
*2 : No authorized guidelines and manuals have been prepared in the Irrigation Section.
*3 : Diversion weir was designed with less consideration of river morphologic characteristics as ephemeral river.

DAT - 4

Project Sheet for the Problem Analysis

Project title: *RBM-SII Project* Name of Scheme: *Mombo scheme* surveyed in Nov. 28,2001

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)



Note: ( ): Fill out the Project's situation as: A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

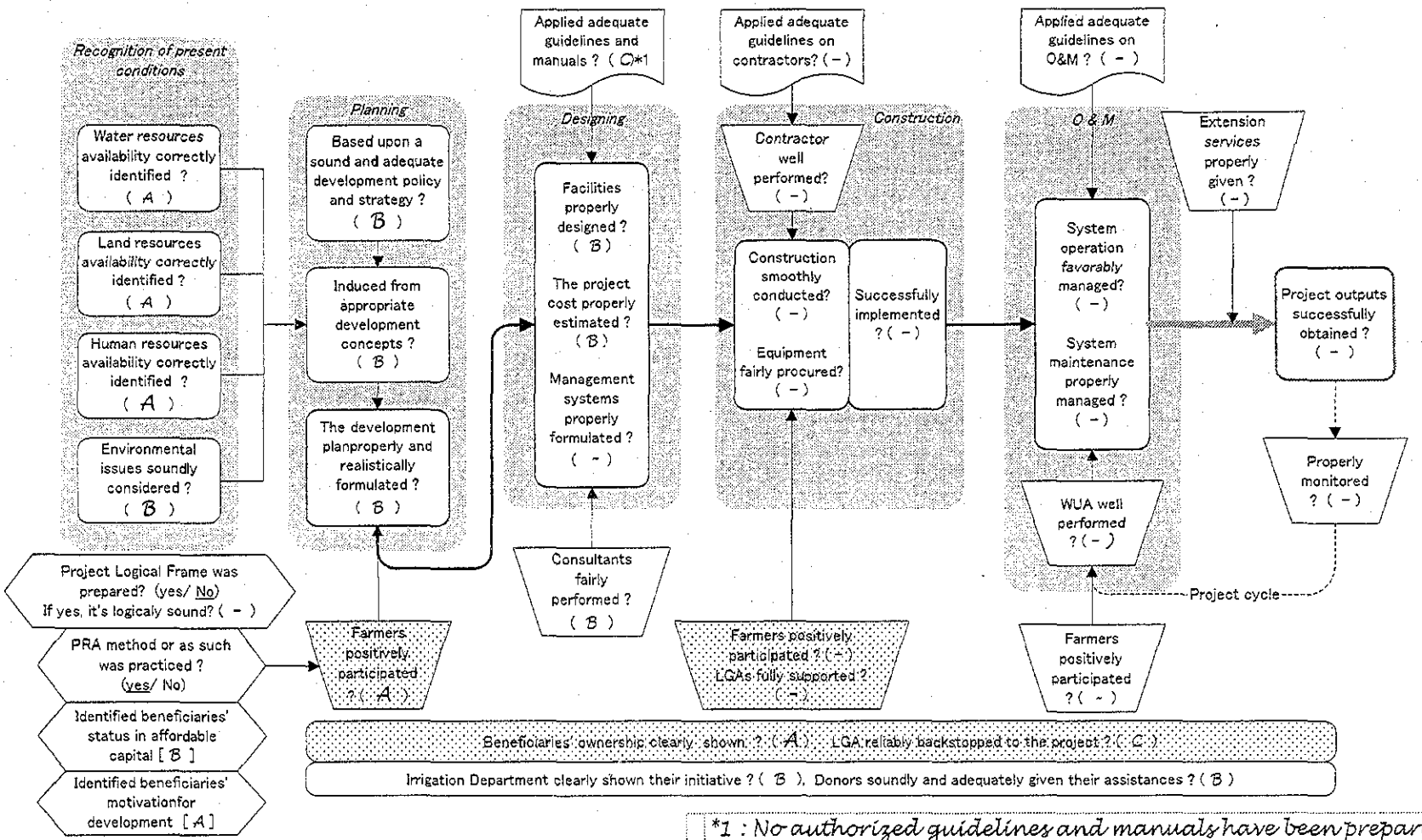
[ ]: Put down the lebel of A to E

Experience of local contractors in execution of irrigation projectsn is still very minimal.

**1 : No authorized guidelines and manuals have been prepared in the Irrigation Section.*

Project Sheet for the Problem Analysis Project title: *ASPS-IC Project* Name of Scheme: *Naming'ongo irrigation scheme* surveyed in Nov. 28,2001

Present stage of the Project: (Under the study, Under construction, Completed construction, Operating, Under rehabilitation)



Note; ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

[ ]: Put down the level of A to E

*1 : No authorized guidelines and manuals have been prepared in the Irrigation Section. The project apply own design criteria, and preparing technical manuals.

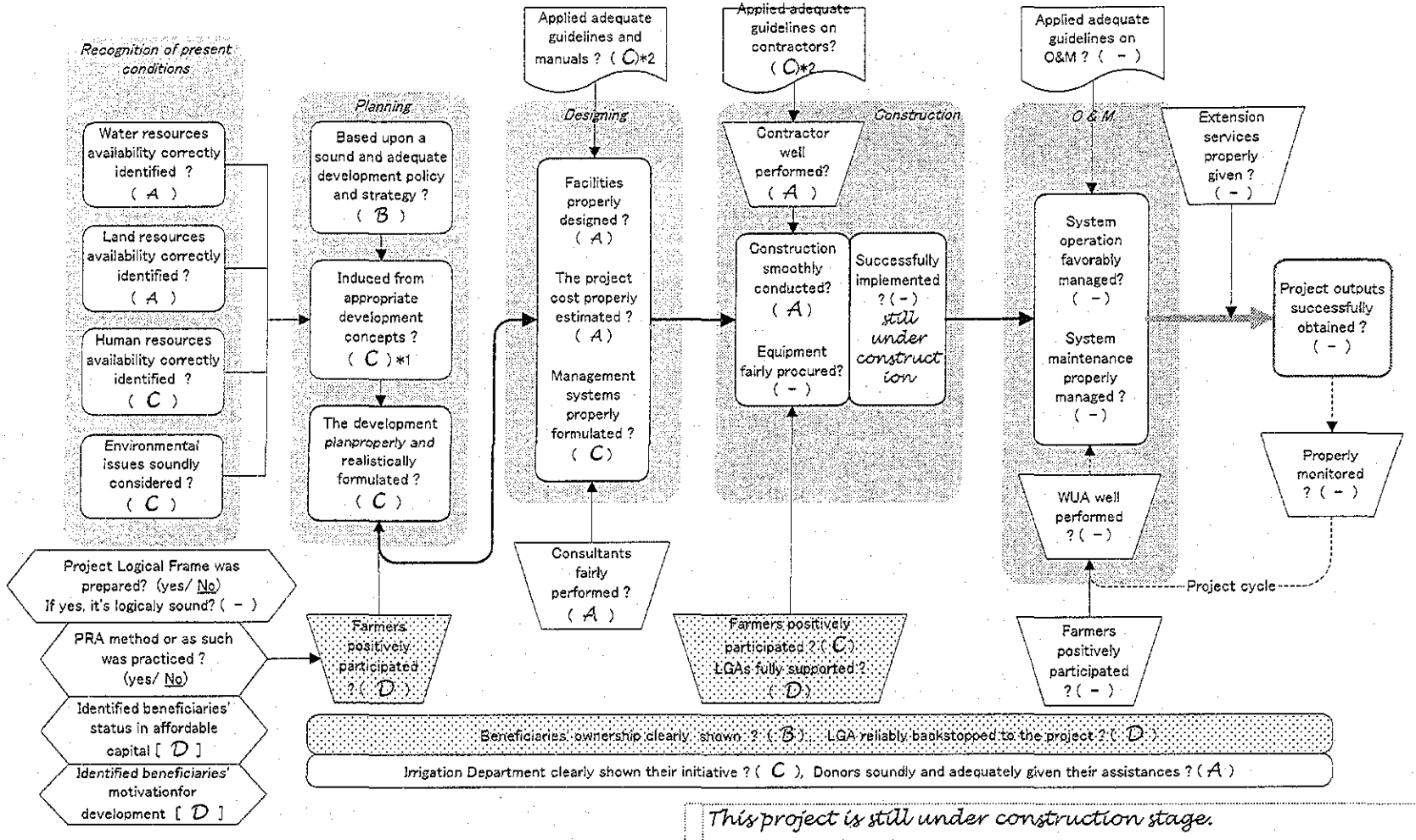
The project applies simple and low-cost technology. The project seemes to worry too much about lowering costs so that project cost is below US$ 2,000 per ha.

DAT - 5

Project Sheet for the Problem Analysis

Project title: *Muega smallholder Irrigation* Name of Scheme: - surveyed in Nov. 25,2001

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)



Note; ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad S:In the case of special condition

[ ]: Put down the lebel of A to E

This project is still under construction stage.

**1 : It will much contribute to the specified project area. It seems to be not always replicable for other areas due to higher invastment rate per ha.*

**2 : No authorized guidelines and manuals have been prepared in the Irrigation Section.*

Attachment 2

Project Sheet

Project Sheet for the Problem Analysis (Project Data)

Project Title Pawaga Irrigation Project **Nameof Scheme** --- surveyed in Dec.,22,2001

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Iringa Rgion, Iringa-rural District	since 1993 to 1994	2,000 ha.	Rice 4.0 ton/ha.	100% (supplemental irrigation during wet season)	4.0 m3/sec.	25%	Gravity surface

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
Tsh. 357.0 million (as of 1991)	EIRR	about 27.6 % (in F/S stage)	Not applicable	Not applicable	---

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Not applicable	Gabion Weir	Earth canal	using exsiting canal	using exsiting canal	Not applicable	Not applicable	-

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Sh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
1,337	Tsh 100,000 (as of 1985)	2,700 man.days/year	Tsh 100/member (as of 1985)	Tsh 8.88 million (as of 1985) (10 years interval)	20 years	---

Project performance					
Adequacy of planning, designing	**Problems during construction**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
Simple and low-cost technology was applied. Though the designing concept is sound, less consideration for river silt transportation causes heavy silt deposition.	Good performance	Good performance	Below expectation	Below expectation	Heavy silting up in canals compels farmers to remove very offen. The project appears to be working on 10 % irrigation efficiency.

Project Sheet for the Problem Analysis (Project Data)

Project Title Madibira Smallholder *Agricultral Development* **Nameof Scheme** --- surveyed in Jan.,04,2002

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Mbeya Region, South-West districts	since 1995 to 2000	3,000 ha.	Rice 3.5ton/ha. (Beans are planted during dry season)	140%	7.5 m3/sec. (assuming 40% irrig. efficiency)	20%	Gravity surface

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
US$ 18.5 million (as of 1995)	EIRR	about 12 % (approximately)	Not applicable	Not applicable	Additionally US$ 1.45 million required for tertiary canals

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Not applicable	Rockfill diversion weir (70 m long)	Lining canal (1.2 km long)	One main canal (5.9 km long: lining in bigining 1.2 km)	6 secondary canals (earth canal with 38.8 km long)	2 main drains (49.8 km long) 7 secondary drains (34.2 km)	Not applicable	-

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Tsh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
About 3,000	Tsh. 94,881,896	No information available	31,627	No information available	50 years	Due to poverty of the farmers, the members fee seems not to enable to collect on schedule.

Project performance					
Adequacy of planning, designing	**Problems during construction**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
The weir was applied unconventional design with big change of river course. Though it was examied through matematicall modeling, special attention for river morphological alteration should be given.	No information available	No information available	Not applicable	Not applicable	---

Project Sheet for the Problem Analysis (Project Data)

Project Title Smallholder Development Project in marginal Area **Nameof Scheme** --- surveyed in Dec. ,30 ,2001

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Central Resions(Dodoma, Mwanza, Shinyanga, Shingida,Tabora)	since 1992 to 1997	4,300 ha./ 18 schemes	Rice 1.0ton/ha.→1.8ton/ha. (Central zone)	100%	depend on rainfall occurance, being under water-stress	60% (practically, harvested twice during 5 years)	flood irrigation

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
US$ 1,230 /ha. (as of June 1999)	EIRR	20.0%	Not applicable	Not applicable	Without any effects of storing or regulating water, areas under project are still under unreliable condition of rainfall occurrence.

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Not applicable	Flood diversion dam (Gavion type)	Not applicable	Earth canal	Earth canal	Floods protection dikes	Constructed in other project component	-

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Sh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
4,800 in total (100 - 650 farmers/scheme)	US$ 50 /ha.	15 days/ha./year	US$ 25 /ha.	It was not considered in the Project, but needed (US$ 120 /ha., 15 years)	25 years	---

Project performance					
Adequacy of planning, designing	**Problems during construction**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
Simple and low-cost technology was applied. Even though, careful consideration and knowledge in river morphology for an ephemeral river is required.	No serious problems were reported.	Good participation in general was reported.	Below expectation	Below expectation	1997/98 El Nino rains caused severe damages, 16 schemes will be rehabilitated under PIDP.

Project Sheet for the Problem Analysis (Project Data)

Project Title RBM-SIIP **Nameof Scheme** Mombo Irrigation scheme surveyed in Dec., 15,2001

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Tanga Rgion, Korogwal District	since 1999 to 2002	220 ha.	Rice 3.5 ton/ha.	150%	6.84 MCM (regulated by the reservoir)	25%	Gravity surface

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
Tsh. 346.6 million (as of 1999)	EIRR	20.0%	Not applicable	Not applicable	Project aims at increasing productivety by irrigation system improvement. Water availability is higten by improving efficiency.

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Storage reservoir (for night storage; 30,000 m3)	Concrete intake facility	Maisonry lined canal (1.28 km long)	Maisonry lined canal (1.37 km long)	Earth canals	Earth drains	along the canals	-

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Sh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
429	Tsh. 12.8 million	No information available	No information available	No information available	25 years	---

Project performance					
Adequacy of planning, designing	**Problems during construction (Delay of construction, cost increasing, contractors' capability)**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
No serious problems were recognized.	Tere are delays due to low capability of the contractor. .	Excellent performance	Excellent performance	Good performance	Expected improvement in irrig. Efficiency is not realized due to losses from earth canal. Some siltation is found in the resoervoir.

Project Sheet for the Problem Analysis (Project Data)

Project Title ASPS-IC **Nameof Scheme** Naming'ongo Irrigation Scheme surveyed in Jan., 02 ,2002

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Mbeya rigion, Mbozi district	Under F/S	1,008 ha.	Rice	100% (supplemental irrigation during Jan. to April)	1.5 m3/sec.	25%	Gravity surface

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
US$ 1,690,200 (as of 2001)	EIRR	about 20 % (approximately)	Not applicable	Not applicable	---

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Not applicable	Stone Masonry Weir (35 m wide)	Earth canal (2.4 km long)	2 Main canals (earth canal with 5 km long)	7 secondary canals (earth canal with 15.2 km long)	4 drains (earth canal with 8.5 km long)	Not applicable	-

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Sh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
No information available	Assuming at 2 % of the construction cost	No information available	No information available	US$ 187,640 (15 years interval)	50 years	---

Project performance					
Adequacy of planning, designing	**Problems during construction (Delay of construction, cost increasing, contractors' capability)**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
Not applicable (not yet implemented)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Project Sheet for the Problem Analysis (Project Data)

Project Title The Project for Mwega Smallholder Irrigation Scheme **Nameof Scheme** --- surveyed in Dec. ,20,2001

General Information							
Location (region/district)	**Project period**	**Target Area (ha)**	**Appled crops and its planned yeild**	**Proposed crop intensity**	**Annual water requirement**	**Drought occurrences (percent)**	**Irrigation method**
Morogoro Region, Kilosa District	since 2000 to 2002	580 ha.	Rice 5.0ton/ha. (maize, onion and tomato during dry season)	200%	0.714 m3/sec. (assuming 51 - 58 % irrig. efficiency)	20%	Gravity surface

Project evaluation					
Project investment cost (as of When)	**Indicator for project evaluation**	**Value of the indicator in Planning stage**	**Value of the indicator after implementation**	**Major factor for the causes of change in the indicator**	**Comment**
US$ 6,369,000 (as of 1997)	EIRR	about 15.2 % (in F/S stage)	Not applicable	Not applicable	---

Infrastructure (Dimensions, Type or material)							
Dam or impounding facilities	**Intake facilities**	**Diversion canal**	**Main canal**	**Distribution canal**	**Drainage canal**	**Access and /or inspection road**	**Other**
Not applicable	Concrete Weir (24.8 m wide)	Not applicable	One main canal (block lining canal with 21.2 km long)	2 secondary canals (Block lining canal with 5.9 km long)	Improvement of drains (0.5 km long)	1.2 km long	River improvement work (1.3 km)

Operation and Maintenance						
Number of members of WUA	**Annual O&M cost**	**Required labour works for the member**	**Members fee (Sh./person)**	**Facilities' replacement (cost, interval)**	**Assumed project life**	**Problems on O&M, if any**
690	US$ 26 /ha.	No information available	1,000 Tsh./household	US$ 38,800 (25 years interval)	50 years	---

Project performance					
Adequacy of planning, designing	**Problems during construction (Delay of construction, cost increasing, contractors' capability)**	**Beneficiaries' participation**	**Operation of the irrigation system**	**Realization of project objectives**	**Other Problems**
No serious problems were reported.	No serious problems were reported.	No serious problems were reported.	Not applicable	Not applicable	---

Attachment 3

Guideline of Irrigation Development Level

APPENDIX D

IRRIGATION AND WATER MANAGEMENT

ATTACHMENT 3 GUIDELINE OF IRRIGATION DEVELOPMENT LEVEL

1. Introduction..... DAT-14

2. Objectives of the Guideline..... DAT-16

3. Classification in Irrigation Type..... DAT-17

4. Indicators on Irrigation Development Level..... DAT-18

5. General Aims of the Indicators..... DAT-20

6. References for Adoption of the Guideline DAT-26

7. Additional Remarks..... DAT-27

1. Introduction

1.1 General

As identified in the results of the Problem Analysis conducted during the 1st field survey of the Study, irrigation development in Tanzania has been executed without certain authorized guidelines prescribing for irrigation development level. In Tanzania, it seems to be difficult to thoroughly reflect every variation in natural condition and social situation into a unified principle for irrigation development because of extreme wide spread of the variations. Especially, irrigation development level, which is an important criterion in irrigation development, fell behind minute consideration so far due to the same reasons.

Confusions in technical aspect among implemented projects are too conspicuous even taking variation of characteristics in regional conditions into consideration. The disorders in irrigation development level may bring about; (i) ineffective utilization of limited resources to be appropriated to irrigation development, (ii) keen complain of farmers concerned to the irrigation schemes being in depleted level, (iii) complication in expanding the pilot model effects of existing scheme to other areas, and (iv) complexity in supervising and monitoring irrigation schemes together with others which are under different development levels.

In Tanzania, an original criterion on irrigation development level that will be elastic or widely accommodating for the variation of conditions of projects concerned, is required to be fixed urgently.

1.2 Previous Guidelines and Criteria

Irrigation development level is a basic assumption or a fundamental condition for planning, designing and construction in irrigation development. So far, several technical guidelines were prepared in relation to the specified projects. Following table shows a general view of the technical guidelines already prepared:

Existing Technical Guidelines in Irrigation Development

Name of Project	Prepared term	Manual Title	General Status
ISID	1991 - 1994	Project Planning manual	The manual consisting of several volumes, covers all technical fields related to irrigation. The manual has been hardly utilized by every concerned personnel.
ASMP	1996 -	Technical Manual for Planning and Design of Irrigation Systems, Construction Manual for irrigation Works, Technical Manual for Operation & Maintenance of Irrigation Systems	The manual is intended to provide technical and procedural guidance to all personnel involved in the planning, designing, implementation and operation &maintenance of irrigation system in the country. Though a draft of the manual was prepared, it has not been finalized or not made public.

RBM-SIIP	1999 - 2000	Irrigation Design Manual	A design manual for irrigation system was prepared which consisted of two volumes of Guidelines and Drawings. It is a well-organized outcome. It is expected to be utilized in common, with giving some improvements in the contents.
PIDP	2000 - 2001	Rainwater Harvesting Design Manual for Irrigated Agriculture in Marginal Areas	A design manual was prepared consisting of eleven chapters. Many parts of the manual were introduced design methods for conventional irrigation system, few special modalities for water harvesting scheme design are presented.
ASPS-IC	2001 -	Irrigation Water Management Field Handbook for Extension Staff	The handbook consisting of one volume with about 180 pages, is not yet finalized. The handbook will provide information on irrigation water management to extension field personnel as a quick reference manual.

Regrettably existing technical guidelines and manuals have been not utilized in irrigation development widely and effectively. Although such dispread causes from inadequacy of knowledge management system or failure of information delivering and circulating arrangement in Irrigation Section, contents of the guidelines might have a room to be improved.

Existing technical guidelines and manuals are inclined to concentrate to introduce and explain modern technical subjects diverting from international technical guidelines, such as "Irrigation and Drainage Paper, FAO" and so on. Those existing technical references scarcely mentioned the aspect on irrigation development level. In Tanzania, irrigation development should be promoted in various manners corresponding to the variations of projects' sites, from now on. Pursuing optimum irrigation development for each target area where has own constraints and locality, argument on irrigation development level must be enthusiastic.

As a basic irrigation development concept, "low-cost technology" was advocated since NIDP establishment. Then, lower investment cost per hectare became a pressing object of argument. However, the argument seems to lean much to the consideration in affordability, leaving sense of suitability or optimality of project. Subject of irrigation development level should be winded up so as to clarify the suitability or optimality of project in Tanzania in consideration with variations of natural conditions and circumstances of project implementation for individual areas.

2. Objectives of the Guideline

Appropriate approach for successful irrigation development is to be fully corresponding to the natural and social conditions in the concerned project area. As explained within the Inception Report of the Study, many options could be conceived in irrigation improvement in general. Criterion for irrigation development level is firstly to indicate the optimum allowable targets for irrigation development in specified project area.

And also, the criterion for irrigation development level is to designate suitable technical modality and method in order to realize development towards the targets. If we decide a target agricultural productivity in irrigation scheme development as one parameter of irrigation development level, selection extends widely ranging from very high yield to quite low harvest. However, same target of agricultural productivity can be ensured by different ways of irrigation practice, for instance, one is to realize by means of systematic irrigation operation with solid facilities in hardware as an initial investment, another is to achieve by simple facilities with close human cares in software as a post-implementation effort. That is to say, it is a subject for combination balance between hardware (initial investment) and software (cares in post-project implementation). It is also a characteristic factor of irrigation development level to be dealt with in the criterion for irrigation development level. Furthermore, designing stiffness and durability of irrigation facilities are also significant parameter of irrigation development level in technical planning and designing. Considering in these ways, irrigation development level means not only quantitative level of outputs but also quality and/or performance of irrigation system itself, in this regard, the irrigation system is hardware, software and relation of both.

Furthermore, similarly the criterion of irrigation development level should specify advantageous intensity of investing among possible options for irrigation development in specified project area.

From these understandings, objectives of the study on irrigation development level are to provide conceivable options of irrigation development with appropriate modalities and resources for every patterns of irrigation development in entire Tanzania, then to specify appropriate ones for every irrigation category. Concrete values of selected factors of irrigation development level shall be given in the criteria for the irrigation development level. Some specific values of input in hardware and software will be also proposed in corresponding to the establishment of standards on the irrigation development level.

3. Classification in Irrigation Type

In Tanzania, many forms of irrigation scheme are available and practical. Irrigation development level varies widely within all alterations of irrigation scheme. It is realistic to classify irrigation development level by categorization of irrigation type divided into some conspicuous modalities of irrigation practice and sorts of irrigation system.

In the National Irrigation Development Plan (NIDP), every potential irrigation schemes are divided into following three kinds of intervention, having a sense of prioritization for scheme implementation.

- Rehabilitation or Upgrading of Traditional Irrigation Schemes
- Schemes based on Water Harvesting Technology
- New Smallholder Schemes

These sorts are one classification of irrigation type, however, it doesn't cover all possibilities, and isn't sufficient for the purpose of defining its irrigation development level.

Through reviewing other classification of irrigation type in Tanzania proposed before, in this Study, irrigation type in Tanzania is classified into following types from three different angles, namely, scheme style, kind of water source, and scale of scheme.

Classification of Irrigation Type

Scheme Type	Rehabilitation of existing scheme			New irrigation scheme			Water harvesting scheme		
Water sources	Surface water	Ground water	Others(lake etc.)	Surface water	Ground water	Others(lake etc.)	Stream flood	Catment water	Rain water
Village scheme	R-V-S	R-V-G	R-V-O	N-V-S	N-V-G	N-V-O		W-V-C	W-V-R
Small-scale	R-S-S	R-S-G	R-S-O	N-S-S	N-S-G	N-S-O	W-S-F	W-S-C	
Medium-scale	R-M-S	R-M-G	R-M-O	N-M-S	N-M-G	N-M-O	W-M-F		
Large-scale	R-L-S			N-L-S					

Note: above irrigation scheme pattern is shown in (Scheme type) – (Scale of scheme) – (Water source), where,
(Scheme type), R: Rehabilitation of existing scheme, N: New irrigation scheme, W: Water harvesting scheme
(Scale of scheme), V: Village scheme, S: Small-scale. M: Medium-scale, L: Large-scale
(Water source), S: Surface water, G: Ggroundwater, O: Others

Within the above classification, village scheme has a special characteristic. Size of the village scheme is smaller than the small-scale scheme, furthermore, it would be implemented on the basis of farmers' initiative without public intervention.

4. Indicators on Irrigation Development Level

Indicators on irrigation development level are extracted as follows among many, taking result of problem analysis into consideration.

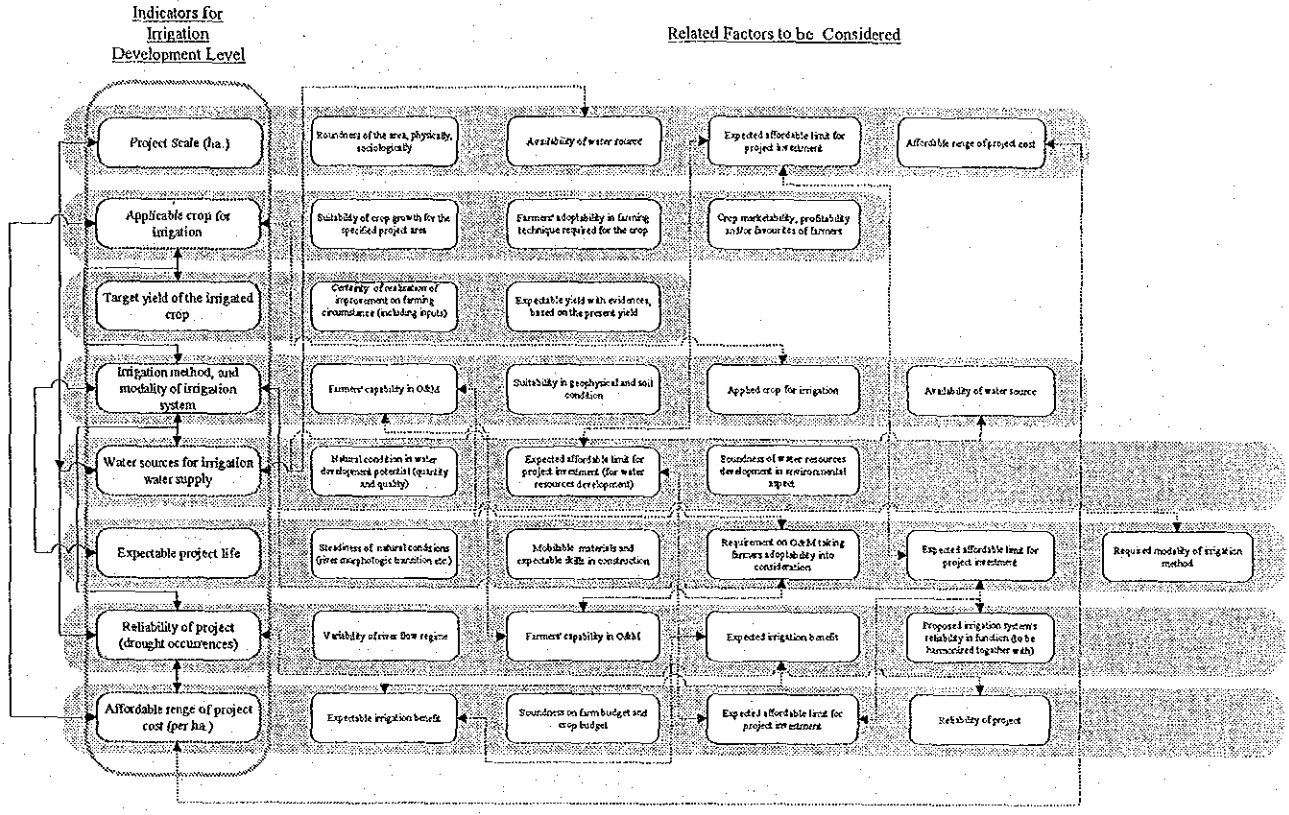
(1) Position of a balance in hardware and software
(2) Project Scale
(3) Applicable Crop for Irrigation
(4) Target Yield of Irrigation Crop
(5) Irrigation Method, and Modality of Irrigation System
(6) Expectable project Life
(7) Reliability of project
(8) Affordable Range of Project Cost
(9) Allowable Limit in Economic Indicator

Indicators proposed above are come up with in consideration with three points of view, namely, Sustainability, Adoptability and Feasibility. Relation between the indicators proposed and these points of views are shown in following table:

Characteristics of the Indicators for Irrigation Development Level

No	Indicators of Irrigation Development Level	Points of Consideration		
		Sustainability	Adoptability	Feasibility
(1)	Position of a balance in hardware and software	○	○	
(2)	Project Scale	○	○	○
(3)	Applicable Crop for Irrigation		○	○
(4)	Target Yield of Irrigation Crop		○	○
(5)	Irrigation Method, and Modality of Irrigation System	○	○	
(6)	Expectable project Life	○	○	○
(7)	Reliability of project	○	○	○
(8)	Affordable Range of Project Cost		○	○
(9)	Allowable Limit in Economic Indicator			○

Furthermore, relations between indicators each other are shown in following figure.



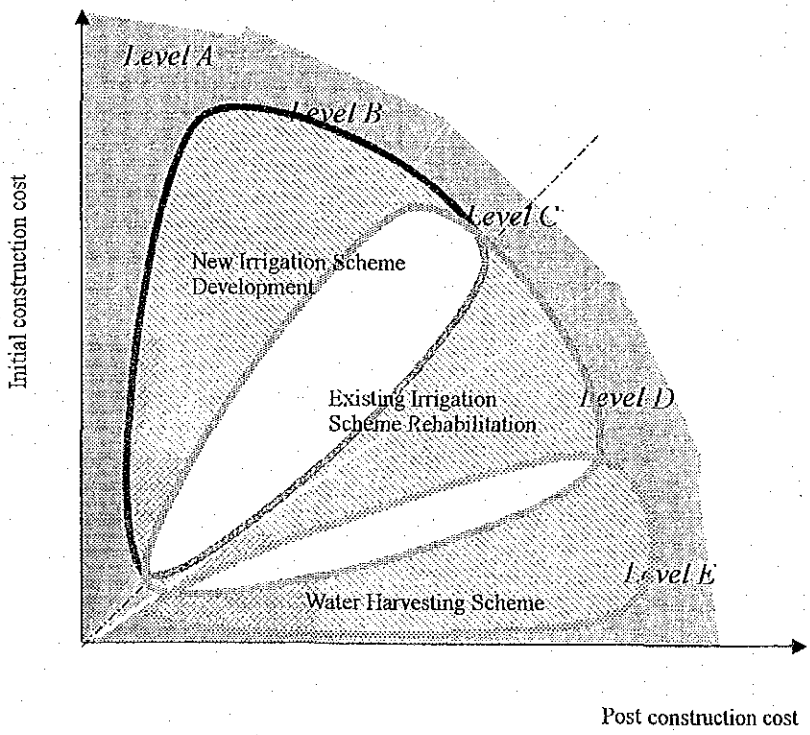
Indicators for Identification of Irrigation Development Level

5. General Aims of the Indicators

General aims of indicators on the irrigation development level are summarized into table 5.1. Herein under, descriptions of each indicator are given.

(1) Position of a balance in hardware and software

As explained in the previous Progress report1 of the Project, a balance in hardware and software is the most important aspect for irrigation development. Hardware in irrigation development might indicate physical facilities for irrigation practice. On the contrary, software in irrigation development might specify every activities during post-project implementation including project up-holding doings such as O & M and additional care efforts of all concerned of the Project. All necessary expenses on the both wares are defined as initial construction cost and post construction cost, respectively.



As shown in the Progress Report 1, different of characteristics of irrigation development in each irrigation development type could be clarified within a graph having two-axis of the initial construction cost and the post construction cost. For the new irrigation development scheme, rather higher-cost facilities are required to substitute farmers' shortcoming of experiences and knowledge in water management which causes from previous poor or no irrigation practices. On the contrary, for the rehabilitation scheme, the post construction cost surpasses the

other attributing to the advantages in farmers performance. Furthermore, many efforts of farmers are required in water harvesting development.

Then, irrigation development types are positioned into the two-axis graph as shown in the above figure.

(2) Project scale

"Project scale" is the covering area of irrigation service provided by the concerned irrigation Project. Generally, three classes of irrigation scheme, namely, small, medium and large scale are stipulated. It is difficult to stick to the rule in categorizing into the irrigation classes, however, three classes of irrigation scheme are stipulated by the covered area as follows:

Covered Area by Project Scale

Irrigation class	Covered area (ha.)	Remarks
Small-scale	~500	Generally lower limit (about 20ha) exists.
Medium-scale	500~2,000	
Large-scale	2,000~	

Designated values of irrigation area in the above table, are generally assumed to be applied a primary cultivation of rice. Therefore, it may give a broad interpretation of application of the designated values of irrigation area.

Furthermore, in Tanzania, smaller irrigation practice in village community level rather than above three irrigation classes of small, medium and large is widely existent and being expected to expand more. That smaller irrigation practice is mostly covered 5~10ha of neighboring formers. As this irrigation practice is required a irrigation development activities differed from the designated irrigation scheme classes, it is given another irrigation category of village scheme for the smaller irrigation practice.

(3) Applicable Crop for Irrigation

Suitable crop for irrigation is the most important theme of irrigation development. It is evidenced by the result of economic evaluation on crop suitability for irrigation. Rice is the major crop for irrigation, and crops of maize and vegetables in horticulture are supplementary required irrigation depend upon cultivating duration and location of the project.

Applicable crop for irrigation is selected among the crops which higher superiority is evidenced into other economical and practical analysis, on the basis of

beneficiaries' intension. To say nothing of rice, other crops like maize, vegetables may deserve irrigation water supply in some cases.

(4) Target Yield of Irrigated Crop

Target yield of irrigated crop is a focal target and a concrete fruit of the project, which have to be realistic and be also provided related measures into the Project in order to realize the Project's objectives thoroughly. The target yield of irrigated crops were proposed in various figures in every previous irrigation development schemes, like from 1.5 ton/ha to 5.0 ton/ha in the case of rice production. It varies within the range depending on the circumstances of natural condition and formation of the Project. Various target yields of irrigated crops are being proposed under the previous irrigation schemes.

Target yield of Irrigated Crop

Crop	Scheme style	Target yield	Remarks
Paddy	New scheme	3.0~6.0ton/ha	
	Rehabilitation	3.0~5.0ton/ha	
	Water harvesting	1.0~1.5ton/ha	Considering yearly fluctuation
Maize	New scheme	3.0~5.0ton/ha	
	Rehabilitation	3.0~5.0ton/ha	
	Water harvesting	1.0~1.5ton/ha	Considering yearly fluctuation
Beens	New scheme	1.0~2.0ton/ha	
	Rehabilitation	1.0~2.0ton/ha	

(5) Irrigation Method, and Modality of Irrigation System

Irrigation method may broadly be classified into 1) Surface irrigation, and 2) Sub-surface irrigation as explained below table.

Classification of Irrigation Method

Major Classes	Detail Classification (1)	Detail Classification (2)	Remarks	Category
Surface irrigation	Flow irrigation (gravity irrigation)	Perennial irrigation	In perennial system of irrigation, constant and continuous water supply is ensured to the crops in accordance with the crop requirements, throughout the "crop period". In this system of irrigation, water is supplied through storage canal head works and canal distribution system.	A
		Flood irrigation (water harvesting)	Flood irrigation is sometimes called as *Inundation Irrigation*. In this method of irrigation, soil is kept submerged and thoroughly flooded with water, so as to cause thorough saturation of the land. The moisture soaked by the soil, when occasionally supplemented by natural rainfall or minor watering, brings the crop to maturity.	B

	Lift irrigation	The water is lifted up by some mechanical or manual means, such as pumps, etc. and then supplied for irrigation, therefore it is called Lift irrigation.	C
Sub-surface irrigation	Natural sub-surface irrigation	Water dose not wet the soil surface. The underground water nourishes the plant roots by the soil, when occasionally supplemented by capillarity. Leakage water from channels, it may irrigate crops, sown on lower lands, by capillarity. Sometimes, leakage causes the water table to rise up, which helps in irrigation of crops by capillarity. When underground irrigation is achieved, simply by natural processes, without any additional extra efforts, it is called natural sub-irrigation.	-
	Artificial sub-surface irrigation	When a system of open jointed drains is artificially laid below the soil, so as to supply water to the crops by capillarity, then it is known as artificial sub-irrigation.	

Besides categories of above irrigation methods, watering practice is widely adopted at the farm level. Such watering practice is grouped into the conventional surface irrigation method.

In consideration with the Distribution of Flow Duration Curves (Q1(75)), Figure 1.5.2 in the Appendix E, river regime in Tanzania can be identified.

Broadly Applicable Irrigation Methods

River regime type	Indicator	With reservoir		Without reservoir	
		Higher altitude	Lower altitude	Higher altitude	Lower altitude
Perennial rivers	Q1(75)>20	C	A	C	A
Intermittent rivers	20>=Q1(75)>0	C	A	B	B
Ephemeral rivers	Q1(75)=0	-	B	B, C	B, C

"Higher altitude" means higher elevation position of irrigation area in compare with the height of water source, "Lower altitude" is in opposite condition.

"A,B and C" means the category of irrigation to be referred the above table of "**Classification of Irrigation Method**"

(6) Expectable Project Life

Project life is a life expectancy of the constructed irrigation facilities, which is optimally selected taking expected project performance and circumstances surounding the project. Taking longer project life is clearly obtainable of much valuable project outcomes, even though required more physically powerful facilities or higher investment. Generally, the project life is selected to an optimized point of the relation of input and output of the Project, in viewpoint of economy. However, in some cases, optimality keeps behind of other factors, capability of implementation, possibility of acquisition of required inputs, stability of project conditions etc. Even though a plan is optimum, it couldn't be chosen if executed body of project is not capable or manageable for the project plan. And also, if some conditions surrounded project are variable and remodeling of the project may probably require when the conditions alter, life of project should be restrained within focusable duration. For instance, being under a transitional

condition in river morphology, project life of the project concerned with the stream should be selected within the years in which remarkable change will not be expected likely 10 to 20 years.

(7) Reliability of Project

Reliability of the project is defined as probability of reliability (or of failure) in viewpoint of statistical uncertainty. Sometimes, it is also defined as a volumetric reliability. In the case of project related to water use, it often relates the volume of water supplied to the volume of water demanded for the project period as an indicator of Rv = actual supply /demand.

Reliability of irrigation project means a dependability of project against certain targeted drought occurrences to secure irrigation needs by means of construction of irrigation system. Adopting lower reliability of irrigation with simpler and cheaper facilities, only lower secularity of irrigation water supply against drought occurrence is obtained. Otherwise, accepting an irrigation development having higher reliability against harder drought occurrence, much expensive irrigation system is to be facilitated. On a discussion for reliability of project, optimum trade-off between spending and gain is essential. For the investment level of project implementation, affordable limit and manageable scale of project is very crucial. Therefore, the final project formulation is not to be an optimum choice in economy, but to be an optimum selection in good balance of the input and output.

(8) Affordable Range of Project Cost

Unit cost for irrigation development project is a topical subject for the interested persons of project, especially government staff and donors. Approximate unit project cost of around US$2,000/ha has been induced and standardized gradually. However, adequate project cost must be varying corresponding to the own circumstances of the project. Some projects may be optimal to take lower standard than the unit project cost, otherwise, some can be advantageous taking much higher cost than the unit cost.

Affordable range of irrigation project cost is subject to affordability and admissibility of a party of project concerned, and project economy. It will be decided at the minimum among the values. It is surveyed as follows:

Affordable Limit of Project Cost by Production Yield and Project Life

(unit: US$/ha)

Project life / Unit yield (benefit)	~10 years			10~20years			20~30years			~50years		
	N.	E.	W.	N.	E.	W.	N.	E.	W.	N.	E.	W.
~$100/ha	500	400	300	650	500	400	750	600	500	800	650	-
$100~$200/ha	1,000	800	600	1,250	1,000	800	1,500	1,200	1,000	1,650	1,300	-
$200~$400/ha	2,000	1,600	1,200	2,500	2,000	1,600	3,000	2,400	2,000	3,300	2,600	-
$400~$600/ha	3,000	2,400	-	3,750	3,000	-	4,500	3,600	-	5,000	3,900	-
$600~$800/ha	4,000	3,200	-	5,000	4,000	-	6,000	4,800	-	6,600	5,200	-
$800~$1000/ha	5,000	4,000	-	6,250	5,000	-	7,500	6,000	-	8,250	6,500	-
$1000~	6,000	4,800	-	8,000	6,000	-	9,000	7,200	-	10,000	7,800	-

N.: New irrigation scheme, E.: Existing irrigation scheme, W: Water harvesting scheme

Above indicated unit irrigation project cost is major part of initial investment cost. New irrigation scheme cost much initial cost with small O&M cost. Instead of the situation of new irrigation scheme, existing and water harvesting scheme require much O&M cost in spite of lower initial cost.

(9) Allowable Limit in Economic Indicator

Economic indicator of EIRR or B/C etc. could be adopted for irrigation project as well as other sectoral development projects in order to specify a position in economic aspect. Around 12 % and the more of the IRR are usually selectable as the project allowable limit in consideration with possible rate of interest when loan is adopted. The economic indicator is not only useful to identify absolute status of the project in economic feasibility but also to enable to compare with other candidate projects standing on a same ground. Basin-wise approach has been recently highlighted in the sector of water-resources development and management in Tanzania, in which good consent and objective prioritization corresponding to the economic superiority among concerned water users are highly attached importance.

Irrigation project may not be selectable to an implementing scheme due to relatively low EIRR rather than other sectral projects. Preventing from these situations, allowable standard of EIRR is the value to surpass to the other competitive projects. However, it is difficult to gain such high EIRR for irrigation development projects generally, rather than other sectral projects.

Allowable limit of EIRR for the irrigation projects are not standard indicator to defeat other sectoral projects in the indicator, but to obtain soundness and sustainability of project itself. Final selection of project r to be implemented should be done by comprehensive advantage rather than single phase for economy. Therefore, the standard of EIRR listed here is a general hurdle to be cleared for its self-reliance.

6. References for Adoption of the Guideline

This guideline for irrigation development level is an indication of principles on technical decision making for irrigation scheme implementation, and not always required to obey formalistically. Sometimes, it may be modified flexibly depend upon peculiarity of scheme site.

At the same time, it is by no means a criterion for scheme selection or prioritization. Some criteria for scheme selection were prepared in several projects/programmes, and a standard of scheme screening will be provided so much as this Study. This guideline for irrigation development level is essentially different from the criteria for scheme selection in those purposes. Scheme selection is generally based on an intention that schemes below standard shall be prevented from intervention. On the other hand, guideline for irrigation development level is based on a mind that every areas may practice irrigation as far as farmers want. In that case, every areas are naturally restricted irrigation practice within allowable range of irrigation development corresponding to the development potential of their own area. This criteria for irrigation development level can show possible and most suitable modality of irrigation development by irrigation development type on the basis of recognition of potential and limitation of irrigation development of the same.

Many sorts of irrigation facilities are applicable in Tanzania. For irrigation scheme implementation, one among those sorts would be selected depending on the requirement and possibility of the scheme site even though there are still some options. It is not advisable to persist on a fixed modality of irrigation system, but it should be flexible as far as being allowable. For the convenience of planners of irrigation scheme development, a standard on applicable sorts of irrigation facilities by irrigation development type was prepared and shown in Table 6.1.

7. Additional Remarks

Within this chapter, some related themes to the argument on irrigation development level are post-scripted.

(1) Irrigation Efficiency

Efficiency is the ratio of the water output to the water input and is usually expressed as percentages. Input minus output is nothing but losses, and hence, if losses are more, output is less and, therefore, efficiency is less. There are different kinds of subdivided irrigation efficiencies as given below:

(i) **Efficiency of water-conveyance.** It is the ratio of the water delivered into fields from the outlet point of the channel, to the water pumped into the channel at the starting point. It may be represented by η_c.

(ii) **Efficiency of water- distribution.** It is the ratio between water received at the field inlet and that received at the inlet of the block of fields. It may be represented by η_b. Sometimes, its efficiency may be called as "field canal efficiency".

(ii) **Efficiency of water – application.** It is the ratio of the quantity of water stored into the root zone of the crops to the quantity of water actually delivered into the fields. It may also be termed as *Farm Efficiency* as it takes into account the water lost in the farm. It may be represented by η_a.

(iv) **Efficiency of water use**. It is the ratio of the water beneficially used, including leaching water, to the quantity of water delivered. It may be represented by η_p. Sometimes, its efficiency may be called as "project efficiency".

Here, $\eta_P = \eta_c \times \eta_b \times \mu_a$

Generally, a "irrigation efficiency" means the efficiency of water use as an overall efficiency. In Tanzania, the overall efficiency could be gained at from 10 to 20 % due to not well-controlled condition of irrigation water supply. It might be;

$\eta_P (0.1 \approx 0.2) = \eta_c (0.6 \approx 0.7) \times \eta_b (0.5 \approx 0.6) \times \mu_a (0.4 \approx 0.5)$

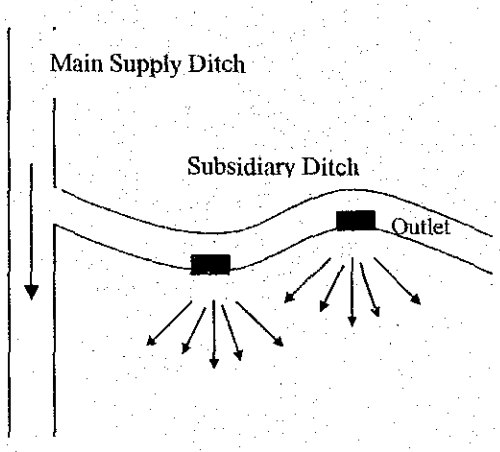
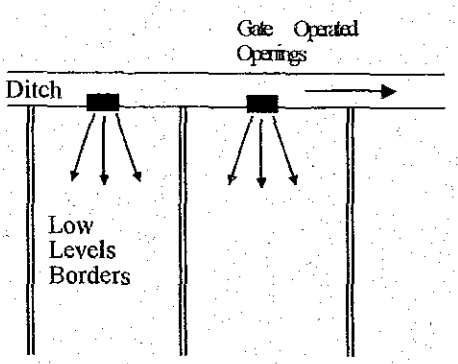
However, the irrigation conditions corresponding to irrigation efficiency implicates not only circumstance in hardware but also situation in software. Providing that water loss at the field application covers mismanaged water waste and other losses caused by failures in software, modern irrigation system having perfectly lined canals may gain lower irrigation efficiency. During the design stage of irrigation schemes, the efficiencies are not know actually, therefore their values have to be based on previous field experience taking expectable farmers' manner in water

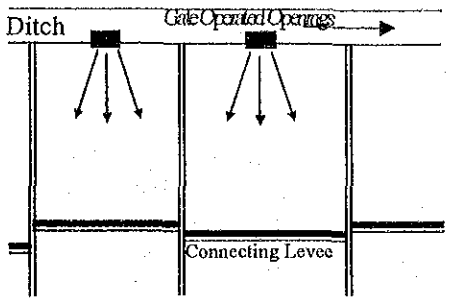
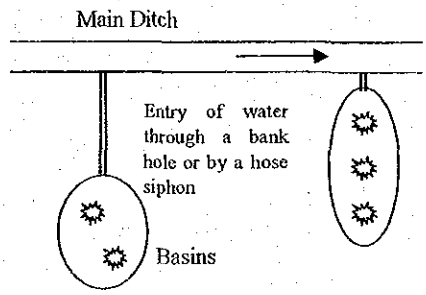
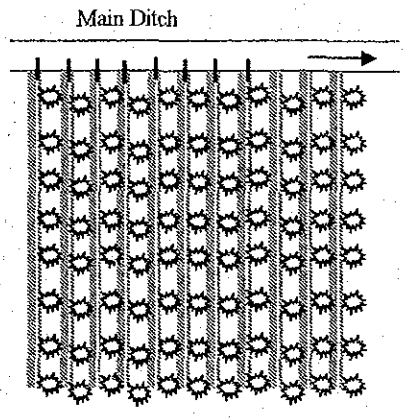
management into consideration. That is to say, irrigation efficiency may not be a factor to be designed, but a factor to be achieved and maintained. This is a reason why the factor of irrigation efficiency is excluded from the significant factors defining the irrigation development level.

(2) Irrigation Method

As to techniques of water distribution in the farm, there are various ways in which the irrigation water can be applied to the fields. Their main classification is as follows:

Typical Irrigation Methods

Irrigation method	explanation	views
Free flooding	Ditches are excavated in the field, and they may be either on the contour or up and down the slope. Water from ditches, flows across the field. After the water leaves the ditches, no attempt is made to control the flow by means of levees, etc. Since the movement of water is not restricted, it is sometimes called *Wild flooding*. Wild flooding , is most suitable for close growing crops, pastures, etc., particularly where the land is steep. Contour ditches called laterals or subsidiary ditches, are generally spaced at about 20 to 50 metres apart, depending upon the slope, texture of soil, crops to be grown, etc. This method may be used on rolling land where borders, checks, basins and furrows are not feasible.	
Border flooding	The land is divided into a number of strips, separated by low levees called borders. The land area confined in each strip is of the order of 10 to 20 metres in width and 100 to 400 metres in length. Ridges between borders should be sufficiently high to prevent overtopping during irrigation.	

Check flooding	Check flooding is similar to ordinary flooding except that the water is controlled by surrounding the check area with low and flat levees. Levees are generally constructed along the contours, having vertical interval of about 5 to 10 cm. These levees are connected with cross-levees at convenient places. The confined plot area varies from 0.2 to 0.8 hectare. In check flooding, the check is filled with water at a fairly high rate and allowed to stand until the water infiltrates. This method is suitable for more permeable soils as well as for less permeable soils, thus reducing the percolation losses. These checks, are sometimes used to absorb water, where the stream flow is diverted during periods of high run off.	
Basin flooding	This method is a special type of check flooding and is adopted specially for orchard trees. One or more trees are generally placed in the basin, and the surface is flooded as in check method by ditch water.	
Furrow irrigation method	In flooding methods described above, water covers the entire surface, while in furrow irrigation method, only one-fifth to one-half of the land surface is wetted by water. It therefore, results in less evaporation, less puddling of soil, and permits cultivation sooner after irrigation. Furrow is a narrow ditch, excavated between rows of plants. Spacing of furrows is determined by the proper spacing of the plants. Furrow vary from 8 to 30cm deep and may as much as 400 metres long. Deep furrows are widely used for row crops. Small shallow furrows called Corrugations, are particularly suitable for relatively irregular topography and close growing crops such as meadows and small grains.	

Porous hose method	It is also termed as *Ozo-Irrigation*, because in this method, a porous canvas hose is used for throwing water over the land to be irrigated. Water is pumped into the hose, and it oozes through the canvas walls and falls freely on the ground, providing sufficient irrigation. This method is useful, where there is a scarcity of water, and economy in the use of water is required. It is a cheap method, but the disadvantage is that the porous hose lasts for a short life of not more than two to three year or so.
Spray method	In this farm-water application method including micro-irrigation methods, water is applied to the soil in the form of a spray through a network of pipes and pumps. It is a kind of an artificial rain and, therefore, gives very good results. It is a costly process and widely used in U.S.A. Depending upon the soil, crops, the climate, etc., various networks have been designed and are used these days. Some of them are: (i) Fixed Nozzle Type (ii) Perforated Sprinkler Type (iii) Oscillating Sprinkler Type (iv) Rotary Sprinkler Type

(3) River Basin Approach

At the moment, river-basin approach is the most highlighted topic, when talking about water use in Tanzania including irrigation as the biggest water user. Under these circumstances, irrigation is not always regarded as the most prioritized user because of inferior economic viability in comparison with other sectoral users. Furthermore, an argument is raised like "irrigation water use has hindered people's livelihoods and environment". In Usangu, following problem of water has been underlined:

> *Problem of water in Usangu has many effects, it is the seasonal drying up of the Great Ruaha River which is causing the most national concern. There is the same amount of water in Usanga today as there was thirty years ago. Despite commonly held beliefs, records show that rainfall, and river flows from the highlands to the Usangu plain, have not changed over the last 50 years. However, demands for water have been increasing rapidly, especially on the plain.....*
>
> *There are many other things in Usangu which may be affecting the river. Various possible causes have been suggested, including activities within the wetland and upstream land degradation. However, if there is any impact from these, it is very, very small. There is no doubt that* ***use of water for irrigation****, especially during the dry season, is the main reason why the river is drying up. There is no other activity that has as important impact on the amount of water in the river.....*
>
> *"Restoring Flows in the Great Ruaha River: THE CHALLENGES AHEAD" M.W.L.D., May 2002*

It is agreeable that irrigation has affected significantly to the area. But we couldn't consent about their conclusion that use of water for irrigation is the main

reason for the environmental hazard. Though they explained that climate change is not symptomatic last 50 years, it is not convicting because of no scientific evidence. More detailed analysis with reliable data should be carried out.

Irrigation water uses may sometimes be problematic, but it must be improvable. Even if irrigation is affecting environment like Usange if it is true, remedies are there. It is clearly mentioned that blamed one is never irrigation itself but uncontrolled management in irrigation.

No one doubt that most of farmers in Tanzania who are more than 80 % of a nation rely upon irrigated agriculture for their livelihood. River basin approach should focus not to exclude irrigation within the river basin, but to settle sustainable irrigation by means of improving method and modality of irrigation water use.

Table 5.1 Indicators on the Irrigation Development Level

Scheme Type			Rehabilitation of existing scheme			New irrigation scheme			Water harvesting scheme		
Water Sources			Surface water	Groundwater	Others(lake etc.)	Surface water	Groundwater	Others(lake etc.)	Stream flood	Catchment water	Rainwater
1	Position of a balance in hardware and software*	Village scheme	level E	level C	level D	level D	level C	level C	not applicable	level E	level E
		Small-scale	level C～level E	level B～level D	level B～level D	level A～level C	level B～level C	level A～level C	level D～level E	level E	not applicable
		Medium-scale	level C～level D	level B～level D	level B～level D	level A～level C	level B～level C	level A～level C	level D～level E	not applicable	not applicable
		Large-scale	level C～level D	not applicable	not applicable	level A～level C	not applicable	not applicable	not applicable	not applicable	not applicable
2	Project Scale (ha.)	Village scheme	up to 10～20 ha	up to 10～20ha	up to 10～20ha	up to 10～20 ha	up to 10～20ha	up to 10～20ha	not applicable	up to 10～20ha	up to 10～20ha
		Small-scale	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	Area ≤ 500 ha	not applicable
		Medium-scale	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	500ha < Area ≤ 2,000ha	not applicable	not applicable
		Large-scale	2,000ha < Area	not applicable	not applicable	2,000ha < Area	not applicable	not applicable	not applicable	not applicable	not applicable
3	Applicable Crop for Irrigation	Village scheme	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	not applicable	Rice, Maize, Tree crops, others	Rice, Maize, Tree crops, others
		Small-scale	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Maize, Tree crops, others	Rice, Maize, Tree crops, others	not applicable
		Medium-scale	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Vegetable, others	Rice, Maize, Vegetable, others	Rice, Maize, Tree crops, others	not applicable	not applicable
		Large-scale	Rice, Maize, Vegetable, others	not applicable	not applicable	Rice, Maize, Vegetable, others	not applicable	not applicable	not applicable	not applicable	not applicable
4	Target Yield of Irrigated Crop	Village scheme	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	not applicable	1.0t<Paddy<1.5t	1.0t<Paddy<1.5t
		Small-scale	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	1.0t<Paddy<2.0t	1.0t<Paddy<1.5t	not applicable
		Medium-scale	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<5.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	3.0t<Paddy<6.0t	1.0t<Paddy<2.0t	not applicable	not applicable
		Large-scale	3.0t<Paddy<5.0t	not applicable	not applicable	3.0t<Paddy<6.0t	not applicable	not applicable	not applicable	not applicable	not applicable
5	Irrigation Method, and Modality of Irrigation System	Village scheme	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	not applicable	Submerged water	Submerged water
		Small-scale	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	Gravity surface	Submerged water	not applicable
		Medium-scale	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	Gravity surface	Gravity surface, pressured water	Gravity surface, pressured water	Gravity surface	not applicable	not applicable
		Large-scale	Gravity surface	not applicable	not applicable	Gravity surface	not applicable	not applicable	not applicable	not applicable	not applicable
6	Expectable Project Life (years)	Village scheme	～20	～20	～20	～20	～20	～20	not applicable	～10	～10
		Small-scale	20～50	20～50	20～50	20～50	20～50	20～50	～20	～10	not applicable
		Medium-scale	25～50	25～50	25～50	25～50	25～50	25～50	～20	not applicable	not applicable
		Large-scale	50	not applicable	not applicable	50	not applicable	not applicable	not applicable	not applicable	not applicable
7	Reliability of Project (drought occurrences; %)	Village scheme	～50	～50	～50	～50	～50	～50	not applicable	depending on the rain occurrence	depending on the rain occurrence
		Small-scale	50～20	50～20	50～20	50～20	50～20	50～20	depending on the rain occurrence	depending on the rain occurrence	not applicable
		Medium-scale	25～20	25～20	25～20	25～20	25～20	25～20	depending on the rain occurrence	not applicable	not applicable
		Large-scale	20～10	not applicable	not applicable	20～10	not applicable	not applicable	not applicable	not applicable	not applicable
8	Affordable Range of Project Cost (per ha.)	Village scheme	～1,500US$/ha	～2,000US$/ha	～1,500US$/ha	～2,000US$/ha	～2,500US$/ha	～2,000US$/ha	not applicable	～500US$/ha	～500US$/ha
		Small-scale	1,000～5,000US$/ha	1,000～5,000US$/ha	1,000～5,000US$/ha	1,250～10,000US$/ha	1,250～10,000US$/ha	1,250～10,000US$/ha	400～1,600US$/ha	300～1,200US$/ha	not applicable
		Medium-scale	1,200～5,000US$/ha	1,200～5,000US$/ha	1,200～5,000US$/ha	1,500～10,000US$/ha	1,500～10,000US$/ha	1,500～10,000US$/ha	400～1,600US$/ha	not applicable	not applicable
		Large-scale	1,300～5,000US$/ha	not applicable	not applicable	1,650～10,000US$/ha	not applicable	not applicable	not applicable	not applicable	not applicable
9	Allowable Limit in Economic Indicator (IRR; %)	Village scheme	more than 8%	more tha 8%	more than 8%	more than 8%	more tha 8%	more than 8%	not applicable	more than 8%	more than 8%
		Small-scale	more than 10～12%	more than 10～12%	more than 10～12%	more than 10～12%	more than 10～12%	more than 10～12%	more than 8%	more than 8%	not applicable
		Medium-scale	more than10～12%	more than 10～12%	more than 10～12%	more than10～12%	more than 10～12%	more than 10～12%	more than 8%	not applicable	not applicable
		Large-scale	more than 10～12%	not applicable	not applicable	more than 10～12%	not applicable	not applicable	not applicable	not applicable	not applicable

*: balance of hardware(HW) and software(SW), A:HW remarkably surpasses SW in project investment, B:HW rather surpasses SW, C:HW is almost balanced with SW, D:SW rather surpasses HW, E:SW remarkably surpasses HW, X: Balance of the both highly depends on the characteristics in physical and social conditions of the project area.

Table 6.1 Applicable Sorts of Irrigation Facilities by Irrigation Development Type

Irrigation Development Type			Water sources development facilities				Intake/ Diversion facilities						Distribution facilities					On-farm facilities		
Irrigation Development	Water source	Sorts of abstraction	Dam	Open Well	Bore hole	Catchment bund	Dam intake	Weir	Weir	Weir	Lifting pump	Under-drain	Canal	Canal	Canal	Concrete flume	Conduit	Ditch	No Ditch	Spraying equipment
			Concrete/ fill	without casing	With casing	Earthen	Co-fabrication	Concrete With Steel gate	Gabion With Conven-tional gate	Tem-porarty	Powered pump	Porous pipe	Concrete lining	Block lining	Earthen	Ready-made flume	Ready-made pipes	Earthen	By cascade flow	Sprinkler/ drip nozzle
New Irrigation Scheme	River Surface	With dam	●				●						①	②	③	□	□	①	△	□
		By gravity						①	②		①	□	①	②	③	□	□	①	②	□
		Lifting									●		①	②	③	□	□	①	②	□
	Ground water	By pump		②	①						●		□	□		□	①	①	△	□
		By manual		●											①			①	②	
	Others	Lake		□	□						●		①	②	③	□	□	①	②	□
		Spring						①	②		①		①	②	③	□	□	①	②	□
		Impounding									□		①	②	③	□		①	②	
Rehabilitation Irrigation Scheme	River Surface	With dam	●				●						①	②	③	□		①	②	
		By gravity						①	②		①		①	②	③	□		①	②	
		Lifting									●		①	②	③	□		①	②	
	Ground water	By pump		②	①						●		□	□		□	①	①	△	□
		By manual		●											①			①	②	
	Others	Lake		□	□						●		①	②	③	□		①	②	
		Spring						①	②		①		①	②	③	□		①	②	
		Impounding									□		①	②	③	□		①	②	
Water Harvesting	Stream flood					□			①	②					●				●	
	Catchment water					●									●				●	
	Rain water					●												●		

Note: ● indispensable, ① applicable for the case of higher level, ② applicable for the case of medium level, ② applicable for the case of lower level

□ applicable if other conditions are satisfied, △ applicable when it is reluctant