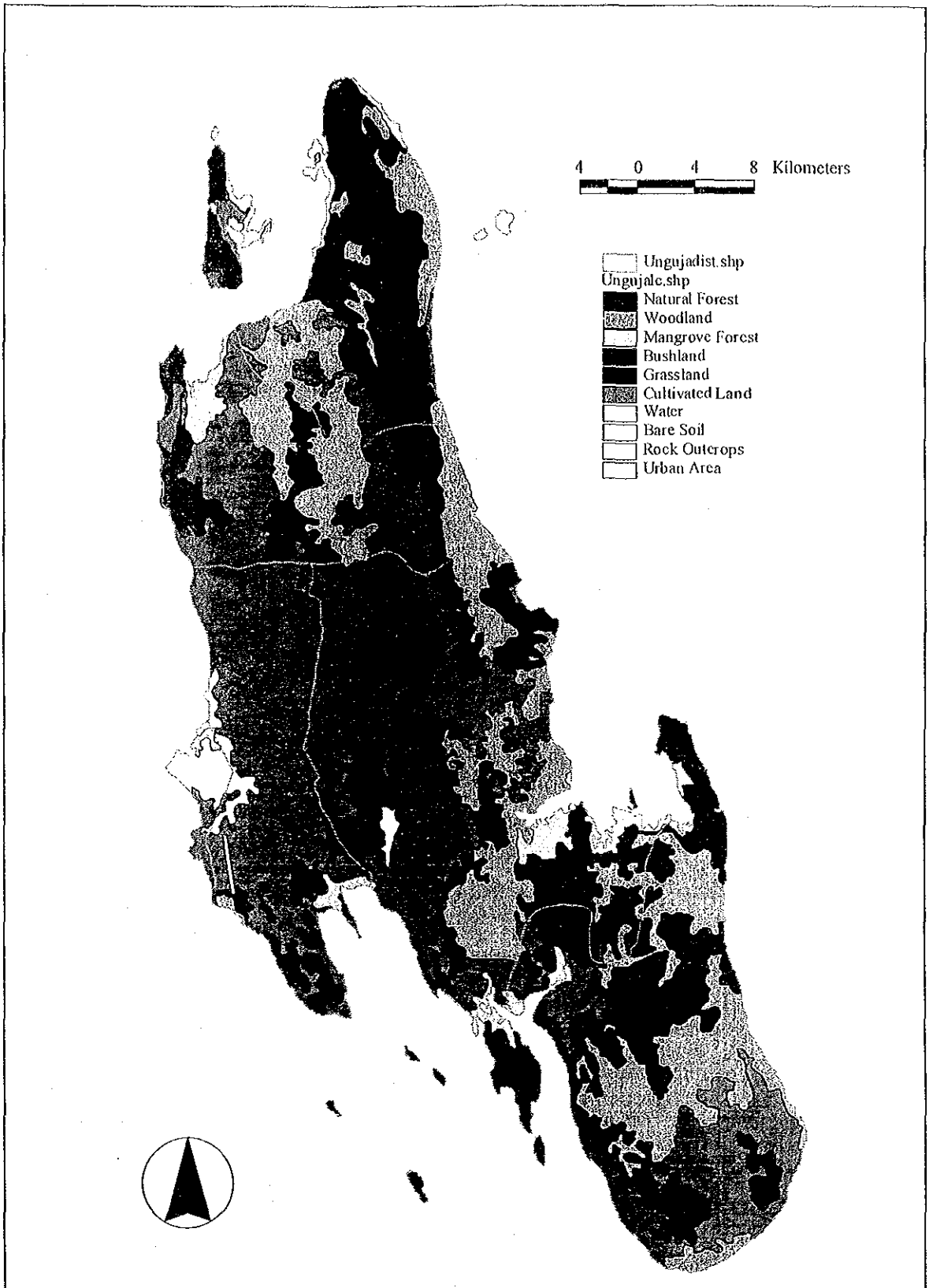
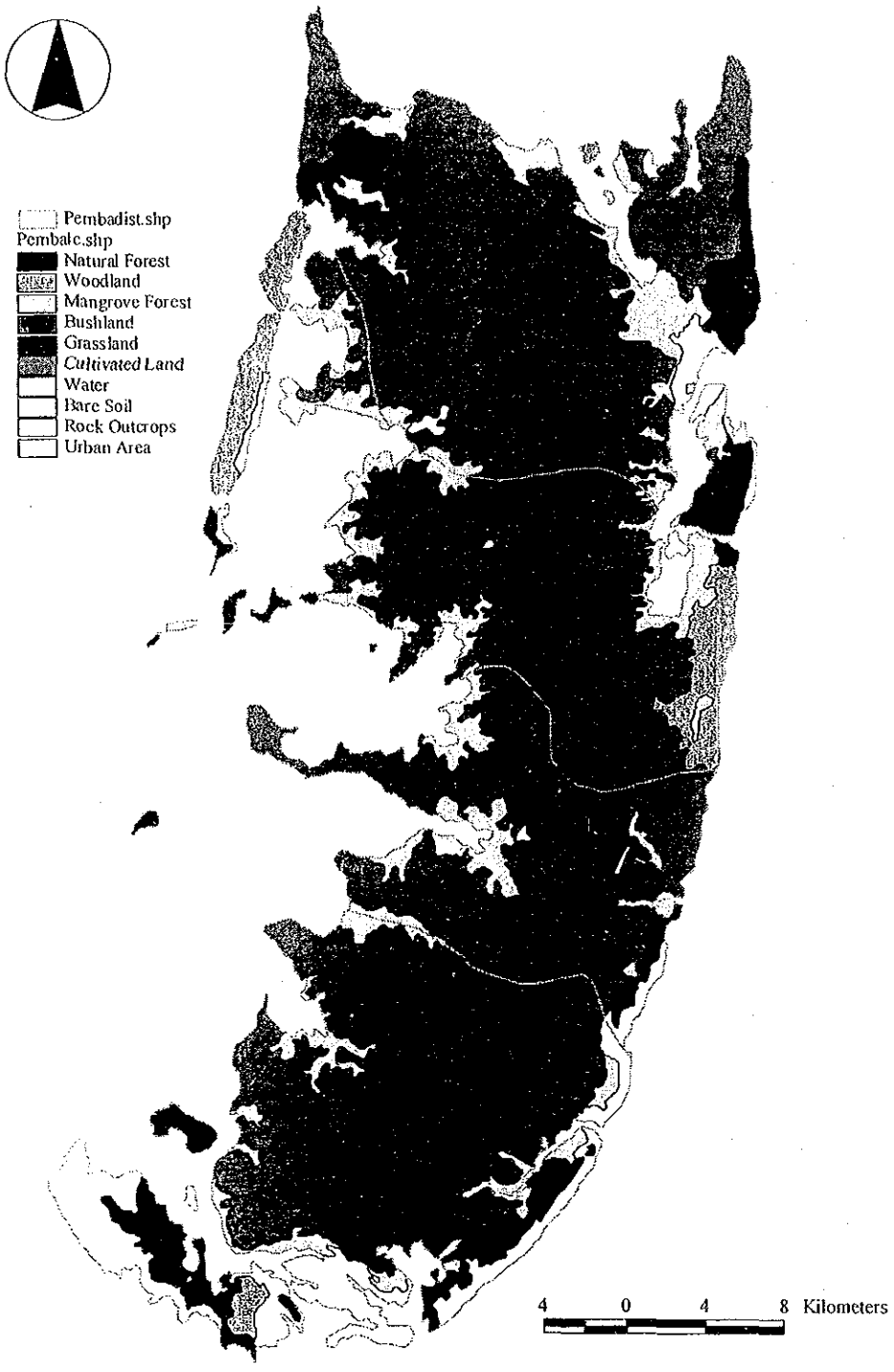
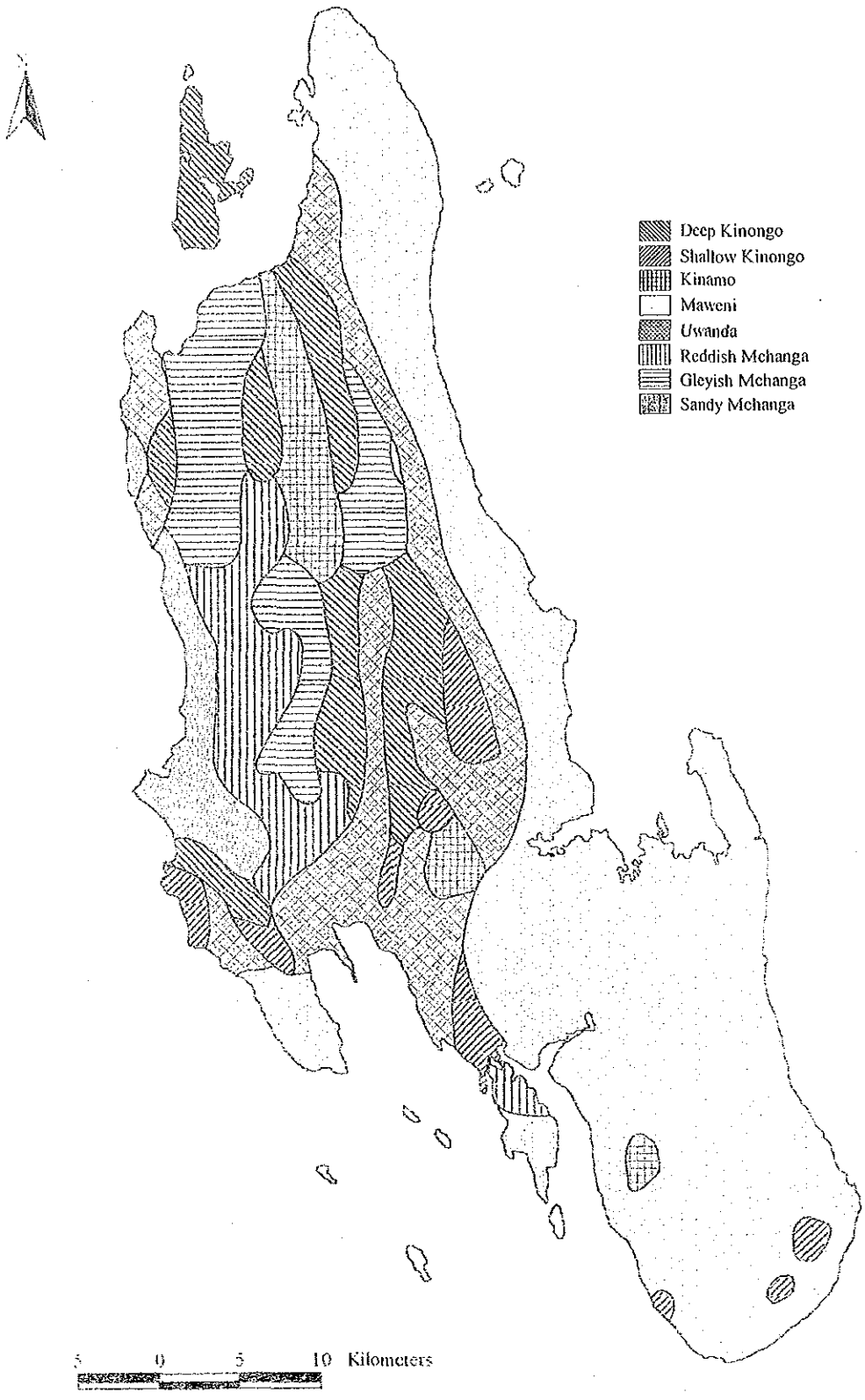
Figure



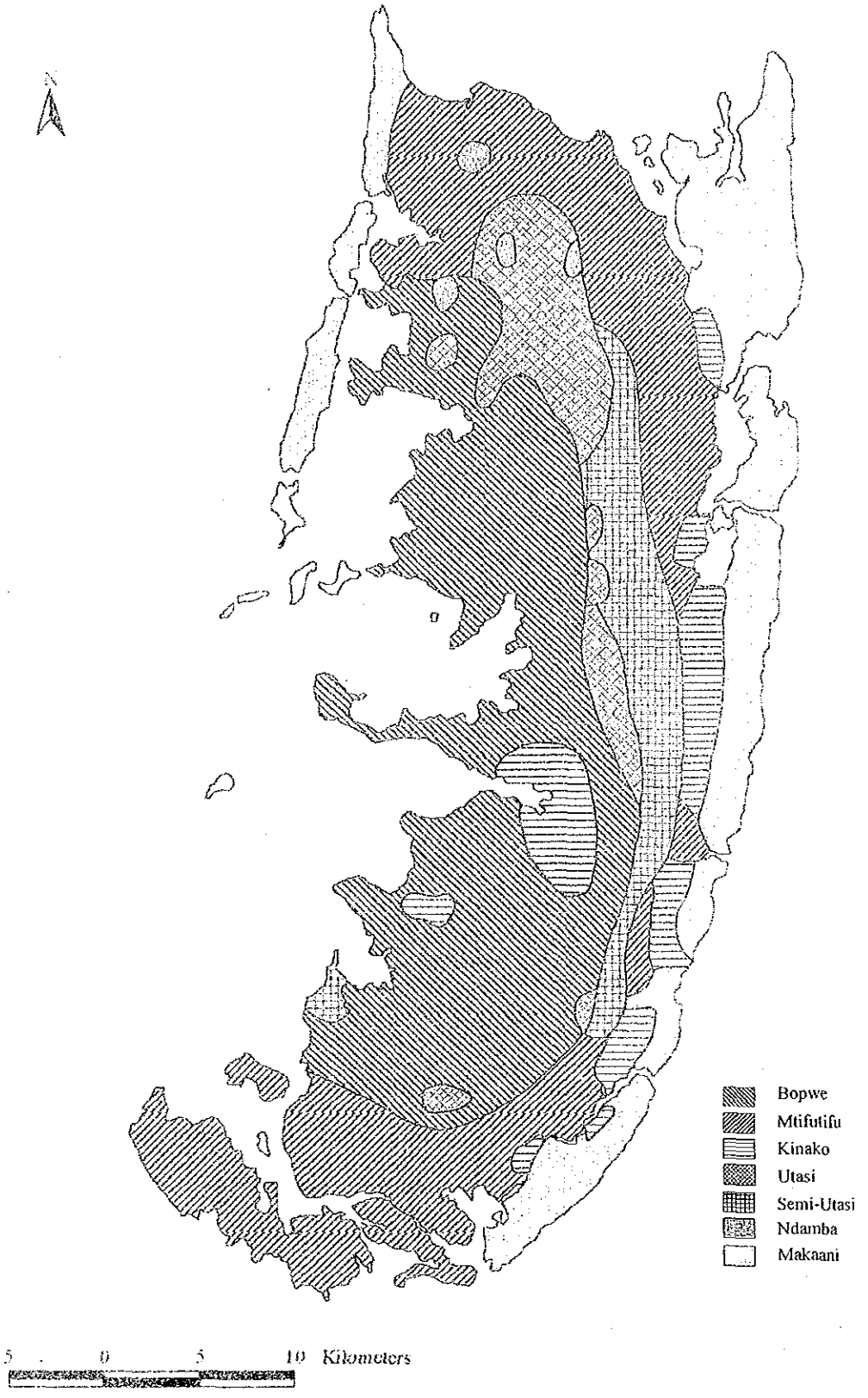
The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 1.1.1** **Land Cover Map of Unguja Island**
Japan International Cooperation Agency	



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 1.1.2** **Land Cover Map of Pemba Island**
Japan International Cooperation Agency	



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.1** **Soil Type in Unguja Island**
Japan International Cooperation Agency	



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.2** **Soil Type in Pemba Island**
Japan International Cooperation Agency	

Appendix D

Water Resources, Irrigation and Water Management

THE STUDY
ON
THE ZANZIBAR IRRIGATION MASTER PLAN
IN
THE UNITED REPUBLIC OF TANZANIA

MASTER PLAN

APPENDIX D

WATER RESOURCES, IRRIGATION AND WATER MANAGEMENT

Table of Contents

List of Tables

List of Figures

APPENDIX D

WATER RESOURCES, IRRIGATION AND WATER MANAGEMENT

CHAPTER 1 ZANZIBAR IRRIGATION DEVELOPMENT PLAN (ZIDP)

1.1 Outline of the DIDP

Following the successful launch of the "National Irrigation Development Plan" (NIDP) for the Mainland, which adopts a radical yet rational and holistic planning methodology, the Government of Zanzibar secured UNDP assistance in order to develop a irrigation development plan for the islands. The objective had been to prepare a development plan for Zanzibar's irrigation sector over the 15 years since 1997 which:

(1) Proceeds from an improved understanding of the current situation especially in terms of; (i) natural resources, (ii) environment, (iii) existing infrastructure, (iv) existing institutions, (v) social dynamics and land use practices, and (vi) existing constraints.

(2) Addresses the needs of the sector and its participants in terms of; (i) constraint removal, (ii) maximized community participation in all stages of the project cycle including financing, O&M, (iii) economic liberalization and privatization, (iv) sustainability and replicability, (v) low cost options and cost recovery mechanisms, (vi) crop diversification based on the principles of comparative advantage, (ix) institutional reform and associated strengthening, (x) legal frameworks, (xi) private sector catalization and facilitation, and (xii) support and extension services.

(3) Present a rational specification and schedule for the sector's development over the 15 years and paying full regard to; (i) community aspiration and abilities, (ii) sound environmental and natural resource management, (iii) financial viability at farm and national levels, (iv) financial viability at farm and national levels, (v) economic viability, and (vi) the institutional implications and requirements.

In the respect, final draft of Zanzibar Irrigation Development Plan (ZIDP) was prepared in 1997 on the basis of Zanzibar's experience in irrigated agriculture over two decades. The ZIDP consists of following eleven (11) chapters:

Structure of the ZIDP

Chp.	Chapters' Title	Contents of the Chapter	Remarks
1	Introduction	The Introduction describes how it started, and about the objectives of irrigation development during 15	It was also mentioned that successful launch of the NIDP for the Mainland induced GOZ to establish the ZIDP.

		years since 1997.	
2	Background	This chapter explained agriculture situation at the time being. And role of irrigation to meet future demand was also mentioned.	Areas required for self sufficiency in major crops were presented. Incomprehensibly however target irrigated area was not argued, and figures of the areas required was not referred any more.
3	Changing Policies in Agriculture	Transition of agricultural policy and change of the Ministry of agriculture were described.	Present structure of the Ministry was clarified in this chapter.
4	Natural Resources	Availability of natural resources of Land, soil and water were quantified, then, finally potential irrigable rice lands were adopted at 3,750 ha (Unguja: 2,500 ha, Pemba: 1,250 ha) for planning purposes.	Adopted irrigable area is far below of areas required for self sufficiency discussed in Chap.2, however, no justification and adjustment was taken.
5	Environmental Considerations	Issues in environment related to irrigated agriculture in Zanzibar were overviewed.	No concrete proposal in environmental consideration was given.
6	Development Planning for Irrigated Agriculture	General aspects in planning for irrigated agriculture were enumerated, but it was without clear linkage each other.	Focus of description of this chapter is much vague because that clear development target are not presented. In the ZIDP, identification of development target seems to be an important further subject in the Plan.
7	Institutional Framework for Irrigated Agriculture	Based on the analysis of institutional roles in irrigation development, enrolment of private sector was emphasized in future. Discussion on the subject of "transition to self-sustainability" was also highlighted. This chapter is over the many pages rather than others.	ZIDP put particular emphasis on this chapter for institutional improvement.
8	Definition and Scope of the Zanzibar Irrigation Development Plan	Plan and time schedule of the ZIDP is presented in this chapter. Totally 46 activities categorized into 5 groups were proposed so that the Plan would be commenced in 1998.	Every activities were abruptly put in the schedule without any evidences of possibility for implementation. The Plan put off dealing with every issues faced at the time being, and made those issues put into the activities on the Plan.
9	Costs and Benefits	This is the chapter to be presented costs and benefits of the Plan. However, some of paragraph were still not ready.	Besides being not ready for some paragraphs, any target figures are not found within the chapter at all.
10	Monitoring and Evaluation	General description on monitoring and evaluation was given in this chapter. No concreteness is held in those descriptions.	There is a description that "ZIDP may have to change to accommodate changes in external conditions". It is shown that nothing could be decided due to unpredictable external conditions at the time of the ZIDP formulation.
11	Conclusions and Recommendations	At the back of the ZIDP, conclusions and recommendations were given. In this chapter, Pemba was given highest priority to surface fed gravity smallholder irrigation schemes, on the other hand, production of high value crops with private investors' enrolment were recommended in Unguja because of the incompatibility of subsistence smallholder schemes.	The description in this chapter is still unfinished.

Source: ZIDP, 1997

"Transitioning to self-sustainability through proper institutional improvement"

was put as a basic concept of the ZIDP. The ZIDP was prepared under a expectation like, "if the institutional improvement is once completed, all necessary operations in irrigation development may possibly run well through the improved institutional system". Therefore, no concrete plan was prepared in the ZIDP, even scheme ranking for future implementation was put off out of the ZIDP.

1.2 Progress of Implementation of ZIDP

In the ZIDP, totally forty-six(46) activities were proposed to be executed during from 1998 to 2013. Out of these, twenty-nine(29) activities were scheduled to be completed by the end of 2001, which were almost all activities in "Study and Research", and some of activities in "Institutions and Human Resources". The proposed activities and its implementation schedule under the ZIDP are shown in Table 1.1.1.

At present as of August 2002, nothing of the activities proposed in the ZIDP had been started and completed. Although a few schemes have been implemented or committed its implementation after preparation of the ZIDP, the schemes have not been directly selected from the ranked schemes inventory proposed in the ZIDP.

There is one opinion that the ZIDP was not yet authorized practically. In spite of proposing an activity for finalization of the ZIDP within the ZIDP prepared in 1997, so far no finalization works have been taken yet. It seems to be suspended from its implementation.

It is an obvious that the ZIDP has not progressed on schedule especially in the component for institutional building. Besides the constraints in irrigation development which were already identified when the ZIDP established, inexperienced constraints to be additionally overcome have raised as the change of economic and political climate. Even the constraints specified in the ZIDP have been hardly settled and still remained accordingly.

Following reasons for the unsuccessfulness of the ZIDP are supposed:

- The ZIDP itself was not completed,
- No endorsement of financial requirement for the implementation of the ZIDP were not given at all, and
- Initiatives for promotion of the ZIDP have been weak.

Weakness of the institutional capability and vulnerability of the irrigation sector was given greater attention in the ZIDP, and thus the ZIDP aimed at elimination of the constraint through institutional building with high priority. However, it is

an irony, because the constraints itself (such as weakness) hampers successful implementation of the ZIDP. Route causes of the weakness are supposed to be due to poor basic institutional circumstances. It is a dilemma that MOA couldn't show conspicuous initiative. Because the activities on institutions and human resources development itself were just proposed to overcome such its own weakness.

In addition to the above identified constraints, some studies analyzed constraint on irrigation sector so far. Identified issues on irrigation sector in the latest study are tabulated as follows for reference:

Referential Constraint Matrix for the Zanzibar Irrigation Sector

Constraints	Root Cause	Manifestation	Status
Poor allocation of financial resources (Initially wrongly directed via subsidies later simply inadequate)	- Wrong prioritization - No clear strategy for the sector - Poor understanding of the sector - Unhelpful political dimension tagged onto the sector - Poor performance of irrigation scheme	- Under utilization of land - Retarded Irrigation productivity - Low productivity and unsustainability	Constraint still effective Political dimensions are improving
Low farmer understanding and motivation	- Irrigation is a new technology in Zanzibar - Historic subsidies were counter productive - Unattractive marketing/pricing policy - Minimal organization amongst farmers - Unavailability of credits - Uncertain land tenure - Inputs no reliability - Top down approach - Water not available when promised - Poor supports services - Poor health - Competition for labour - No incentives towards producing a surplus (to disposable income)	- Discouragement and lack of commitment - Doubtful sustainability - Under performance irrigated crop production - Some destruction of infrastructure	Improving but not done
Inadequate professional skills, planning, background studies and engineering related research	- Low priority given to training irrigation professionals - poor understanding of the technical requirements of the sector - Donor pressure - Inadequate data resources	- Too much too soon - Un-sustainability - Poor designs	Constraints still persist

Source: Status of Irrigation Development in Zanzibar – 2001, DARI

CHAPTER 2 PRESENT CONDITIONS AND CONSTRAINTS IN IRRIGATION DEVELOPMENT

2.1 Type of Irrigation Development in Zanzibar

Latest situation of irrigation in Zanzibar was investigated and be exactly unveiled. Eleven (11) existing irrigation schemes have been operated at present, of which salient features are shown in Table 2.1.1. Identified irrigated areas in both islands are summarized as follows:

Present Irrigated Area in Zanzibar

Island	Name of Scheme	Irrigated Area (ha)	Water Sources	Supported Donors
Pemba	Kinyakuzi	8.0	Stream flow	ILO
	Saninga	16.4	Stream flow	ILO
	Tungamaa	6.0	Stream flow	FAO
	Mangwena	10.0	Stream flow	ILO, FAO(SPFS) is supported now.
	Mipopooni	13.6	Spring/Stream flow	ILO
	Kwalempona	13.6	Spring/Stream flow	ILO
	Tibirinzi	6.0	Spring/Stream flow	FAO(SPFS) is supported now.
	Machigini	-	Stream flow	ILO
	Sub-total	**73.6**		
Unguja	Cheju	42.0	Groundwater	FAO
	Kibokwa	-	Groundwater	FAO
	Mwera	12.0	Stream	FAO, FAO(SPFS) is supported now.
	Bumbwi sudi	136.0	Groundwater	FAO
	Mtwango	78.0	Stream flow	FAO
	Sub-total	**268.0**		
Total		**341.6**		

Source: Result of Inventory Survey of ZIMP

Applied sorts of irrigation system on the existing schemes in Zanzibar vary depending upon the availability of water sources. In Unguja, irrigated area by groundwater exceeds the same by surface water in acreage, even though "water harvesting" has been focused recently. It is because surface water is rather less advantageous in off-taking water in Unguja. On the contrary, no irrigation by groundwater has been done in Pemba due to different topographic conditions from Unguja like that surface water is rather available in many small valleys.

In Zanzibar, even the rainfed agriculture could somehow succeed at least single harvesting due to more appropriate amount of rainfall rather than the Mainland. Therefore, "irrigation for Zanzibar" is required to be kept a development level as obtaining twice harvesting. Makeshift irrigation like a rainwater harvesting

which could cope with immediate needs was not essential in Zanzibar.

Applicability on irrigation practice varies by natural conditions, sociological condition and size of the targeted site. Advantages of the possible irrigation types in Zanzibar are summarized as follows:

Advantages of the Irrigation Type

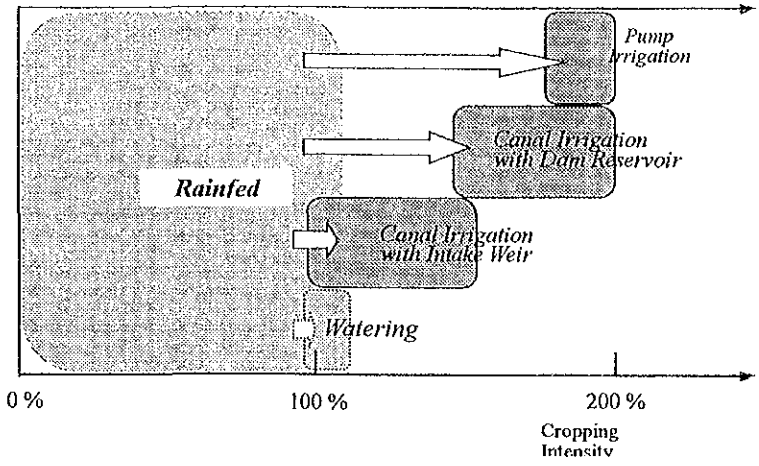
Classification	Advantages	Indispensable Conditions
Canal irrigation with intake weir	Reliable water supply could be achieved with moderate investment as far as river flow is available. O&M is rather easier due to water flowing by gravity.	It highly depends upon availability and stability of river water. Basically, it is applied for perennial flow. Obtaining a consent of other concerned water users is compulsory.
Canal irrigation with dam reservoir	High reliability and well workability in operation can be given because natural fluctuation of river water can be regulated by the water storage.	It requires higher investment for dam construction. Site suitability for dam construction is much important, and careful consideration should be given to environmental impact.
Pump irrigation	Even higher elevated area is irrigable by lifting if pump irrigation is adopted. High irrigation efficiency is expectable because of delivering water by conduit	Productivity of groundwater is essential for sustaining the scheme operation. High burden in O&M is inevitable, and periodic replacement of equipment is also needed.
Watering	Basically, it is applied for spotted area having an impounding or spring as such. High irrigation efficiency is realizable by farmers' close efforts.	It requires heavy laborious work for farmers. Reliable water source is necessary, otherwise, irrigable term is limited.

Remarks: JICA Study Team

In Zanzibar, "Pump irrigation" is the most reliable irrigation type as long as groundwater is sustainably exploitable and farmers' financial viability is ensured. "Canal irrigation with intake weir" can be applied if reliable perennial stream flow is available, in which expectable crop intensity would be moderate because irrigable area in dry season might be limited corresponding to the available discharge in the stream. Having same water source of stream flow, "Canal irrigation with dam reservoir" might be applicable if natural conditions surrounding the project's site meet to the requirement for the construction of small dam. For this irrigation type, the present crop intensity under rainfed condition could be improved significantly depending on the formable capacity of the dam reservoir.

Besides these irrigation types which would be implemented in scheme basis having certain covered area, watering could be applied for farmers themselves in farmland-plot's basis individually utilizing small impounding water and spring as such. It is expectable not to extend cropping but to stable fluctuation of production of rainfed crop caused by partiality of seasonal rain. Effects of irrigation in Zanzibar are schematically shown by irrigation type as following:

Schematic Figure for the Achievable Crop Intensity by Irrigation Type



2.2 Problems in Present Irrigation and Drainage

In spite of giving positive efforts to irrigation development in Zanzibar throughout more than twenty years, achievement in irrigation development was reported as falling far short of the expectation. In July 1990, FAO conducted a joint evaluation survey for the Project of "Development of Smallholder Oriented Irrigated Rice Production" of which the report mentioned that final development costs of the project was calculated over US$23,000 per hectare. Though the project had not only been one of irrigation development, but also an institutional building measure and a pilot/research study, it seems excessive by any standard in economic viability.

In other viewpoint of financial viability, an excessiveness from the common standard can be found especially for the cases of pump irrigation. Cost for the pump operation was estimated at US$330/ha/year in FAO project assuming lifting discharge of 3.0l/s/ha with lifting head of about 35 m in average. It must be a heavy burden of farmers, even nearly 200 % of crop intensity is achieved. It is hardly affordable unless some subsidies are given.

Furthermore, there are remarkable problems within technical aspects. As low irrigation efficiency is sometimes problematic, additional works of lining canals have been taken in the implemented schemes. The FAO's report mentioned that conveyance efficiency was averaged about 50 to 60 % compared to the designed figure of 70 %. And also lower application efficiency was pointed out due to cascade flowing field by field. General water use efficiency could be estimated at 20 to 30 %. It is rather fair compared to the situation in the Mainland, however, it should be improved because water is much valuable in Zanzibar rather than. Other noteworthy problem in technical aspect is on the matter of small dam construction. Although some number of small dams was constructed in

Pemba, those small dams do not function to reserve surplus of stream flow during rainy season because capacities of the dam ponds are extremely small compared with the requirement. It comes from inadequate topographic conditions of the sites and limitation of capital resources, however it must be a wasted halfway measure.

In these respects, problems and constraints in irrigation development in Zanzibar are summarized below:

Problems and Constraints in Irrigation Development in Zanzibar

Problem and Constraints	Content	Reasons
Economic Viability	Implementation cost of irrigation schemes were high (In the case of FAO project, it was reported at US$23,000/ha.)	It is because of inexperience and institutional inadequacy of irrigation section. Although the complicated and small shape of schemes like in Zanzibar requires comparatively high costs, there is certain room to be devised.
Financial Viability	In pump irrigation scheme, pump operation costs are not affordable for the beneficiaries.	Groundwater is only reliable water resources in those areas. Proper subsiding is compulsory, otherwise irrigation must be given up in those areas.
Technical Soundness	Adequate irrigation efficiency is not attainable.	It is caused not only impervious material of the canal construction, but also weeds' deep roots and rats-roots and so on. Farmers' neglectful water management is sometimes a significant cause for the water losses.
	Small dams do not function adequately.	Generally small dams were constructed without rational planning and designing on the basis of sound estimation for the water requirement.

Source: Internal information in the DARI

During rainy season, large amount of dairy rainfall sometimes with high magnitude rainfall intensity occurs frequently. Drainage is serious problem in somewhere especially in Pemba. Perimeter drainage and side slope protection for irrigation scheme development in Pemba are required.

As a reference, the identified technical problems by the FAO teams on the study of "Status of Irrigation Development in Zanzibar – 2001" is shown below:

Identified technical problems on the study of "Status of Irrigation Development in Zanzibar"

Identified Problems	Information
Substantial Irrigation Water Losses	This is due to a high infiltration and or percolation rate in the development plots, earth irrigation canals due to light textured soil in most schemes, numerous crab holes and weeds, and or poor construction. Valuable scarce water is pumped at a high cost and 60 % of it is lost.
Topography and Canal Construction Problems	This is due to serious errors during surveying. It leads to poor/inadequate design. Most of the raised land areas are not irrigated because of this anomaly.
Very Small Size of Farmers Rice Holding	Most farm families have two plots of 0.1 ha each. This is not only insufficient but also uneconomic.
Pumps	There are frequent breakdowns of pumps due to inadequate maintenance and lack of spare parts. The diesel driven pumps are too expensive to maintain. There is also frequent collapse of the brothels, due to probably, (i) Poor design of boreholes, (ii) Poor borehole construction, and (iii) Over extraction of groundwater.
Machinery	Both land development and farm machinery together with their implements have deteriorated beyond repair. The remaining small fleet of farm machinery is often out of order due to lack of maintenance and spare parts. The serious problems inevitably lead to; (i) Low yield per season, (ii) Less land cropped, and (iii) Large proportion of developed land left un-irrigated or completely abandoned.

Source: Status of Irrigation Development in Zanzibar – 2001

CHAPTER 3 IRRIGATION DEVELOPMENT LEVEL

3.1 Needs for Benchmarking of Irrigation Development Level

Available variations of irrigation type in Zanzibar are restricted, and alternatives in irrigation development level are also limited. However, knowledge on optimum irrigation development level and suitable irrigation modality are indispensable in order to succeed irrigation development effectively. Irrigation development in Zanzibar has been executed without certain authorized guidelines prescribing for irrigation development level. In this Study, a knowledge on irrigation development level and irrigation modality is put in order.

Although there are not a lot of irrigation schemes implemented so far in Zanzibar, differences in technical aspects among the implemented schemes are conspicuous even to take variation of characteristics in regional conditions into consideration. If adopting various irrational irrigation development levels in different schemes' implementations, it may bring about; (i) ineffective utilization of limited resources to be appropriated to irrigation development, (ii) complaining of farmers concerned to the irrigation schemes being in depleted level, (iii) confusion in expansion of model effects to other areas, and (iv) complexity in supervising and monitoring irrigation schemes together with others which are under different development levels.

3.2 Concept of Irrigation Development Level

Irrigation development level of implementing irrigation schemes are optional in some aspects, and not optional in others which are under critical situation. There are no other choices in water source selection if available water are scarce, for instance, groundwater is only one option allowable for the areas where have no streams. On the contrary, features like dam type whether earth fill or concrete, and dimensions of dam height and so on are considerably optional. These might be decided alternatively taking other factors into consideration.

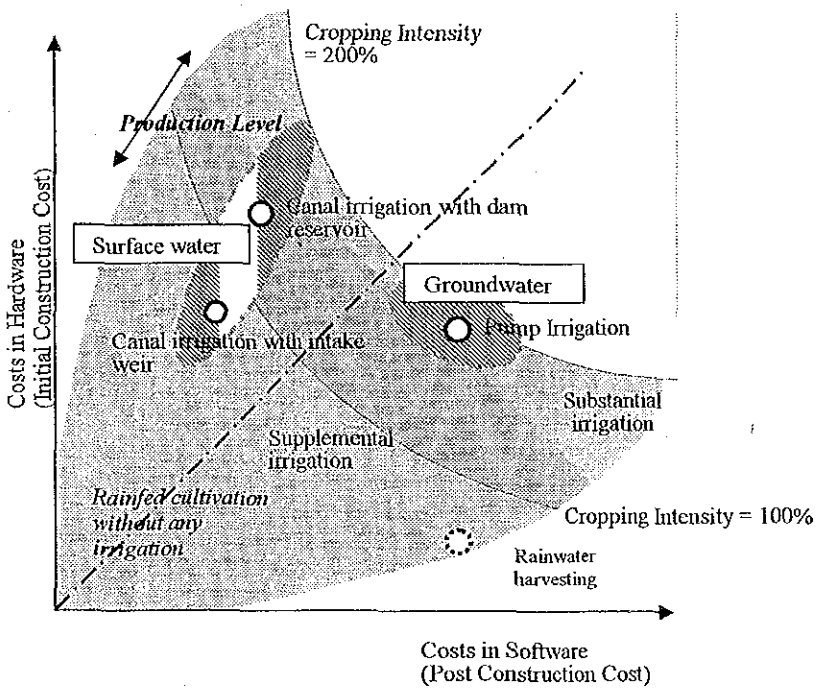
In Zanzibar, four irrigation types are allowable in general, namely, pump irrigation, canal irrigation with dam reservoir, canal irrigation with intake weir, and watering. Considering advantages of each irrigation type, these irrigation types could be put in order in the relation among level of expectable benefit, required initial costs and required post-construction cost as follows:

Relation of Three Factors by Irrigation Type

Irrigation Type	Expectable benefit	Required initial costs	Required post-construction cost
Canal irrigation with intake weir	Low - Medium	Medium	Medium
Canal irrigation with dam reservoir	Medium - **High**	**High**	Medium
Pump irrigation	**High**	Medium	**High**
Watering	Low	Low	Medium - **High**

These situations could be characteristically shown in two-axis graph of Costs in hardware and Costs in software as shown below:

Relation between Hardware and Software



Irrigation type is incidentally selected depending upon scheme's site condition. For the case of canal irrigation utilizing surface water, some range of irrigation development level are selectable within the scope of canal irrigation system. Even for pump irrigation type, development levels in efficient performance or operational life of equipment and so on are also selectable.

3.3 Concept of Guideline of Irrigation Development Level

Required guideline for irrigation development level must be an indication of principles on technical decision making for irrigation scheme implementation, and not always required to obey formalistically. Sometimes, it may be given broad

interpretation flexibly depending upon peculiarity of scheme site.

At the same time, it should not be a criterion for scheme selection or prioritization. Some criteria for scheme selection were prepared in several irrigation development projects/programmes. However, the guideline for irrigation development level is required one that is essentially different from the criteria for scheme selection in those purposes. Scheme selection is generally based on an intention that schemes being below standard shall be prevented from intervention. On the contrary, guideline for irrigation development level is based on a mind that farmers in every area may practice irrigation as far as they want. In that respect, farmers are naturally restricted their irrigation practice within allowable range of irrigation development corresponding to the development potential of their own areas. Required guideline for irrigation development level could show a possible and most suitable modality of irrigation development by irrigation development pattern on the basis of recognition of potentiality and limitation of irrigation development of the relevant area.

3.4 Classification of Irrigation Development Type

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

In the ZIDP, no concrete description on irrigation development type was given, but only following priorities on infra-structural improvement including irrigation facilities were proposed in the ZIDP:

(i) **Rehabilitation of Existing Schemes**:	Required repairs and allowable extensions concerning to the existing schemes was aimed at, emphasizing importance of improvement of water management. Perimeter drainage and side slope protection was also highlighted.
(ii) **New Irrigation Schemes**	Community based promotion and fulfillment of scheme implementation was proposed. No proposal on modality and method of irrigation was given.

No informative guidelines on irrigation development methods and irrigation development level were given in the ZIDP. Therefore, it is required to indication initiative idea on irrigation development modality and its level for Zanzibar in this ZIMP.

Referring to other classification of irrigation types in the Mainland analyzed in this Study, irrigation development types in Zanzibar is classified into following types from three different angles, namely, scheme style, kind of water source, and scale of scheme.

Classification of Irrigation Development Type

Scheme Type	Rehabilitation of existing scheme			New irrigation scheme		
Water sources	Ground water	Surface water	Rain water harvesting	Ground water	Surface water	Rainwater harvesting
Individual irrigation	-	R-I-S	R-I-W	-	N-I-S	N-I-W
Small-scheme	R-S-G	R-S-S	-	N-S-G	N-S-S	-
Medium-scale	R-M-G	R-M-S	-	N-M-G	N-M-S	-
Extensive-scale	R-E-G	R-E-S	-	N-E-G	N-E-S	-

Note: above irrigation development pattern is shown in (Scheme type) – (Scale of scheme) – (Water source), where,

(Scheme type), R: Rehabilitation of existing scheme, N: New irrigation scheme

(Scale of scheme), S: Small-scale. M: Medium-scale, E: Extensive-scale

(Water source), S: Surface water, G: Groundwater, R: Rainwater harvesting

According to the related statements of Government of Zanzibar, "Water harvesting" is broadly interpreted like supplying irrigation water from surface water. Within the classification shown above, the irrigation type so far called as "Water harvesting scheme" is correctly categorized into the schemes irrigated by surface water. "Individual irrigation" practice on the above classifications has a special characteristic. Size of the individual irrigation is smaller than the small-scale scheme, moreover, it would be implemented on the basis of farmers' initiative without public intervention. Farmers could apply individual irrigation as far as there is available water source around their farmlands.

Furthermore, these classifications may be subdivided into by water abstraction. For the irrigation types categorized into "for surface water", those could be subdivided into "by intake weir" or "by dam reservoir". The sub-classification would be utilized as required, it might not always be considered for the case of general purpose.

3.5 Guideline of Irrigation Development Level

Guideline of irrigation development level shall be in a form of giving indications in selected indicators by irrigation development type. Seven(7) indicators on irrigation development level are extracted among many prospective ones, taking

views in Sustainability, Adoptability and Feasibility of scheme implementation into consideration, namely, (i) Project scale, (ii)Water resources availability, (iii) Satisfying site condition, (iv) Type of irrigation facilities, (v) Requirement for land development works, (vi) Allowable costs, and (ix) Project life. Applicable indications in these indicators are outlined as follows:

Guidelines of Irrigation Schemes Implementation by Irrigation Type

Items	Irrigation Type			
Irrigation Type	Pump Irrigation	Canal Irrigation with Dam Reservoir	Canal Irrigation with Intake Weir	Watering
Irrigated area (Rainy season)	X_1	X_1	X_1	X
Irrigated area (Rainy season)	X_2	X_2	X_2	-
Water Resources	Groundwater: discharge>2.0xX_2l/sec Lifting head< about 30 m.	Stream flow:	Stream flow: low flow discharge or spring yield> 3.0xX_2l/sec	Individual impounding, spring or well
Site conditions	Site having exploitable groundwater yield more than the above	Proper dam site having storage capacity of more than 11,000x X_2 m^3	Proper weir site for construction	-
Proposed modality of water resources development facilities	Appropriate and manageable pumping set with high efficiency	Concrete(or fill) dam with proper spillway (silt excluder if necessary)	Concrete (or gabion) weir	-
Type of canal	Conduit or lining canal	Lining canal	Earthen canal or partly lining canal	-
Land Development works	As required	As required	Not required in general	-
Allowable costs	~US$8,000x$X_2$	~US$8,500x$X_2$	~(US$3,000x$X_1$+ US$5,000xX_2)	~ US$2,000xX
Project life	~25 years	30~50 years	~30 years	-
Remarks	Proper subsiding for operation costs is required for sound farm financial viability	Perimeter drainage and side slope protection is required	Perimeter drainage and side slope protection is required	Farmers could practice individually depending upon its possibility

(1) 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 extensive scale (bigger than the medium) are stipulated. It is difficult to stick to the rule in categorizing into the irrigation classes, however, three classes of irrigation scheme are specified by the covered area as follows:

Indications in Project Scale

Irrigation class	Covered area (ha.)	Remarks
Small-scale	~50	Assuming to adopt single block for irrigation rotation
Medium-scale	50~100	
Extensive-scale	100~	

Boundary value of the small-scale class of 50 ha was fixed assuming to apply rotational irrigation as a rotational unit block of 50 ha.

Designated values of irrigation area in the above table, were 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. According to the result of the Inventory Survey, most of the candidate schemes are categorized into the small-scale. Especially in Pemba, almost all schemes are classified into the small-scale reflecting the peculiar characteristic of its topography.

(2) Water resources availability

Water resources availability is the most important factor for the formulation of scheme implementation. In other words, irrigable area of schemes during dry season is determined by the availability of water resources. Net water requirement for rice production in Zanzibar could be estimated at about 1.0 l/sec/ha at the most. Required gross water requirement are highly influenced by the probable irrigation efficiency. Even though gross water requirement of 3.0 l/sec/ha has been popularly applied in Zanzibar in anticipation of poor irrigation efficiency, shortage of irrigation water supply was frequently caused due to more inferior irrigation efficiency in actuality.

However, gross water requirement of 3.0 l/sec/ha seems to be reasonable for the case of applying earthen canal on condition that fair construction and management of facilities especially irrigation canal could be performed. In the case of applying lining canal or conduit, rather smaller gross water requirement par ha may be adopted. Water resource availability decides irrigable area in scheme development under the profound influence of irrigation efficiency.

As to the pump irrigation, not only quantitative availability but also required head for lifting should be considered because it is directory related to a burden in scheme operation.

(3) Satisfying site condition

Proposed site should be satisfied required physical conditions in order to ensure feasibility of the project implementation. Pump scheme is absolutely specified its development feature by the possibility of exploitation of groundwater. For the case of dam construction, topographical and geological situation are essential for feasibility of scheme implementation. Irrigable area in dry season is certainly restricted within allowable limit by the secured storage capacity of dam reservoir. In further stage of scheme development, detailed and specified study/investigation in concerned fields are required to carry out at the site.

(4) Type of irrigation facilities

Types of irrigation facilities have several range of option depend upon solidarity of facilities and convenience for water utilization. It highly relates with affordability of the scheme. For the case of pump irrigation, advanced and good facilities might be selected as long as being within adequate economic viability of the scheme. Electric-motor powered pump is recommended rather than in viewpoint of economy and sustainability as long as steady current is available with low unit price of electricity.

For the case of surface water irrigation, it is generally depending upon expected benefit. Concrete or gabion weir could be opted for in consideration of not only economy of project but also easiness of construction and availability of materials at the site. Concrete or fill type of dam is also decided on in consideration of situation of dam foundation and advantage for water storage.

(5) Requirement for land development works

If water-standing paddy cultivation is newly introduced on the irrigation development, proper land development works like land leveling and equipping of field channels and drainage are required. Costs for the land development works are influenced by the sorts of works included and workability of heavy equipment. According to the previous experiences, a cost of the land development works varies from US$4,000/ha to US$8,000/ha.

For the schemes in Pemba, it seems to be problematical to fulfill land development works due to unfavorable site condition for construction works like narrowed shape of the site. Land development works may not be recommended in Pemba, if only drainage improvement is considered properly.

(6) Allowable costs

Allowable cost of scheme implementation is a topical subject. Adequate project cost must be varying corresponding to the own circumstances of the project. Affordable range of irrigation project cost is subject to affordability and admissibility of a project executor concerned, and project economy. It would be decided at the minimum one among the values. For the case of canal irrigation with dam reservoir as well as pump irrigation, relatively higher allowable cost could be given because of much benefiting by increasing cropping intensity for supplying water during dry season sufficiently. On the contrary, for the case of canal irrigation with intake weir, lesser allowable cost could be allocated because of supplying little water during dry season. In such case, stable irrigation water supply during rainy season is a major project benefit.

Standard allowable unit costs are indicated in the guideline shown above. Irrigation scheme should be designed optimally to meet planning requirement. The indicated range of allowable unit costs by irrigation development type imply that optimal plan of scheme implementation might be settled within the range of costs.

(7) Project life.

Project life is a life expectancy of the constructed irrigation facilities, which is optimally selected taking expected project performance and circumstances surrounding the project into consideration. Generally, the project life is selected to an optimized point of the relation of input and output concerning to 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. It must be at best 50 years. If applying solid concrete made facility, project life of 50 years is applicable, otherwise, decision between the range from 20 years to 30 years is safer as a matter of fact. Anyhow, it is under an assumption that proper O&M and replacement of the facilities would be done.

For the case of pump irrigation, it is restricted by the expectable life of pump equipment. In case, expectable project life is smaller than the standard, for instance due to overflowing reservoir by sedimentation earlier for the surface irrigation by dam reservoir.

CHAPTER 4 WATER RESOURCES POTENTIAL IN ZANZIBAR

4.1 General Environment in Water

(1) Climate and Hydrology

The climate of Zanzibar is dominated by two annual and reliable wet seasons, the Masika rains from the south through March to May, and the Vuli rains from the northeast during November and December. The wet season showers and storms are usually scattered, local, torrential and of short duration. Average rainfalls for north Unguja are 1,800 mm and for south Unguja 1,500 mm. Pemba receives a higher rainfall with a similar irregular pattern of Unguja, at 2,000 mm on average, which trends from a high 2,500 mm in the south to a low 1,500 mm in the northeast.

Rainfall is a meteorological factor that has been collected continuously for the longest period of time in Zanzibar. Rainfall stations which give relatively reliable rainfall data in Zanzibar are tabulated with its average rainfall as follows:

Rainfall Stations and Its Record of Average Annual Rainfall

Unguja			Pemba		
Station	Average Annual Rainfall (mm)	Duration of Observation	Station	Average Annual Rainfall (mm)	Duration of Observation
H. Mchana	1,587	1950-91	Chake Chake	1,797	1952-90
Chwaka	1,460	1051-55	Chambani	1,531	1950-88
Kisauni	1,623	1952-92	Kigomasha	1,584	1950-91
Kisongoni	1,297	1950-91	Limbani	1,960	1950-86
Kizimbani	1,857	1950-92	Mtambile	1,891	1950-91
Makunduchi	1,453	1950-92	Mkoani	1,812	1950-91
Mkokotoni	1,863	1951-71	Ole	1,542	1950-91
Mkwajuni	1,946	1950-91	Wesha	1,912	1950-91
Muongoni	1,567	1950-91	Wete	1,571	1950-92
Mwera	1,642	1950-91	Mtanga Fwani	1,751	1950-91
Selem	1,515	1950-91	Karume	1,716	1974-92
Tunguu	1,265	1955-93			
Victoria Gardens	1,459	1951-91			
Pangani	1,626	1966-93			

Source: Zanzibar Water Resources Development Project (ZWRDP), Annex B, 1994

Utilizing above given values of annual rainfall, isohyt-graph was newly prepared in Unguja and Pemba, those are shown in Figure 4.1.1 and Figure 4.1.2, respectively.

Few streams flow into sea, as most become lost in the peripheral limestone flowing directly into a cave, it is called as "Pokezi". On the other hand, some streams flow underground for short periods, re-appearing occasionally as spring zone.

(2) Surface Water

River discharge have been observed and arranged its record only for eight major river basins in Unguja. Even though limited discharge data are available since 1997 in Unguja, features in flow regime were overviewed as follows:

Salient Features in Flow Regime in Unguja

Name of river	Catchment Area (km^2)*	Length (km)	Annual Specific Discharge ($m^3/sec/100km^2$)	Drains into **	Concerned Irrigation Scheme
Mwera	28.0	20.0	1.70	Pokezi	Mwera, Mtwango
Kipange	15.0	9.0	1.67	Indian Ocean	Kipange
Mwanakombo	10.0	9.2	1.78	Indian Ocean	Chechle/Mahonda
Zingwe-zingwe	9.0	25.5	0.77	Indian Ocean	-
Bwabwaja	3.6	6.0	1.33	Pokezi	Chaani
Mawe	4.5	5.3	1.07	Pokezi	Kibokwa
Kinyasini	7.6	9.7	1.10	Pokezi	Mgambo
Pangeni	8.6	23.0	1.07	Pokezi	Pangeni
Average			1.31		

Source: Report on Surface Water Availability in Unguja, by MALANR, June 1999

** : Catchment area is not always covered full catchment, but it is area at the site of the observation.*

*** : "Pokazi" means not to drain into Indian Ocean but to drain into the coral limestone.*

Almost all of rivers in Unguja flood rapidly having peak discharge several times, but very low flows or no water are seeable during dry season. Averaged annual specific discharge of 1.31 $m^3/sec/100km^2$ is considerably abundant, as it is more than five times of the same in the Mainland. However, ephemeral characteristic of flow regime is a fatal attribute of small area of catchments likely in Zanzibar.

Although no periodic observation of stream discharge has been carried out in Pemba, river regime is similar with the same in Unguja. Additionally, as rivers in Pemba form small valleys having more complicated topographical features, perennial current with delicate flow or intermittent flow are outstanding rather than Unguja.

Within the Study of the Zanzibar Water Resources Development Project (ZWRDP), river discharge observation was carried out for eight rivers in Unguja during over three months from April to June in 1994. It was mentioned in the report that possible sources of surface water lied along the ridge system in the north west of Unguja only. Results of the observation was too short to unveil stream flow system, however, a runoff efficiency was newly obtained at 30 % to 50 % through comparing the amount of river discharge and rainfall.

(3) Hydrogeology

Unguja and Pemba islands are part of the ancient Miocene Rufiji/Ruvu river delta, which are presently 2,560 m section of rhythmic sediments, and mainly marls, clays and clayey sands. Unguja is a complex junction of four blocks with evidence of past artesian leakage with ferruginous and siliceous cements, and anhydrite deposits over most of eastern Unguja. Whereas Unguja still retains extensions of mainland structures, mainly prior stream systems. On the other hand, Pemba is a simple fault block and raised higher than Unguja, it is thus composed of lower stratigraphic rocks of which structures do not continue on to Pemba. The topography can be separated into distinct landforms which relate directly to the geologic condition:

- the undulating and elevated to precipitous and broken Miocene country rock,
- the channel country, in Unguja and on the east coast of Pemba,
- the flat coastal periphery or "coral rag" country, developed mainly on Unguja and to a lesser extent on Pemba

Generally, all the Unguja and Pemba strata have aquifer potential to a greater or lesser extent, having measurable permeability and porosity. Aquifer extend as reflecting the characteristics in hydrogeology and topography.

Hydrogeological Status in Unguja

Structures	Aquifer	Storativity	Average seasonal fluctuation	Water quality (Ec:mmhos)	Active area (km2)	Annual water availability based on 10 m water table curve (m^3x10^6/mms)			
						Zero drawdown	1 m drawdown	2 m drawdown	3 m drawdown
Quaternary	$Q_3Q_2Q_1$	25 %	1.67 m	<500	56	23.38/420	37.38/670	51.38/920	65.38/1170
				>500	51	21.29/420	34.04/670	46.79/920	59.54/1170
Lower Miocene	M_1	15 %	3.27 m	<500	36	17.66/490	23.06/640	28.46/790	33.86/940
				>500	177	86.82/490	113.37/640	140.00/790	166.47/940
	M_3	7 %	7.91 m	<500	146	80.84/553	91.06/624	101.28/694	111.50/764
				>500	21	11.63/553	13.10/624	14.57/694	16.04/764
Total					487				

Source: Hydrogeological Map of Zanzibar, UNDTCD, 1987

In Pemba, the quaternary aquifer do not exist, extending only aquifer of elevated country rock areas, similar of the Miocene M_3. It extends Pemba Island at about 650km^2. The aquifer is extremely friable and running sands are problematic.

4.2 Previous Studies on Assessment of Water Resources Potential

The Zanzibar Water Resources Development Project (ZWRDP) is only one of comprehensive water resources potential assessment study so far carried out. The study was conducted in 1994 in line with a Water Resources Management Strategy for Zanzibar. The report concluded and proposed a water resources management strategy for Zanzibar on the basis of the results of assessment of

water resources of the both islands, and outcomes on water resources utilization and constraints for development. The ZWRDP was concluded following aspects at the back of the report:

- Acceptable yields of groundwater were estimated for Unguja and Pemba from the viewpoints of quantity and quality, 292 MCM and 46 MCM, respectively.
- As to groundwater potential, it was identified that "storativity" was the most essential factor for the aquifers,
- It was identified that the percentage of rainfall recharging the aquifers was much lower on Pemba than on Unguja,
- A significant increase in salinity has been measured in a number of areas on Unguja compared with data from 10 years ago. These areas include Jumbi, Kinyasini, Chwaka and Makunduchi.

It is still effective and useful, however it might be required to commence an updating assessment reflecting the situation change and new information during last about one decade.

4.3 Macroscopic Water Balance in Zanzibar

Macroscopic water balance based upon annual hydrological cycle is estimated for the both islands as follows:

Macroscopic Water Balance in Unguja

Zone	Area (km^2)	Unit	Anntial Rainfall	Evaporation Loss	Surface Runoff			Groundwater Recharge		
					Stream flow	Non-strea m	Total	Annual yield	flows to the sea	Total
1	81.2	MCM	122.60	49.04	2.65	46.92	49.57	14.50	9.49	23.99
		mm	*1,509.1*	*603.6*	*32.6*	*577.5*	*610.2*	*178.5*	*116.8*	*295.3*
2	159.2	MCM	251.80	97.49	85.78	0.00	85.78	33.49	35.04	68.53
		mm	*1,582.0*	*612.5*	*538.9*	*0.0*	*538.9*	*210.4*	*220.1*	*430.6*
3	180.7	MCM	289.90	115.96	0.00	101.54	101.54	34.07	38.33	72.40
		mm	*1,604.1*	*641.6*	*0.0*	*561.9*	*561.9*	*188.5*	*212.1*	*400.6*
4	187.4	MCM	285.10	114.04	0.00	111.42	111.42	24.05	35.59	59.64
		mm	*1,521.7*	*608.7*	*0.0*	*594.7*	*594.7*	*128.4*	*190.0*	*318.3*
5	99.5	MCM	134.20	53.68	0.00	61.39	61.39	7.45	11.68	19.13
		mm	*1,349.0*	*539.6*	*0.0*	*617.1*	*617.1*	*74.9*	*117.4*	*192.3*
6	119.4	MCM	178.10	71.24	26.90	44.69	71.59	17.02	18.25	35.27
		mm	*1,491.9*	*596.8*	*225.3*	*374.4*	*599.7*	*142.6*	*152.9*	*295.5*
7	273.6	MCM	391.90	156.76	0.00	105.14	105.14	91.67	38.33	130.00
		mm	*1,432.5*	*573.0*	*0.0*	*384.3*	*384.3*	*335.1*	*140.1*	*475.2*
8	117.7	MCM	174.40	69.76	0.00	67.89	67.89	23.97	12.78	36.75
		mm	*1,481.5*	*592.6*	*0.0*	*576.7*	*576.7*	*203.6*	*108.6*	*312.2*
9	439.4	MCM	616.60	246.64	0.00	226.95	226.95	60.88	82.13	143.01
		mm	*1,403.4*	*561.3*	*0.0*	*516.5*	*516.5*	*138.6*	*186.9*	*325.5*
Total	1,658.0	MCM	2444.60	974.61	115.33	765.94	881.27	307.10	281.62	588.72
		mm	*1,474.4*	*587.8*	*69.6*	*462.0*	*531.5*	*185.2*	*169.9*	*355.1*

Source: The Development of Water Resources in Zanzibar, MWCELE, 1994

Macroscopic Water Balance in Pemba

Zone	Area (km^2)	Unit	Annual Rainfall	Evaporation Loss	Surface Runoff			Groundwater Recharge		
					Stream flow	Non-strea m	Total	Acceptable yield	flows to the sea	Total
1	225.6	MCM	353.30	141.32	166.21	18.47	184.68	8.32	18.98	27.30
		mm	1,566.3	*626.5*	*736.9*	*81.9*	*818.7*	*36.9*	*84.1*	*121.0*
2	286.6	MCM	458.50	183.40	217.39	24.15	241.54	14.40	19.16	33.56
		mm	1,599.6	*639.8*	*758.4*	*84.3*	*842.7*	*50.2*	*66.8*	*117.1*
3	182.2	MCM	290.50	116.20	137.29	15.25	152.54	8.07	13.69	21.76
		mm	1,594.2	*637.7*	*753.4*	*83.7*	*837.1*	*44.3*	*75.1*	*119.4*
4	148.7	MCM	222.10	88.84	103.31	11.48	114.79	10.26	8.21	18.47
		mm	1,493.3	*597.3*	*694.6*	*77.2*	*771.8*	*69.0*	*55.2*	*124.2*
9	141.8	MCM	200.70	80.28	93.47	10.39	103.86	2.32	14.24	16.56
		mm	1,415.0	*566.0*	*659.0*	*73.2*	*732.2*	*16.4*	*100.4*	*116.8*
Total	985.0	MCM	1525.10	610.04	717.67	79.74	797.41	43.37	74.28	117.65
		mm	1,548.3	*619.3*	*728.6*	*81.0*	*809.6*	*44.0*	*75.4*	*119.4*

Source: The Development of Water Resources in Zanzibar, MWCELE, 1994

For Unguja, around 307 MCM of groundwater is exploitable and 70 MCM of stream discharge are utilizable at maximum according to the water balance. Concerning to these water resources potential, water demands were forecasted to 2015, shown as follows: Total demands of 57.2 MCM in 2015 was expected to supply by groundwater in Unguja. It may say to be suppliable as far as quantitative potential of groundwater. Furthermore, surface water is still usable in some manners.

Water Demand Forecasting in Unguja

Water Demand	1994	...	2002	...	2015	...	2020	Remarks
Urban water supply	4.9	→	→	→	14.9			
Rural water supply	7.5	→	→	→	10.4			50 lpcpd applied
Irrigated agriculture	2.4	→	→	→	22.3			Bumbwi/Sudi, Cheju complete, and Kibokwa (182ha)->(1712ha)
Industrial	3.3	→	→	→	8.8			in ZUWSP
Tourism	0.1	→	→	→	0.8			(1110beds)->(8553beds)
Total	18.2	→	→	→	57.2			

Source: The Development of Water Resources in Zanzibar, Final Report, Oct., 1994

For Pemba, around 43 MCM of groundwater is exploitable and 717 MCM of stream discharge are utilizable at maximum according to the water balance. Concerning to these water resources potential, water demands were forecasted to 2015, shown as follows: Total demands of 10.9 MCM excluding irrigation purposes in 2015 was expected to supply by groundwater with certain surplus in Pemba. Irrigation water could be supplied by surface water as long as being possible to take off. Potential of water source for irrigation is not critical quantitatively in Pemba.

Water Demand Forecasting in Pemba

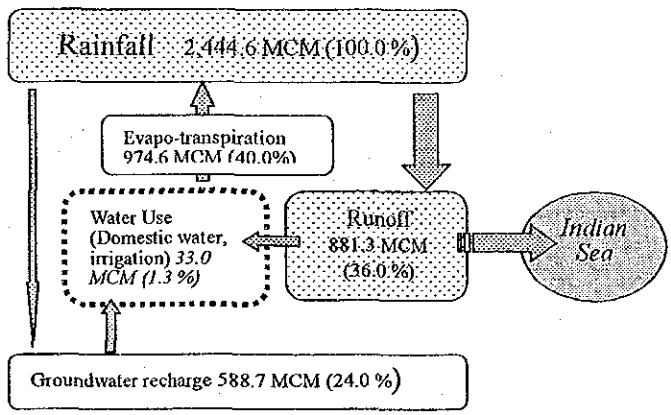
Water Demand	1994	・・・	2002	・・・	2015	・・・	2020	Remarks
Urban water supply	2.2	→	→	→	4.8			
Rural water supply	4.3	→	→	→	6.0			50 lpcpd applied
Irrigated agriculture	1.6	→	→	→	-			(124ha)->(- ha)
Industrial	0.0	→	→	→	0.0			
Tourism	0.0	→	→	→	0.1			(0beds)->(125beds)
Total	8.1	→	→	→	10.9			

Source: The Development of Water Resources in Zanzibar, Final Report, Oct., 1994

Additionally speaking, above discussion was focused on quantitative aspect in natural condition, no problematic phenomena have been reported excluding an incident of intrusion of sea water due to over-pumping. Furthermore, at the moment, no water rights are systemized in Zanzibar. From now on, regulations and water right systems must be operated avoiding conflicts between water users.

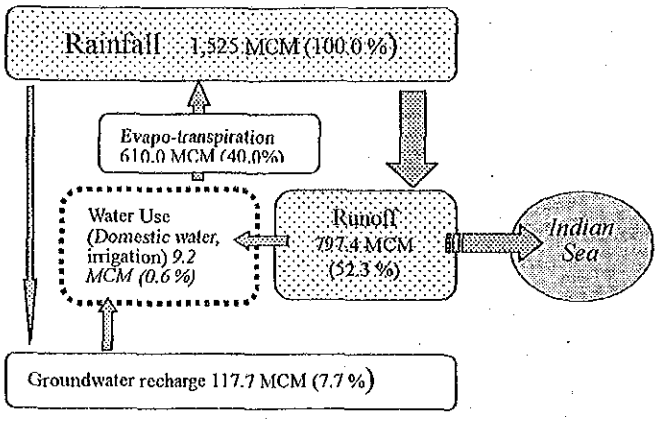
Consulting to the obtained results, hydrological cycle in Unguja is schematically shown in following figure:

Schematic Figures of Hydrological Cycle in Unguja



Also the same in Pemba is schematically shown in following figure:

Schematic Figures of Hydrological Cycle in Pemba



4.4 Pre-identified Water Resources Potential for Irrigation Development

Through carrying out of the Inventory Survey, all possible irrigation development schemes were identified during the Study. The Scheme-wise development plan which is a comprehensive scheme implementation plan as the results of screening and scooping of schemes, is described within the Master-Plan. In this section, an explanation for the supplemental analysis on water resources development which was carried out prior to the formulation of the Scheme-wise development plan, is given.

During the Study, possibility of small-dam construction was assessed thoroughly for the proposed schemes of which site conditions seemed to be allowable to reserve water by a dam facility especially in Pemba. The investigation on small-dam construction was carried out under following procedures and assumptions:

- Narrow parts of river bank were picked out along the rivers in search of possibility of small-dam construction on the topo-map at the scale of 1 to 10,000,
- If the site picked out seems to be possible to construct dam, catchment area concerning to the dam site was measured,
- Rough dimensions of the allowable dam were designed in consideration of topographic conditions,
- Submerged area of dam reservoir was outlined taking the designed dam height into consideration,
- Reservoir capacity of the dam was calculated,
- Irrigable area to be supplied water from the dam reservoir during dry season was estimated dividing the calculated reservoir capacity by the unit water requirement par ha of 11,000 m^3/ha. The unit water requirement was obtained through an analysis of dam operation.

Through carrying out of the investigation, totally 44 dam sites (Ungja:4, Pemba:40) were identified, and 41 dam sites (Ungja:4, Pemba:37) out of the all candidate sites were confirmed possibility of dam construction in the preliminary survey level as shown in Table 4.4.1.

Results of the investigation on small-dam construction are summarized as follows:

Summary of the Investigation on Small-dam Construction

Island	Number of investigated sites	Number of identified sites	Total Concerned Catchment Area (ha)	Total Identified Storage Capacity (m^3)	Total Area of Concerned Project (ha)	Identified irrigable area during dry season (ha)
Pemba	40	37	6,628	6,806,300	1,246	618.8
Unguja	4	4	1,400	2,170,000	1,200	1,05.0
Total	44	41	8,028	8,976,300	2,446	1,668.8

Source: Analyzed result by the DARI

In Pemba, total expected capacity of dam reservoirs of 6.81 MCM were confirmed through these investigations, and 2.17 MCM of the reservoir capacity of Kipange Dam was confirmed but other dams were not confirmed due to lack of information in Unguja.

Table

Table 1.1.1 Proposed Activities in ZIDP

Proposed Activities	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Present Status
Background																						
- Present the Draft ZIDP																						Drafted as it was
- Prepare the Final ZIDP																						Not yet finarized.
- Funding preparation and negotiations																						Not yet funding
Study and Research																						
- Finalise WUA legal framework																						
- Review and revise land tenure laws																						
- Socio-economic baseline survey at exiting schemes.																						
- Establish the opportunity cost of water																						
- Study opportunities and method for capital cost																						
- Assess Pemba's surface water resources																						
- Assess Pemba's groundwater resources																						
- Assess upland irrigation possibilities for Pemba																						
- Design a rural credit programme																						
- Prepare operation and maintenance guidelines																						
- Establish recurring cost recovery system at scheme																						
- Crop diversification studies																						
- Monitoring of local and export markets																						
- Downsize Irrigation Section (Workshop)																						
- Downsize Irrigation Section (Studies)																						
- Evaluate private sector capabilities																						
- Mechnisation studies																						
Institutions and Human Resources																						
- Downsize Irrigation Section																						
- Train and strengthen extension services																						
- Establish data resources and facilities																						
- Train the private sector																						
- Establish/strengthen water boards																						
- Strengthen input supply institutions																						
- Strengthen distribution and marketing institutions																						
- Initiate charging system for irrigation water																						
- Initiate rural credit programme																						
Schemes																						
- Socio-economic baseline survey at new schemes.																						
- Scheme rankings in Pemba																						
- Community conscientisation for existing schemes																						
- Side slope protection on Pemba																						
- Interception drainage on Pemba																						
- Sensitise local authorities																						
- Establish WUA's																						
- Community conscientisation for new schemes																						
- Participatory based planning and design of new scheme																						
- Labour based implementation of new scheme in Pemba																						
- Implementation of new scheme in Unguja																						
Long Term																						
- Train communities in operation & maintenance																						
- Community based operation & maintenance																						
- Capital cost recovery																						
- Recurring cost recovery																						
- Update scheme ranking																						

Table 2.1.1 Present Status of Fanctioning Existing Irrigation Schemes in Zanzibar

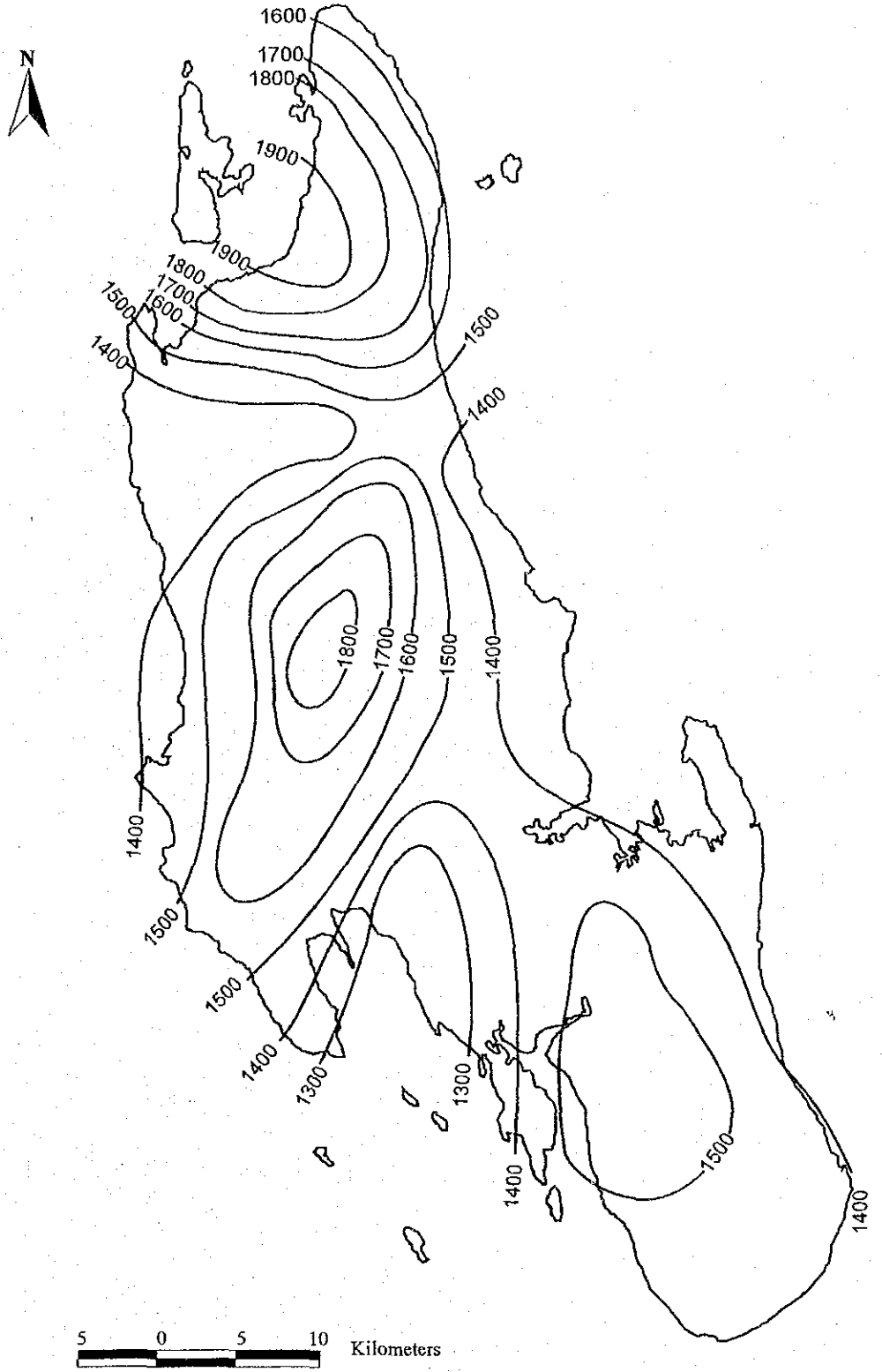
Island	Scheme	Region	District	Area (ha)		Present Condition
				Actual	Potential	
Pemba	Kinyakuzi	South	Central	8	40	Part A has been developed and would appear to be well maintained although theft of moveable infrastructure is a problem. Also there remains a tendency to leave much of the operation and
	Saminga	North	Michewen	16.4	38	It is an irrigation scheme of gravity fed surface and spring water.
	Tungamaa	North	Wete	6	33	It is an irrigation scheme of gravity fed surface
	Mangwena	North	Wete	10	29	Three parts of covered areas, parts A, B, and C has been developed as a gravity fed surface water scheme. The part A remains traditional rainfed.
	Mipopooni	North	Wete/ Michewen	13.6	65	It is a modern irrigation scheme of gravity fed surface water.
	Kwalempona	North	Wete/ Michewen i	13.6	53	It is an irrigation scheme of gravity fed surface water divided into 12 parts. The part A was completed, and the part B has been implemented.
	Tibirinzi	South	Chake Chake	6	25	It is an irrigation scheme of gravity fed surface and spring water. There were no water management structures however, valley side slopes were fragile and unprotected.
	Machigini	South	Mkoani	0	547	It is an irrigation scheme of gravity fed surface water. But failed due to lack of familiarity with
Unguja	Cheju	South	Central	42	1,198	Three bore holes were equipped with 30 l/s pump each, with lister diesel engines. They perform fairly good, with little sand pumping. Improvement on screens and filter materials may be required.
	Kibokwa	North	North"A"	0	250	The two boreholes' performance were still good, however the diesel engines failed. The engines could not be repaired due to unavailability of replacement parts.
	Mwera	Urban West	West	12	12	It is gravity surfaces scheme comprising 10 ha smallholder and 2 ha seed production. Leaked headworks has been rehabilitated under FAO/SPFS. Canals have also been reapired.
	Bumbwi sudi	Urban West	West	136	560	Fifteen holes were equipped with 30 l/s pumps, with diesel engines, later replaced by electric motors to irrigate about 130 ha. Four pumps among them collapsed, and other four pumps are under poor performance. Remaining pumps are still good performance.
	Mtwango	Urban West	West	78	120	The borehole is used for domestic water supply by small hand pump. There have been no problems with the borehole.
Total				341.6	2,970	

Table 4.4.1 Salient Features of Proposed Small-Dam Sites

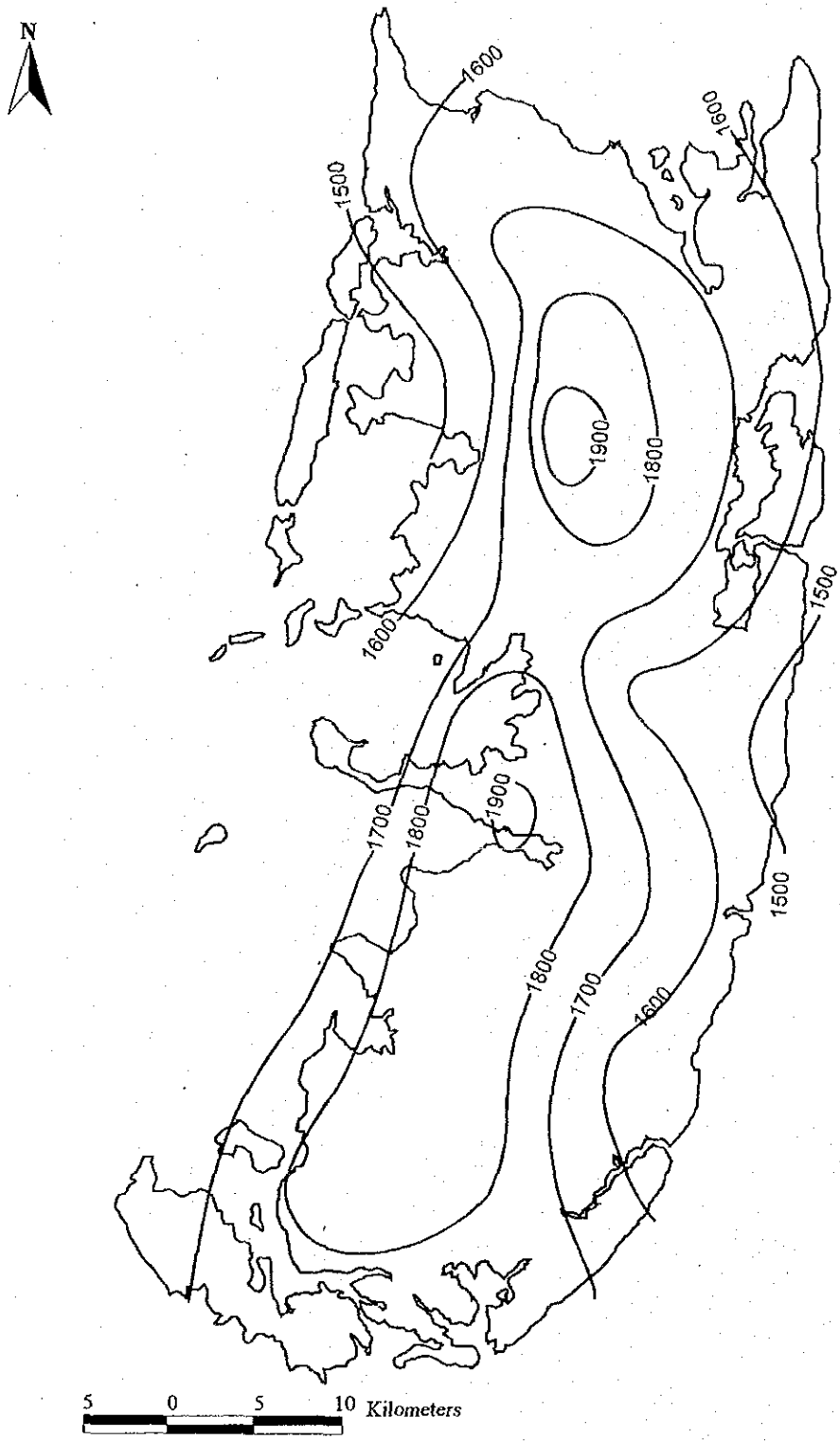
Name of Dam Site	Catchment Area (ha)	Possible Dam hight (m)	Dam Length (m)	Dam Volume (m^3)	Reservoir Area (ha)	Reservoir Capacity (m^3)	Project Area (ha)	Irrigable area during Wet season (ha)	Irrigable area during Dry season (ha)	Concerned Irrigation Scheme
Matangatwani	88.0	3.0	50.0	788	8.0	80,000	19.0	19.0	7.3	Matangatwani
Bule	152.0	3.0	40.0	630	24.0	240,000	12.0	12.0	21.8	Bule
Mshashni	185.0	5.0	120.0	4,650	10.0	166,700	25.0	25.0	15.2	Mshashni
Kwalempona(1)	88.0	5.0	110.0	4,263	6.0	100,000	53.0	53.0	9.1	Kwalempona
Kwalempona(2)	119.0	5.0	90.0	3,488	3.0	50,000			4.5	
Kwalempona(3)	43.0	5.0	120.0	4,650	5.0	83,400			7.6	
Mangwana	77.0	5.0	100.0	3,875	4.0	66,700	29.0	29.0	6.1	Mangwana
Mipopooni(1)	58.0	5.0	100.0	3,875	8.0	133,400	65.0	65.0	12.1	Mipopooni
Mipopooni(2)	33.0	5.0	120.0	4,650	5.0	83,300			7.6	
Mipopooni(3)	174.0	5.0	120.0	4,650	9.0	150,000			13.6	
Chwaka	197.0	5.0	120.0	4,650	15.0	250,000	17.0	17.0	22.7	Chwaka
Ngwia	627.0	5.0	160.0	6,200	22.0	366,700	76.0	76.0	33.3	Ngwia
Weni	144.0	5.0	130.0	5,038	0.0	0	35.0	35.0	0.0	Weni
Tungamaa	552.0	5.0	100.0	3,875	13.0	216,700	33.0	33.0	19.7	Tungamaa
Mleteni	72.0	5.0	130.0	5,038	6.0	100,000	31.0	31.0	9.1	Mleteni
Kinyasini	134.0	5.0	80.0	3,100	6.0	100,000	23.0	23.0	9.1	Kinyasini
Ngong'ombe	250.0	5.0	120.0	4,650	0.0	0	41.0	41.0	0.0	Ngong'ombe
Kwapweza	342.0	5.0	140.0	5,425	18.0	300,000	62.0	62.0	27.3	Kwapweza
Kinyakuzi	250.0	5.0	100.0	3,875	20.0	333,400	40.0	40.0	30.3	Kinyakuzi
Dobi	110.0	5.0	130.0	5,038	8.0	133,400	25.0	25.0	12.1	Dobi
Mlemele(1)	542.0	5.0	120.0	4,650	25.0	416,700	73.0	73.0	37.9	Mlemele
Mlemele(2)	183.0	5.0	150.0	5,813	20.0	333,300			30.3	
Kwamavi	185.0	5.0	120.0	4,650	26.0	433,300	22.0	22.0	39.4	Kwamavi
Mabieni	143.0	5.0	150.0	5,813	12.0	200,000	35.0	35.0	18.2	Mabieni
Tibirizi	47.0	6.0	80.0	4,320	3.8	76,000	25.0	25.0	6.9	Tibirizi
Giriama	70.0	5.0	100.0	3,875	9.0	150,000	33.0	33.0	13.6	Giriama
Masingni	48.0	3.0	100.0	1,575	9.0	90,000	15.0	15.0	8.2	Masingni
Mchangapwao	90.0	5.0	90.0	3,488	5.0	83,300	10.0	10.0	7.6	Mchangapwao
Kwamachigi	140.0	2.0	140.0	1,120	13.0	86,700	51.0	51.0	7.9	Kwamachigi
Maumbwini	144.0	2.0	140.0	1,120	12.0	80,000	29.0	29.0	7.3	Maumbwini
Egeani	34.0	3.0	100.0	1,575	5.0	50,000	9.0	9.0	4.5	Egeani
Kimbuni	52.0	5.0	50.0	1,938	7.0	116,700	21.0	21.0	10.6	Kimbuni
Mizingani	46.0	3.0	60.0	945	7.0	70,000	25.0	25.0	6.4	Mizingani
Kwamkoba(1)	42.0	5.0	120.0	4,650	6.0	100,000	93.0	93.0	9.1	Kwamkoba
Kwamkoba(2)	218.0	5.0	120.0	4,650	22.0	366,700			33.3	
Saninga	305.0	5.0	50.0	1,938	14.0	233,300	38.0	38.0	21.2	Saninga
Makwararani	466.0	5.0	120.0	4,650	21.0	350,000	114.0	114.0	31.8	Makwararani
Maotwe	64.0	10.0	130.0	18,200	10.0	333,300	13.0	13.0	30.3	Maotwe
Makunge	114.0	5.0	120.0	4,650	17.0	283,300	54.0	54.0	25.8	Makunge
Sub-total (Pemba)	6,628.0				433.8	6,806,300	1,246.0	1,246.0	618.8	
Chaani	-	-	-	-	-	-	250.0	250.0	250.0	Chaani
Kibokwa	-	-	-	-	-	-	250.0	250.0	250.0	Kibokwa
Chechele/Mahond	-	-	-	-	-	-	300.0	300.0	150.0	Chechle/Mahonda
Kipange	1,400.0	15.0	37.0	90,000	-	2,170,000	400.0	400.0	400.0	Kipange
Sub-total (Unguja)	1,400.0				-	2,170,000	1,200.0	1,200.0	1,050.0	
Total	8,028.0				433.8	8,976,300	2,446.0	2,446.0	1,668.8	

Source: Investigation Result conducted by DARI in August 2002
"-" : not identified

Figure



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 4.1.1** *Isohyt-Graph in Unguja*
Japan International Cooperation Agency	



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 4.1.2** **Isohty-Graph in Pemba**
Japan International Cooperation Agency	

Appendix E

Marketing

THE STUDY
ON
THE ZANZIBAR IRRIGATION MASTER PLAN
IN
THE UNITED REPUBLIC OF TANZANIA

MASTER PLAN

APPENDIX E

MARKETING

Table of Contents

List of Tables

APPENDIX E

MARKETING

CHAPTER 1 MARKETING

1.1 Present Condition

1.1.1 Marketing System

There are a variety of marketing systems for food products operating in Zanzibar. The type of marketing depends on the type of product being sold. There are different marketing systems for locally produced cereals, imported cereals, pulses and for products like cassava and bananas. Both middlemen and producers market cereals and other foodstuffs. The buyers are shopkeepers and petty traders who travel to purchase the products in the production areas. This also occurs during shortages or when the crop is out of season. Otherwise, farmers take produce to the town markets themselves. When this happens, all the marketing costs and risks are borne by farmers.

Facilities

The main agro-industries in Zanzibar are mostly small-scale plants processing the following cereal products: maize, rice, and sorghum. Zanzibar has also two large-scale industries both dealing with grains: these are the Zanzibar Milling Corporation (ZMC) and the Zanzibar Poultry Company (ZAPOCO). The annual capacity of ZMC plant is 6,000 tonnes. In addition, there are small scale feed mills like Kwahaji Tumbo and Matambuu.

The key institution responsible for trade and marketing is the Department of Trade and Marketing in the Ministry of Trade, Industries and Marketing. The main activities of this Department include trade fairs and missions, information and research, export promotion and facilitation, licensing of exporters and formulating of export procedures. The Department is, however, understaffed, lacks adequate facilities and requires more training to effectively implement the above activities.

1.1.2 Channels of Distribution

There are different types of distribution systems for crops. Distribution starts from the farm gate and products are taken to the central wholesale markets where the produce is auctioned. Produce is then taken to retail markets or directly to the final consumer. This applies mainly for the cereal rice. However, for bananas and cassava, petty traders who serve as middlemen, purchase the products from producers and sell them at retail in semi-open air markets in the townships or vend the products from street to street usually on bicycles.

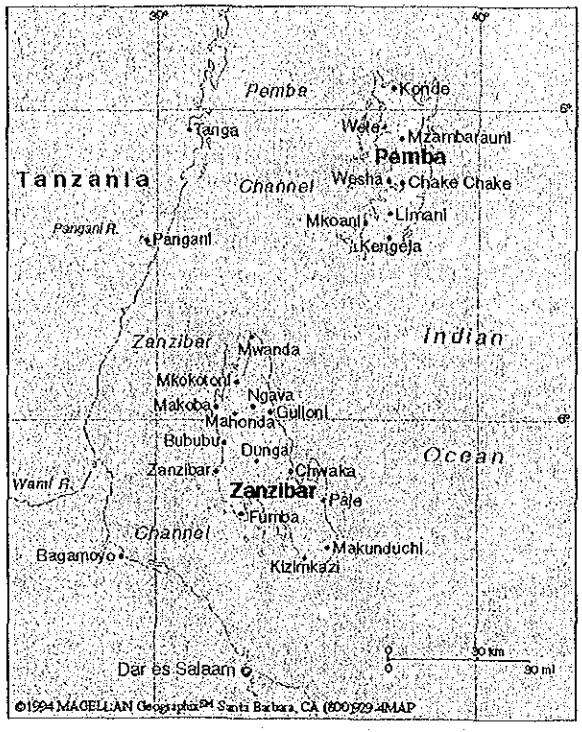
Wholesale Markets

Currently there is no policy guiding the operation of wholesale markets. Unspecified numbers of middlemen are involved in acquisition and distribution of major food crops. There are also no facilities provided at the wholesale markets for storage and handling.

Retail Markets

There is similarly no policy guiding the operation of retail markets for agricultural commodities in Zanzibar. With the approval and license from the municipal council, retailers can sell their commodities in the public retail markets or at their own retail shops. There are similarly no controls and guidelines for the handling of products in retail markets. Most marketed agricultural commodities are prepared and packed using local packaging materials such as bags, tengas, polos, pakacha etc., and then sent to the market for sale. Conventional commercial fresh produce packaging and storage facilities do not exist in Zanzibar. Most farmers lack skills and knowledge for post harvest processing, hence substantial food losses occur shortly after harvesting due to ineffective handling. Most farmers can store crops for one or two days after harvesting on the farm and even longer depending on the crop e.g. bananas can be kept for a week. If the market for perishable is oversupplied it may be impossible for late farmers to sell their produce and then may have to wait until the next day.

The figure below shows the location of main market sites in the islands of Zanzibar and Pemba.



Standards and Quality Control of Agricultural Commodities

The quality of the produce is, among other factors, very important in influencing the price of agricultural commodities. Consumers are always interested to see agricultural commodities that are attractive in appearance, have a good taste and a pleasant smell. Moreover, customers who buy large quantities of produce to be stored for longer periods usually prefer a commodity that has an extended shelf life. Apart from the above-mentioned characteristics, agro-processed products should be tested and certified fit for human consumption. Few agricultural commodities are currently checked for quality.

There are also few quality controls on imported agricultural products due to inadequate facilities for inspection, particularly canned and all agro-industrial processed products. The Chief Government Chemist has to send samples to Tanzania Mainland for laboratory analysis. As a result expired goods are easily sold to consumers who take advantage of their low prices.

1.1.3 Pricing

Input prices

The Ministry of Agriculture, Livestock and Natural Resources is currently the main supplier of agricultural inputs. These include fertilizers,

chemicals and seeds. Fertilizer, seed and chemicals are provided at subsidized prices. Tractor services are also subsidized. Extension services are also freely provided. There is an emerging private sector mainly non-governmental and community based organizations (NGOs, and CBOs) involvement in the supply of agricultural inputs and some of the above mentioned services. However, their contribution in providing services and inputs is currently insignificant.

Output prices

Output prices for all food crops are free market determined. Market prices are often lower than the real cost of production. Retail prices paid by consumers for the period 2001 are also shown in table below.

Fluctuations in Some Staple Food Retail Prices in Zanzibar

(Unit: Tsh./kg)

Month 2001	Cassava	Irish Potatoes	Sweet Potatoes	Bananas
Jan.	87.03	208.33	59.43	208.33
Feb.	85.82	N/A	72.12	146.93
Mar.	75.52	N/A	86.21	125.26
Apr.	65.67	N/A	N/A	122.24
May	69.66	108.70	N/A	125.54
Jun.	74.94	128.21	106.38	132.08
Jul.	70.11	115.79	129.51	136.67
Aug.	67.25	100.33	63.50	148.78
Sep.	68.88	103.34	63.54	118.63
Oct.	73.75	136.00	61.87	149.42
Nov.	75.75	147.23	62.58	192.04

Source: Statistic Bureau of Zanzibar (2002)

1.2 Constraints and Opportunities

The main weaknesses of current market distribution channels include the following:

- The system has no regulations or guidelines for collection and distribution of agricultural produce.
- It has created opportunities for many intermediate middlemen to buy products at cheaper prices from producers and resell at exorbitant prices.
- Producers do not always have assured markets for their produce.
- The role of wholesale markets is not well defined. Facilities such as packaging and temporary storage are unavailable which leads to an unstable pricing system.
- Supply of agricultural products is declining while markets for the same

are expanding.

- Lack of agricultural credit facilities, high interest rates and lack of collateral. As most farmers lack title deeds for their farms, there is little use of the formal banking system to finance agricultural production, trade and agribusiness.
- Rate of loan repayments from farmers is very low.
- There is currently no institution mandated to control the marketing of agricultural commodities. The municipal authorities are only responsible for the provision of licenses to sell commodities. There are no guidelines regulating the local market.
- Services and skills in marketing, particularly in the area of marketing information and marketing advice, are in their infancy in Zanzibar. The market information facilities in the Ministry of Trade, Industries and Marketing are inadequate.
- Infrastructure such as feeder roads are not very well developed, market information is lacking and there is no quality control of agricultural commodities and agro-processed products due to lack of facilities for product inspection.
- Inadequate facilities for storage, packing and transport especially for perishable commodities like bananas and cassava.
- The Ministry of Agriculture, Livestock and Natural Resources has not made enough efforts to reduce cost of production for agricultural commodities by:
  - increasing output per unit area;
  - reducing the use of expensive, external inputs;
  - providing guarantees for bulk purchases and;
  - adopting specific measures to reduce markets and transaction costs

Opportunities

- There is a need to reform and simplify export procedures in order to encourage agricultural exports.
- Formulation of guidelines and regulations for marketing agriculture commodities.
- There is a need to formulate standards for agricultural commodities sold both internally and for exports.
- Need to create a support system for promoting and sustaining research for both export crops and those sold internally, as well as research into new markets and marketing strategies for both traditional and

non-traditional commodities.

- Produce Promotion.

  Produce promotion either by producers or traders is not widely practiced. However product advertising in trade fares both locally and internationally has recently developed. Other means of advertising products include the use of mass media (radio, newspapers, TV) and posters which are widely used for non-agricultural products.

- Efforts are under way to promote exports. Under the Joint Integrated Technical Assistance Programme (JITAP) jointly financed by WTO, ITC and UNCTAD a project "Follow-up to the WTO agreements and exploitation of business opportunities by Tanzanian enterprises" started in November 1999. The project's major objectives are: building a national capacity for understanding the changing multilateral trading system and its implications for Tanzania's trade; conforming to, and seeking maximum advantage from, the multilateral trading system and enhancing Tanzania's export readiness. This project will cover both mainland Tanzania and Zanzibar.