NEED FOR WATER RESEARCH DURING PLANNING OF RURAL INTEGRATED DEVELOPMENT PROJECTS- BASED ON LESSONS LEARNED IN MAHAWELI GANGA DEVELOPMENT SCHEME

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ABSTRACT

The purpose of this paper is to demonstrate that research for both irrigation and potable water should necessarily be an integral part of initial planning, particularly in the case of rural integrated development projects. Mahaweli Ganga Development Scheme (MGDS) has been the centerpiece of the public investment programme since 1970. The development areas under MGDS are called systems, and they are scattered over the dry zone. The thirteen systems are identified as A,B,C, ... K,L, M. The independent project areas, which have been developed so far to receive the water resources of Mahaweli ad its adjacent basins are System-H, System-C, System-G, System- B and System-L.

All functions related to resource management within a system, are made to take place in the following environments.
(a) Terrestrial Environment (b) Aquatic Environment (c) Human Environment

The basic facility that is most essential in a Mahaweli System is irrigation infrastructure. Therefore, quality of irrigation water is of paramount importance. Several water samples taken from a number of sources such as, rivers, streams, reservoirs, ground wells, etc. located over the Systems implemented so far had been tested before the development activities got underway. The findings of such testing, it is reported, had been favourable for both agriculture and human consumption. However, the quality of water available in the areas in question, during operation of the system for agricultural production, has been found, to be contaminated with bacteria, toxic metals, salt and iron at least at some locations . A notable feature characterised in the minor reservoirs particularly as a post implementation result is eutrophication due to high nutrient loadings in the water.

The settlement planning of the villages and their homesteads is such, each settler would have a ground well in their homesteads, in addition to a few community wells in each village, as a public amenity. These community wells are either ground wells or tube wells.

As a policy in the Mahaweli Systems, a township is provided with a full fledged drinking water supply scheme. An Area Centre, which is also an Urban Centre, but much below the level of a township, in respect of civic amenities, is also provided with a water supply scheme, catering to the facilities in the Centre only. In designing a water supply scheme, the water source is tested for physical, chemical and biological characteristics. Very often, the water is tested, long before the actual activities of irrigated agriculture get underway.

The changes that would take place in a System, when the land within is augmented with regulated or diverted water are too numerous. One such change is the increase in water spread area or the creation of water bodies. In other words, the land use changes would cause various effects on surface water in the watershed.

The impacts and implications of integrated rural development, therefore centered around humans, water and land. The consequences included both benefits and detrimental effects to the natural environment and the man himself. Since the impacts caused by the water and the land uses are of serious concern, intensive research during planning is of vital importance, to derive the desired benefits of the project.

(1.0) MAHAWELI GANGA DEVELOPMENT SCHEME

Mahaweli Ganga Development Scheme (MGDS) has been the largest multipurpose water resources development project ever undertaken in this country. The MGDS was implemented in the year 1970 attaching very high priority by the government of Sri Lanka.

The river Mahaweli which originates from the hill country is the largest river in Sri Lanka and it drains more than 16% of the land surface of the island. It also carries approximately one seventh of the total annual run-off of all the rivers in Sri Lanka.

The development areas under the MGDS are called systems and they are scattered in the dry zone. There are thirteen systems, which are identified as, A,B,C,D.....K,L and M.

(1.1) MAHAWELI SYSTEMS AND INTEGRATED DEVELOPMENT

The cardinal concept adopted in transferring the Systems, H,G,C,B and L into irrigated agriculture based on human settlement is the "Integrated Rural Development Approach". In the planning process, this concept has been enshrined in the development strategy of each system with the integration of the following environments.

(i) Terrestrial Environment
(ii) Aquatic Environment
(iii) Human Environment

SEE DIAGRAM: SYSTEMS APPROACH TO INTEGRATED DEVELOPMENT

The physical infrastructure that have been determined in compliance with the approved policies of the MGDS can be divided into Irrigation Infrastructure and Social Infrastructure basically.

IRRIGATION INFRASTRUCTURE
Reservoirs
Canals
Drainages
Ditches
Streams
Farm lots etc.

SEE DIAGRAM: PHYSICAL COMPONENTS OF IRRIGATION SYSTEM

SOCIAL INFRASTRUCTURE
Roads
Electricity
Telecommunication
Drinking water supply
Sewerage

In each of these "Settlement Centres" the most important natural resource is potable water. As a policy, for domestic uses and drinking water, facilities planned or assistance given to settlers in establishing both community and domestic water sources is as described below.

(a) Hamlet Centre	-	Community Well
Homesteads	-	Ground Well in each homestead
(b) Village Centre	-	Community Well
Homesteads	-	Ground Well in each homestead
(c) Area Centre	-	Water Supply Scheme treated / untreated.
Homesteads	-	Pipe-borne water, Individual Ground wells or community wells
(d) Town Centre	-	Water Supply Scheme with treated water.
Homesteads	-	Treated pipe-borne water.

SEE TABLE: PRESENT STATUS OF DRINKING WATER FACILITIES

It is quite clear, according to the data related to the drinking water facilities available in these systems, that even after one or two decades of operation, one of the most essential services is not in place to facilitate growth of urban centres. Following are some requirements which have not been considered during initial planning.

(a) Availability of a reliable water source in close proximity to urban centre
(b) Suitability of water, when available under irrigated agriculture
(c) Uninterrupted augmentation of source reservoir
(d) Issue of water for both irrigation and drinking water from the reservoir
(e) Social background and cultural practices of consumers (settlers)
(f) Inappropriate design
(g) Poor operation and maintenance

The inference therefore would be, that the availability of adequate supply of drinking water has to be ensured during planning, of infrastructure.

(4.0) DEVELOPMENT OF HOMESTEADS

The extent of a homestead in a Hamlet is 0.20 Ha. and the number of homesteads in a hamlet is generally in the range 200 - 300 except in System - H, in which the range is 100 - 150.

There are three fundamental facilities that should be installed by the settlers in their homesteads. They are, a House, a Latrine and a ground (dug) well. The table produced below shows the status of these three physical facilities in four systems.

SEE TABLE : SETTLERS AND WATER RELATED FACILITIES

Homesteads
Recreational facilities etc.

In the provision of both irrigation and social infrastructure, the fundamental resource, that should necessarily be available is surface water. In planning the irrigation infrastructure, which takes precedence over the other, a necessary condition that must be satisfied is the quality of irrigation water, which would be available in the Reservoirs, Canals and the Drainages eventually and during operation it should be suitable for irrigated agriculture.

(2.0) AUGMENTATION OF BASINS WITH MAHAWELI WATERS

The water flow in the Mahaweli river is diverted at several places in augmenting several other basins.

(a) System - H was the maiden area which was transformed into irrigated agriculture, with the augmentation of the Kala Oya basin with Mahaweli waters. This system has been in operation since 1976.
(b) Elahera-Minneriya Yoda Ela (EMYE) is the feeder canal which releases water to System-G. The EMYE takes off from Amban ganga which is the main tributary of Mahaweli Ganga. System-G comprises the old area and the new area. The latter received irrigation in 1987 or so.
(c) System-C was in the Accelerated Mahaweli Development Programme and the farm allotments have been receiving irrigation water from early 1980's. The full irrigable area was in operation by 1992 or so. System-C is in the Mahaweli basin and the area is augmented by a transbasin canal taking off from the river-Mahaweli at Minipe.
(d) Maduru Oya was the first adjacent basin, to be augmented by Mahaweli waters by means of the Minipe Transbasin canal which carries water to Maduru Oya Reservoir from Mahaweli. System-B is the command area of Maduru Oya Reservoir. The left bank of Maduru Oya within System-B has been under irrigated agriculture since 1985.
(e) Compared to the Systems H,G,C and B, System-L has still not received Mahaweli waters. However, it is an independent basin, part of it is commanded by the Padaviya Reservoir. A relatively small area on the left bank of Ma-Oya is under irrigated agriculture since 1985, with the help of several minor reservoirs in cascade. Therefore, use of return flows is the cardinal principle adopted in the area referred to.

The table shown below explains the incorporation of water bodies into the irrigation network in each System, while highlighting the area occupied by water on a unit area basis.

SEE TABLE: WATER BODIES AND IRRIGATION SYSTEM IN OPERATION

(3.0) CIVIC AMENITIES, UTILITIES AND SERVICES

The "Human Environment" in these systems is made up of the settlement areas, Hamlets, Village Centres and Urban areas. The hierarchy of the settlement areas and the urban areas are shown in the figure produced below.

SEE DIAGRAM: DISTRIBUTION OF SETTLEMENT AREAS, VILLAGES AND URBAN CENTRES IN A SYSTEM

According to the data, the situation in System - G is very poor. Despite a two decade operation of System - H, availability of Latrines and ground wells is very unsatisfactory. Drinking water sources are concerned, all four systems have not come upto the expectations.

However, there are very significant deficiencies in the land, attributing to unhygenic factors in respect of drinking water. A few notable factors are,

(a) Presence of Flouride in excess of permissible limits
(b) Excessive hardness
(c) Underlying hard layer of earth below top soil
(d) Low water table
(e) Easy access to canal water

(5.0) APPLICATION OF AGRO-CHEMICALS (FERTILIZERS, WEEDICIDES, INSECTICIDES)

(5.1) ENVIRONMENTAL CONCERNS

In general, the problems that could commonly occur with irrigation supplies are,
(i) association of high levels of salinity, and
(ii) high proportion of Sodium.

Due to salinity (accumulation of salt in the root zone) reduction in yields can result. The upward movement of water and salts from the groundwater also can cause salinity problems, if the water table is shallow.

Similarly, a high level of Sodium in comparison with other ions such as Calcium, Magnesium and Bicarbonate can result in the formation of alkaline soils with very low permeability.

According to the findings in the Environmental Assessment (Vol.III), Tams, 1980 the quality of waters of the Mahaweli Ganga, Kotmale Oya, Amban Ganga which are tributaries of the largest river, and the Maduru Oya in an adjacent basin were highly suitable for irrigation purposes. The quality of water in the Reservoirs and the Villus was also suitable for most irrigation purposes. Furthermore it confirms both ground water and surface water as suitable for drinking water for livestock. The suitability of surface water as suitable for drinking water for livestock. The suitability of surface water was however limited for swimming, bathing, washing and other related domestic uses. The suitability of well waters for human consumption had not been confirmed, as verification needed in respect of caliform bacteria, metal toxicity etc.
TDS $<$ 500 mg/l (Equivalent to a conductivity of about 700 mocromhos/cm)
The suitability of well water in System-C had been doubted according to these results.
The surface waters in the System under consideration had exhibited quality above standards, as far as fish faunas are concerned. For the protection of aquatic organisms the Iron level is 1.0 mg/litre.

For pest control, chlorinated pesticides including DDT, BHC, Heptachlor, Endrin, Aladin and Dieldrin had been used in Sri Lanka until mid 70's. According to TAMS (1979) the concentration of pesticides had been very high, especially DDT, exceeding mortality levels threshold for some aquatic organisms.

Most of the reservoirs, particularly the smaller were characterized as eutrophic systems with high nutrient (phospate) loadings. These water bodies had extensive algae and aquatic weed growths. It should be emphasized that eutrophic waters are highly productive and they are desirable for the development of inland fisheries.

An Environmental Evaluation of the Accelerated Mahaweli Program (AMDP) was carried out by the USAID in 1992/1993 based on the impacts envisaged in the TAMS Report, (1980). Listed below are some excerpts from the Evaluation Report of the consultants.

(5.2) ADVERSE EFFECTS

(a) Chemical inputs to agricultural systems in the upper and lower catchment areas are degrading surface and ground water quality.
Studies conducted within specific systems do indicate a very high use of agrochemicals. Fertilizer use has probably contributed to the very evident algae blooms in drainage canals, as well as extensive Salvinia growth on the water surface of reservoirs. This eutroprication is partly responsible for some loss of habitat for fish.
It is estimated that less than one percent of farmers even resort to use of gramaxone. The usual response by farmers to insect problems is repeated applications of a variety of chemicals throughout the growth period.

(b) Poor water management practices in irrigated areas, have increased the threat of soil salinization and soil losses.
Salinity levels in System-H appears to be more common in localized patches. These levels are likely to be aggravated during dry spells and reduced during rainy seasons.

(c) AMDP has been cited as a leading cause of the increase in the occurrence of Malaria in general. Data clearly show that the spread of Malaria re-activated during the commencement of AMDP. This is mainly due to,

Standing water in newly developed reservoirs, irrigation canals, and on-farm fields provides an excellent habitat for breeding mosquito vectors.

SEE TABLE: FERTILIZER USAGE IN METRIC TONS

(6.0) AGRICULTURAL PRODUCTION

Development of agriculture is one of the principal aims of the MGDS/AMDP. The other is community development, which includes, education, health, recreation etc. of settlers. The Table and the Diagram produced below confirms that in terms of crop yields, investment on Mahaweli Systems is justified. Also, it is a fact that the potential is available for increase of crop yields further.

SEE DIAGRAM: AGRICULTURAL PRODUCTION

However, it has to be emphasised that the increase in agricultural production should not be at the expense of community development. Particularly the environmental issues, which have a direct bearing on the welfare and the wellbeing of the settlers and their physical environment should be addressed appropriately and their adverse impacts mitigated adequately.

(7.0) CONCERNS AND SUGGESTIONS

(7.1) Establishment of a National Water Research Centre

(7.2) Minimising, managing toxin measurement by means of nutrient management strategies, flow management and destratfication

(7.3) Algal toxins – Safe levels in water for various uses

(7.4) Health assessment – Identify appropriate pollutant loads from urban and rural sources

(7.5) Implications of hydrological changes

(7.6) Salinity – Ecological damage

(7.7) Pesticides - Ecological impacts of chemicals and food chains. Need to develop restoration strategies for contaminated waterways.

(7.8) Riparian Area Management – Nutrient and energy to acquatic ecosystem.

(7.9) Restoration and Rehabilitation of Aquatic Systems

(7.10) Multidisciplinary Collaboration on issues and research

REFERENCES

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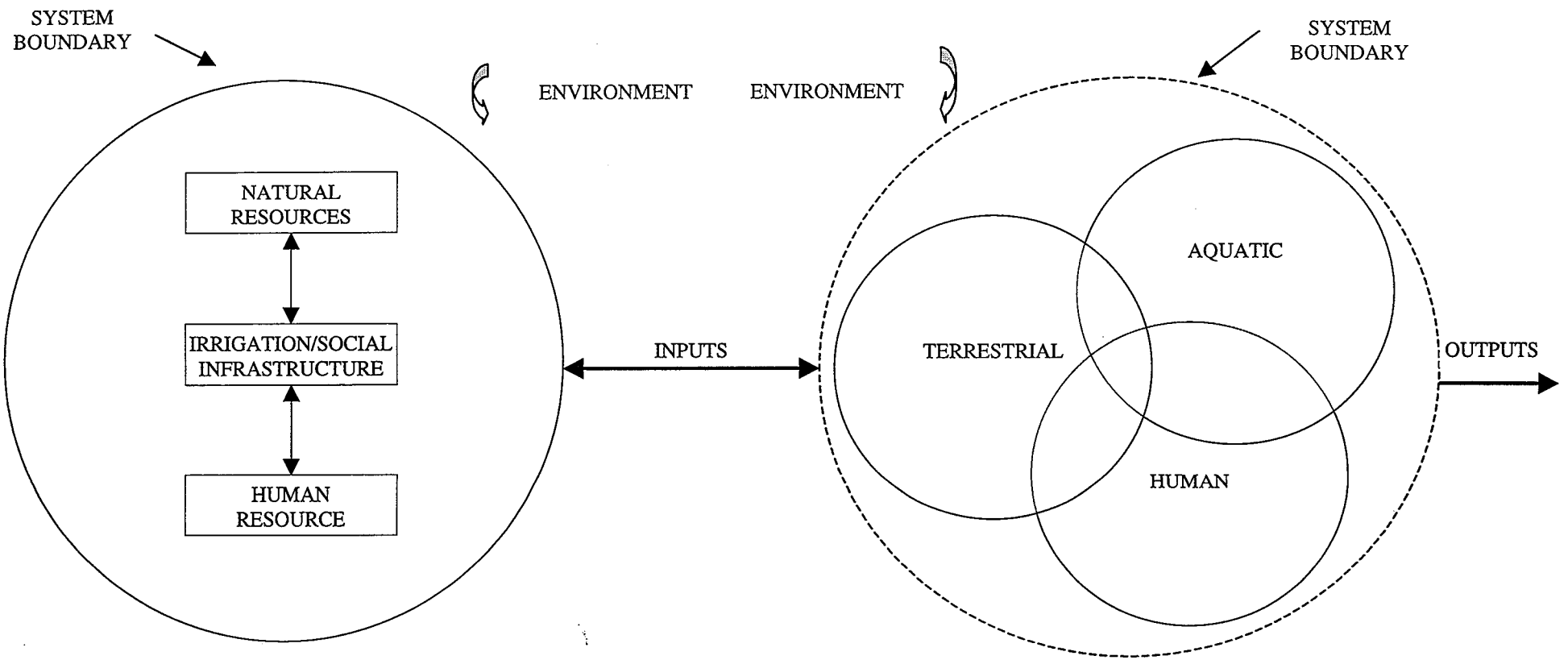
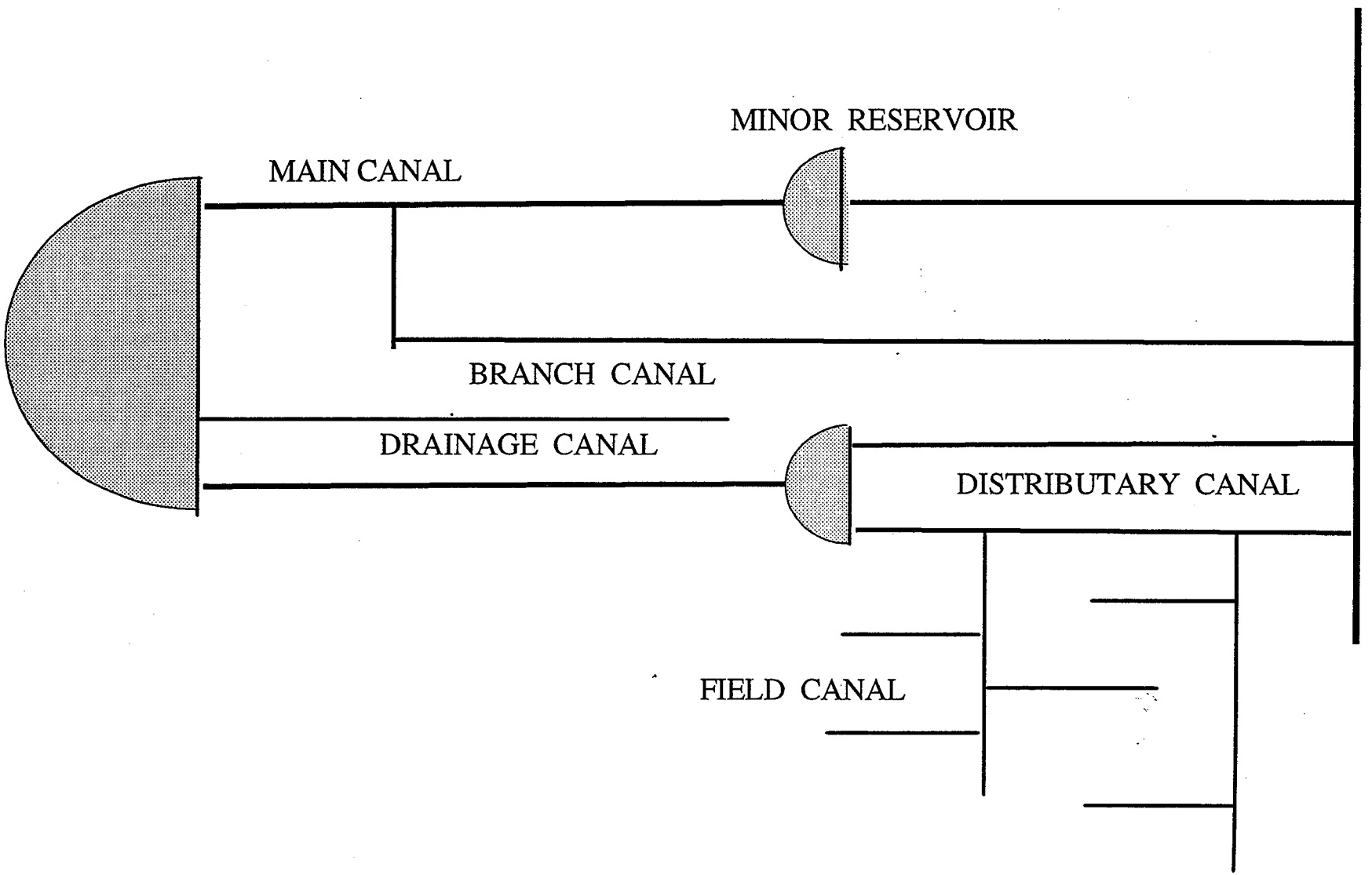
SYSTEMS APPROACH TO INTEGRATED DEVELOPMENT



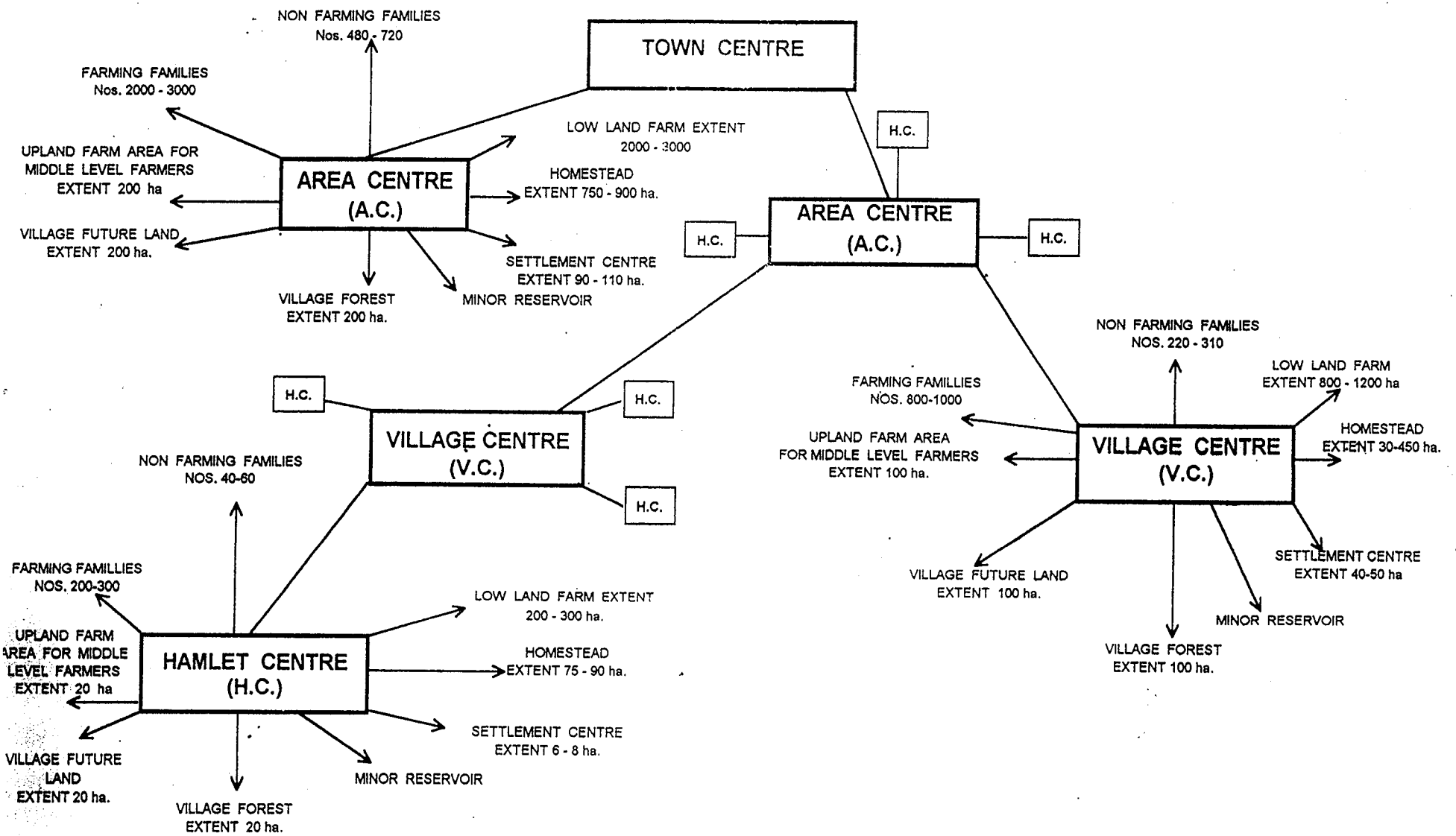
PHYSICAL COMPONENTS OF IRRIGATION SYSTEM



WATER BODIES AND IRRIGATION SYSTEM IN OPERATION

System	Gross Area (Ha)	Farm Area (Ha)	Settler Families (No)	Canals (km)					Total Canal Length/ Gross Area m/Ha	Medium/Minor Reservoirs
				Main	Branch	Distributary	Field	Drainage		
System-H	75,000	31,759	31,000	152	100	660	1,505	2,250	62.2	76
System-G	10,524	5,400	4,585	32	5	89	281	420	78.6	-
System-C	67,950	27,843	21,039	92	98	552	1,275	1,920	57.9	56
System-B	75,640	26,681	18,795	53	72	602	1,536	2,300	60.3	85
System-L	163,000	39,029	1,700	-	-	12	10	36	-	17
Total	*392,114*	*130,712*	*77,119*	*329*	*275*	*1,915*	*4,607*	*6,926*	*64.8*	*234*

DISTRIBUTION OF SETTLEMENT AREAS, VILLAGES AND URBAN CENTRES IN A SYSTEM



PRESENT STATUS OF DRINKING WATER FACILITIES

SYSTEM-H

URBAN CENTRE	SOURCE	WATER SUPPLY SCHEME			
		Function	Supply	Treatment	Management
Thambuttegama T/C	M.R.	Operational	Inadequate	Purified	NWSDB
Galnewa T/C	Well	Operational	Adequate	Purified	L.Authority
Nochchiyagam T/C	M.R	Operational	Adequate	Purified	L.Authority
Eppawal T/C	M.R	Operational	Adequate	Purified	L.Authority
Meegalewa T/C	-	-	-	-	-
Madatugama	-	-	-	-	-
Galkiriyagama T/C	Well	Non Operational	-	-	-
Talawa T/C	-	-	-	-	-
Aukana T/C	-	-	-	-	-
Kekirawa T/C	M.R	Operational	Adequate	Purified	NWSDB
Dambulla T/C	River	Operational	Adequate	Purified	NWSDB
Bulnewa T/C	Well	Operational	Adequate	Purified	L.Authority

SYSTEM-G

URBAN CENTRE	SOURCE	WATER SUPPLY SCHEME			
		Function	Supply	Treatment	Management
Bakamuna T/C	EMYE	Operational	Adequate	Purified	MASL
Attanakadawala V/C	-	-	-	-	-

SYSTEM-C

URBAN CENTRE	SOURCE	WATER SUPPLY SCHEME			
		Function	Supply	Treatment	Management
Dehiattakandiya T/C	River	Operational	Adequate	Purified	MASL
Girandurukotte T/C	MR	Operational	Adequate	Purified	MASL
Batalaya A/C	MR	Operational	Adequate	Purified	MASL
Medagama A/C	MR	Operational	Adequate	Purified	MASL
Sandunpura A/C	MR	Operational	Adequate	Purified	MASL
Lihiniyagama A/C	MR	Operational	Adequate	Purified	MASL
Siripura A/C	MR	Operational	Adequate	Purified	MASL
Mahawanawela A/C	MR	Operational	Adequate	Purified	MASL
Veheragala A/C	MR	Operational	Adequate	Purified	MASL
Nuwaragala A/C	MR	Operational	Adequate	Purified	MASL

SYSTEM-B

URBAN CENTRE	SOURCE	WATER SUPPLY SCHEME			
		Function	Supply	Treatment	Management
Welikanda T/C	MR	under Construction	-	-	-
Aralaganwila T/C	MR	Operational	Inadequate	Purified	MASL
Manampitiya T/C	MR	under Construction	-	-	-
Siddhapura T/C	-	-	-	-	-
Damminna A/C	MR	Operational	Adequate	Purified	MASL
Wijayabapura A/C	-	-	-	-	
Ellewewa A/C	MR	Operational	Adequate	Purified	MASL
Dimbulagala A/C	MR	Operational	Adequate	Purified	MASL

SETTLERS AND WATER RELATED FACILITIES

YSTEM-H

Settler Families - 31,000

EAR	Houses	Latrines		Dug Wells		Tube Wells
		Nos	% of Families	Nos	% of Families	
992	23,922	20,118	64.9	9,468	30.5	171
993	24,258	20,697	66.8	9,673	31.2	185
994	24,862	21,273	68.6	10,060	32.5	200
995	24,934	21,438	69.2	10,084	32.5	200
996	25,209	21,692	70.0	10,846	35.0	200

YSTEM-C

Settler Families - 21,039

EAR	Houses	Latrines		Dug Wells		Tube Wells
		Nos	% of Families	Nos	% of Families	
992	20,028	15,578	74.0	8,522	40.5	23
993	20,913	16,617	79.0	8,831	42.0	23
994	20,995	16,965	80.6	9,482	45.1	23
995	21,160	17,507	83.2	9,569	45.5	23
996	22,453	17,507	83.2	11,176	53.1	23

SYSTEM-G

Settler Families - 4,585

YEAR	Houses	Latrines		Dug Wells		Tube Wells
		Nos	% of Families	Nos	% of Families	
1992	2,590	2,318	50.6	109	2.4	163
1993	2,590	2,318	50.6	109	2.4	163
1994	2,590	2,318	50.6	163	3.6	163
1995	2,590	2,318	50.6	163	3.6	163
1996	2,590	2,318	50.6	163	3.6	163

SYSTEM-B

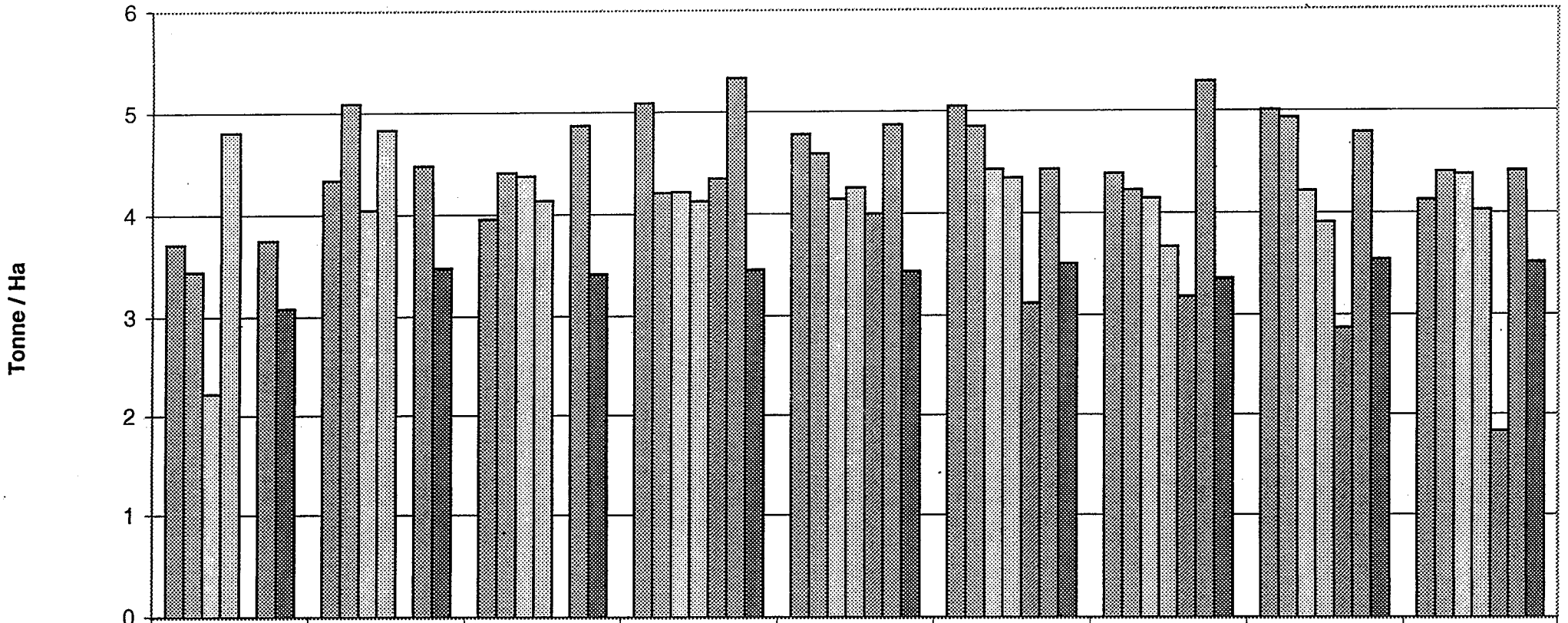
Settler Families - 18,795

YEAR	Houses	Latrines		Dug Wells		Tube Wells
		Nos	% of Families	Nos	% of Families	
1992	14,489	9,665	51.4	5,847	31.1	347
1993	16,330	10,780	57.4	5,963	31.7	414
1994	17,869	11,855	63.1	6,409	34.1	421
1995	18,221	12,478	66.4	7,400	39.4	432
1996	18,372	13,691	72.8	7,401	39.4	432

FERTILIZER USAGE IN METRIC TONNES

SYSTEM	FERTILIZER	1991/1992 MAHA	1992 YALA	1992/1993 MAHA	1993 YALA	1993/1994 MAHA	1994 YALA
C	VMIX	872.00	436.00	823.00	795.00	1091.00	802.00
	UREA	980.00	680.00	2002.00	969.00	1389.00	1259.00
	TDM	760.00	652.00	2183.00	730.00	1223.00	1063.00
	TSP	20.00		16.00		0.90	3.10
	MOP	11.00		9.00		0.70	1.10
B	VMIX		415.00	785.00	688.00	1272.00	1150.00
	UREA		510.00	692.00	634.00	1178.00	1124.00
	TDM		482.00	327.00	289.00	401.00	829.00
	TSP		0.25			2.50	
	MOP		0.25				
H	VMIX	2434.00	81.00	3472.00	186.00	2650.00	935.00
	UREA	3167.00	115.00	3496.00	117.00	2593.00	628.00
	TDM	3060.00	36.00	2081.00	133.00	2243.00	197.00
	TSP						
	MOP						
L	VMIX	4.00		4.00		7.80	
	UREA	36.00		14.00	1.00	41.00	1.10
	TDM	18.00		0.60	0.45	10.00	0.40
	TSP			0.10			
	MOP			1.70			
TOTAL	VMIX	3310.00	932.00	5084.00	1669.00	5020.80	2887.00
	UREA	4183.00	1305.00	6204.00	1721.00	5201.00	3012.10
	TDM	3838.00	1170.00	4591.60	1152.45	3877.00	2089.40
	TSP	20.00	0.25	16.10	0.00	3.40	3.10
	MOP	11.00	0.25	10.70	0.00	0.70	1.10

AGRICULTURAL PRODUCTION



	1984	1986	1988	1990	1992	1993	1994	1995	1996
H	3.71	4.34	3.96	5.09	4.78	5.05	4.39	5.01	4.13
G	3.44	5.09	4.41	4.21	4.59	4.85	4.23	4.93	4.4
C	2.22	4.05	4.38	4.22	4.15	4.43	4.15	4.22	4.38
B	4.81	4.83	4.14	4.13	4.26	4.35	3.67	3.91	4.03
L	0	0	0	4.35	4	3.12	3.18	2.87	1.83
Walawe	3.75	4.48	4.87	5.33	4.87	4.43	5.29	4.79	4.41
National	3.08	3.47	3.41	3.45	3.43	3.5	3.36	3.54	3.51

Year

H G C B L Walawe National