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Constraints, Opportunities and Options in Irrigation Development

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Constraints, Opportunities and Options in Irrigation Development

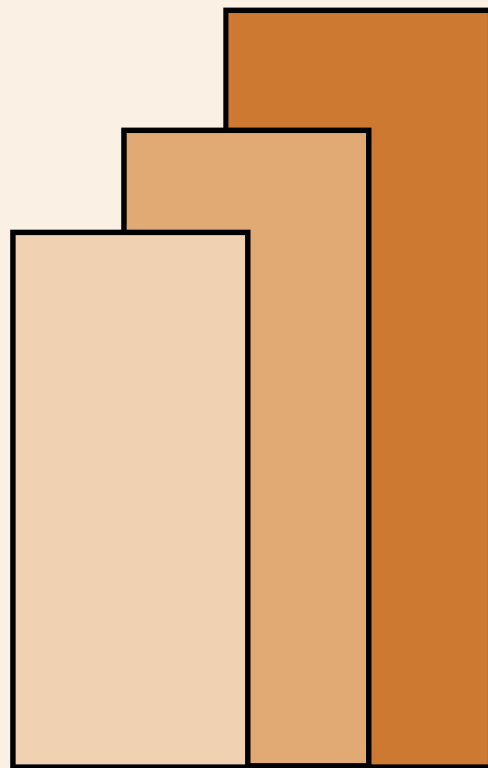
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CONSTRAINTS, OPPORTUNITIES AND OPTIONS IN IRRIGATION DEVELOPMENT

Abstract

There is a dearth of information on the extent of irrigation development in the country. As a result, there has been a great deal of confusion over the statistics on the state of irrigation development.

The NIA defines an irrigation service area as an area with irrigation facilities. In reality, the actual area served is much less than the service area. The disturbing implication is that we are very inefficient in the planning and implementation of irrigation projects. This very low actual over design irrigated area ratio is mainly due to design mistakes, unrealistic assumptions during project preparation stage, overlaps in the service areas of various modes of irrigation and inefficiency in the operation and maintenance of irrigation systems.

The bulk of the available information presented in this paper show that the country is realizing less than half of potential benefits from irrigation development. There are very alarming indications of decreasing efficiency in the planning and implementation of national irrigation systems (NIS) and communal irrigation systems (CIS) as attractive schemes get fewer and fewer and vital watersheds are increasingly subject to exploitation by an ever increasing population.

CONSTRAINTS, OPPORTUNITIES AND OPTIONS IN IRRIGATION DEVELOPMENT ^{1/}

Wilfredo P. David ^{2/}

I. PRESENT STATE OF IRRIGATION DEVELOPMENT

There is a dearth of information on the extent of irrigation development in the country. As a result, there has been a great deal of confusion over the statistics on the state of irrigation development.

On Table 1 are shown the NIA estimates of the service areas of the national, communal and pump irrigation systems in the various regions of the country in 1999. The total irrigation service area was estimated at 1.34 M ha or about 29 percent of the estimated potential irrigable area of 4.66 million ha.

Table 2 shows the service areas by mode of irrigation for selected years as reported by the NIA. It is quite obvious that the data for communal and pump irrigation systems are of questionable reliability. It is very difficult to imagine, for example, the decrease of 300 thousand in the communal irrigation systems service area from 1993 to 1994.

The NIA defines an irrigation service area as an area with irrigation facilities. In reality, the actual area served is much less than the service area. On Table 3 are shown the NIA estimates on the actual irrigated areas by region and by season during the 1997 – 1998 crop year. Note that for all regions and for all seasons, the actual areas irrigated were much less than the reported service areas. This means that the service areas of irrigation systems as calculated during project design and preparation stage, were grossly overestimated. The disturbing implication is that we are very inefficient in the planning and implementation of irrigation projects. During the past 5 years, only about 68 and 54 percent of areas with irrigation facilities (service areas) were actually served during the wet and dry seasons respectively. Characteristic of many gravity irrigation systems, this very low actual over design irrigated area ratio is mainly due to design mistakes, unrealistic assumptions during project preparation stage, overlaps in the service areas of various modes of irrigation and inefficiency in the operation and maintenance of irrigation systems.

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Table 1. Irrigation service areas by region and by mode of irrigation in 1999.

Region	Service area (000 ha) ^{1/}				Potential Irrigable Area (000 ha) ^{2/}	Level of Irrigation development (%)
	National	Communal	Pump	Total		
CAR	17.6	30.5	22.9	71.0		
1	55.9	89.3	27.3	172.5	1,281.2 ^{3/}	34.3
2	136.8	36.4	23.1	196.3		
3	169.3	66.6	14.9	250.8	384.9	65.1
4	52.7	50.3	23.6	126.6	493.5	25.7
5	20.5	65.8	29.5	115.8	251.6	46.0
6	52.2	17.3	5.5	75.0	293.8	25.5
7	5.4	17.3	2.5	25.2	266.9	9.4
8	15.9	25.4	4.5	45.8	459.7	10.0
9	15.2	17.9	2.0	35.0	119.0	29.4
10	23.2	16.0	2.8	42.0	237.5 ^{4/}	36.6 ^{5/}
11	52.5	20.0	10.1	82.6	253.4 ^{4/}	36.6 ^{5/}
12	43.1	18.3	2.2	63.6	321.4	19.7
13	18.4	14.9	3.3	36.6		36.6 ^{5/}
Total	678.5	486.1	174.2	1,338.8	4,662.8	28.7

^{1/} Source: NIA

^{2/} Source: IBRD 1990 Irrigated Agricultural Sector Review

^{3/} Total for CAR and for Regions 1 and 2

^{4/} Totals of Regions 10 and 11 assumed to include those for Region 13

^{5/} Average for Regions 10, 11 and 13

The data shown on Tables 1, 2 and 3 are estimates by the NIA based on reports from its regional offices. The information concerning the actual irrigated areas of national irrigation systems (NIS) are probably accurate. As mentioned before, the reported irrigated areas on communal irrigation systems (CIS) and private systems are of doubtful reliability since the NIA has not been monitoring pump and non-NIA assisted communal irrigation systems. In fact, the NIA had been reporting an almost constant service area of 152 thousand ha under pump irrigation since 1982.

The private irrigation systems include semi-technical run-of-the river systems, STWs, hand tubewells, LLPs and small farm ponds. The total area presently served by these systems would not be less than 500 thousand ha. This would help explain the large discrepancies between the irrigated area estimates of the NIA and the Bureau of Agricultural Statistics (BAS). The BAS estimates shown on Table 4 are much more than those of the NIA.

Table 2. Total service areas and extent of irrigation development for selected years.^{1/}

Year	Service areas (000 ha)				Level of Irrigation Development (%) ^{2/}
	National	Communal	Pump	Total	
1964	218	393	52	663	14.2
1974	355	449	111	915	19.6
1980	472	577	152	1201	25.8
1985	568	704	152	1424	30.6
1990	637	715	152	1504	32.3
1991	646	725	152	1523	32.6
1992	647	734	152	1533	32.9
1993	647	741	152	1540	33.0
1994	652	442	175	1269	27.2
1995	652	474	181	1307	28.0
1996	652	489	183	1324	28.4
1997	663	491	181	1335	28.7
1998	679	486	174	1339	28.7

^{1/} Source: NIA Year End Reports

^{2/} Based on potential irrigable area estimate of 4,662 M ha.

The total irrigation command area at present is most probably in the order of 1.4M ha. This is broken down as follows: NIS – 470 thousand ha; NIA-assisted CIS – 290 thousand ha; and private systems – 650 thousand ha. The command area estimates for NIS and NIA – assisted CIS were based on the wet season irrigated area estimates of NIA from 1990 through 1995. The NIS wet season irrigated area, for example, fluctuated from 453 to 470 thousand ha during this period. The estimate for private irrigation systems was an educated guess.

Table 1 also shows the potential irrigable area estimates as reported in a World Bank 1990 Irrigated Agricultural Sector Study. These estimates were partly based on BSWM base maps on land suitability, land use and slope. With the estimated irrigation command area of 1.4M ha and the total potential irrigable area of 4.66 M ha, the 1999 national level of irrigation development will be around 28 percent. This would indicate vast remaining potentials for irrigation development.

It is also obvious from Tables 1, 2, and 3 that the NIA service area estimates could not be used as accurate indicators of the extent of irrigation development. In the absence, however, of accurate estimates of the irrigation command areas by region, the use of the reported regional service areas can not be avoided if rough approximations of the levels of irrigation development by region are to be obtained.

Table 3. Service areas, cropping intensities and rice yield levels in NIS, CIS and private irrigation systems during crop year 1997-1998.

Region	Total Service Area, 1000 ha	Area irrigated, 1000 ha		Rice Yield Level, t/ha		Cropping Intensity, %
		Wet	Dry	Wet	Dry	
CAR	71.0	45.7	36.6	2.81	2.81	116
Region 1	172.5	136.1	59.3	3.98	4.43	113
Region 2	196.3	139.8	143.9	3.77	4.05	145
Region 3	250.8	150.9	133.5	3.72	4.10	113
Region 4	126.6	80.6	46.6	3.73	3.84	100
Region 5	115.8	48.3	40.9	3.62	3.50	77
Region 6	75.0	57.2	46.5	3.73	3.67	138
Region 7	25.2	15.2	9.7	3.57	3.48	99
Region 8	45.8	23.9	20.1	3.73	3.62	96
Region 9	35.0	27.9	24.2	3.56	3.52	149
Region 10	39.0	22.4	21.6	4.26	4.04	113
Region 11	82.6	63.8	62.2	3.74	3.79	153
Region 12	54.1	41.1	34.9	3.63	3.67	140
ARMM	12.5	6.1	4.4	2.62	3.48	84
CARAGA	36.6	21.2	18.5	3.24	3.07	109
Nationwide	1,338.8	880.4	702.7	3.65	3.68	118

Source. NIA

Table 4 shows that the wet and dry season irrigated areas reported by the BAS in crop year 1993-94 were 1.54 and 0.68 million ha, respectively. As per the NIA reports, the total wet and dry season irrigated area for both seasons in the same crop year were 0.86 and 0.68 million ha, respectively. The very large wet season irrigated area reported by the BAS may be partly explained by the existence of numerous small, semi-technical village irrigation systems. Built and maintained through the collective labour of small groups of farmers, these private systems are mainly for supplemental paddy irrigation during the wet season and early part of the dry season. The areas served by these systems are borderline irrigated – rainfed areas depending on rainfall and how well are the water control structures maintained and repaired on time. In some Asian countries like Indonesia, irrigation authorities recognized the importance of these small, semi-technical village irrigation systems and are extending technical assistance to improve their performance. The Philippines has yet to follow suit.

The BAS surveys most probably captured the presence of areas irrigated by small, semi-technical village irrigation systems as well as those served by other small private irrigation systems such as STWs, LLPs, SWIPs and inundation schemes. Hence, the much larger wet season irrigated area was reflected in the survey. However, a 1.54 M ha 1994 wet season irrigated area would imply a total command area of about 0.7 ha of small private irrigation systems.

Table 4. Irrigated and rainfed rice area estimates, 1989-1995 ^{1/}

Rice Area, 1000 ha	Y E A R						
	1989	1990	1991	1992	1993	1994	1995
Irrigated							
Wet season	1,433	1,395	1,431	1,375	1,399	1,541	1,628
Dry season	631	615	630	605	617	678	717
Subtotal	2,064	2,010	2,060	1,980	2,016	2,219	2,345
Rainfed							
Lowland	946	811	869	727	782	959	977
Upland	488	498	495	490	482	473	462
TOTAL	3,497	3,319	3,425	3,198	3,280	3,651	3,784

^{1/} Source: Bureau of Agricultural Statistics, DA. (Based on farm surveys).

II. TRENDS IN IRRIGATION DEVELOPMENT

On Table 5 are shown the reported total service areas of NIS and CIS, the actual accomplishments of the NIA in terms of service areas rehabilitated, new irrigated areas generated and actual areas irrigated during the wet and dry seasons during the period from 1992 to 1996. During this period, rehabilitation and new area generation covered more than 410 thousand ha, averaging about 83 thousand ha per year. These massive efforts only resulted in an increase of 61 thousand ha in area irrigated during the dry season, or an average annual increase of 12,000 ha. Although nearly 40% of the 1996 total service area had either been newly generated or rehabilitated only about 56% of it was irrigated during the dry season of that year.

It has been estimated by David (1992) that an average of 55 thousand ha of CIS and NIS service areas must be rehabilitated each year in order to arrest the deterioration of irrigation facilities which results in at least 25,000 ha being taken out of the irrigation service area each year. The information shown on Table 1-8 support this estimate. In fact, it now appears that an average of about 70,000 ha per year must be rehabilitated or renovated in order just to maintain the present level of NIS and CIS development.

Table 5. Estimated total NIS and CIS service areas, service areas rehabilitated, new service areas generated and actual areas irrigated, 1992 - 1996.

Year	Service Area, ha.	Service Area Rehabilitated, ha	New Irrigated Area, ha	Actual Area Irrigated, ha	
				Wet Season	Dry Season
1992	1,054,618	21,923	10,666	704,307	574,234
1993	1,062,978	34,495	7,722	717,136	589,901
1994	1,076,575	9,618	6,736	736,025	606,435
1995	1,124,677	267,064	9,831	755,514	610,261
1996	1,132,538	39,408	15,558	791,329	635,961
Total		372,508	45,193		

Source: NIA

In practical sense, rehabilitation is the result of cumulative O & M neglect and design mistakes. Improvement in NIS and CIS operation and maintenance will be more cost-effective than rehabilitation. It is, therefore, but logical that the focus in the case of NIS and CIS in the short and medium terms will not only be on rehabilitation but on improved operation and maintenance as well.

Considering the prohibitive cost of new NIS and CIS development, there will be little contribution from these traditional irrigation systems in the expansion of the area under irrigation. This trend is clearly shown in Table 1-8 where only an average of 9,000 ha is generated each year. Since only about half of this will actually be irrigated during the dry season, the additional new area each year will only be about 4,500 ha or 0.7% of the dry season irrigated area.

The growth in the area under irrigation will come from minor irrigation development such as STW, LLP and village irrigation systems and small farm reservoirs. The country has an estimated 5 million ha shallow well areas of which only a small portion is currently being utilized for STW irrigation. This low level of utilization of these vast water resources offers the best growth opportunity for irrigated agriculture. STWs and LLPs are now becoming very popular with farmers in many regions.

There are now indications of increasing participation of the private sector and individual farmers in minor irrigation development. The surveys of the Bureau of Agricultural Statistics consistently point to a large area (at least 0.5 M ha) served by small, private irrigation systems. For example, the socio-economic survey of STW irrigated agriculture in Central Luzon by the DA-UPLBFI STW irrigation project projected a total STW and LLP population of about 50,000 (as of May, 1997) irrigating an aggregate area of

about 125,000 ha. STWs and LLPs will serve as the engine of growth of Philippine agriculture in the future.

The NIS and CIS are basically for lowland rice irrigation. This is partly because of the stringent requirement of other crops for good soil moisture regime control which is not feasible in medium and large scale gravity irrigation systems. In STW and LLP irrigation systems, farmers exercise a greater degree of water control and have opportunities for crop diversification. An increasing number of STW and LLP irrigators are now irrigating corn and high value crops (e.g., orchards). The shift towards STW and LLP irrigation will result in increasing cropping systems intensification and diversification.

III. ISSUES AND CONSTRAINTS TO SUSTAINABLE IRRIGATION DEVELOPMENT

1. Performance of Gravity Irrigation Systems and Irrigated Agriculture

Tables 3, 6, 7, 8, and 9 show the very poor performance of gravity irrigation systems. The reasons for this include the policy bias in favor of medium and large gravity irrigation systems; inadequate data base for planning; inadequate institutional capacity and mechanisms for integrated irrigation projects planning and development; design mistakes; poor quality of construction; inadequate and fragmented irrigated agriculture support services and the intractability of many of the interrelated socio-economic, institutional and technical aspects of managing medium and large irrigation systems.

The measures to improve the performances of existing systems include: (1) focus on smaller systems which are more efficient, easy to manage, amenable to privatization, cheaper to construct and have shorter gestation periods; (2) streamlining, restructuring and/or reorienting concerned public institutions or agencies for better performance; (3) integrating planning, design and operation activities for much needed interactions among planners, designers and O and M engineers; (4) emphasis on more cost-effective O and M and rehabilitation activities; (5) enhancement of regional and provincial capabilities for planning, design, operation and maintenance of irrigation systems; (6) effective monitoring of irrigation systems performance; and (7) implementing a system of greater accountability in the use of public funds for irrigation. The recommendation to focus on smaller systems that are more cost-effective and efficient has increasingly been supported by recent studies. Many of these remedial measures have yet to be factored in the formulation and implementation of policies and policy instruments.

Table 6. Average yields in irrigated and rainfed farms and average irrigation intensities, in irrigated areas, 1990 and 1994.¹

YEAR	REGION	IRRIGATION INTENSITY, %	IRRIGATED AREA YIELD, t/ha	RAINFED AREA YIELD, t/ha
1990	CAR	99	2.75	1.76
	1	92	2.84	2.52
	2	105	3.46	1.86
	3	123	2.95	2.12
	4	134	3.00	2.05
	5	217	2.60	1.59
	6	151	3.16	2.14
	7	203	2.19	1.06
	8	151	2.73	1.51
	9	166	3.54	1.66
	10	133	3.51	2.21
	11	132	3.75	2.57
	12	156	3.61	2.19
1990	National Average	129	3.10	1.99
1994	National Average	122	3.38	2.11

¹ Source: Department of Agriculture. As shown on Table 3, the average cropping intensity and yield levels for 1998 are 118% and 3.7 t/ha, respectively.

Table 7. Summary statistics, 1965-1983 maximum irrigated areas as a percentage of design areas. (After Ferguson, 1986).

CATEGORY	MEDIAN	MEAN
All systems	75.5	75.1
By size		
Small (less than 1000 ha)	70.5	79.2
Medium (1000 to 3000 ha)	72.1	75.7
Large (greater than 3000 ha)	76.8	72.8
Vintage		
Pre-NIA (before 1965)	92.6	94.0
Early NIA (1965 to 1972)	71.0	69.5
Recent NIA (1972 to 1983)	52.1	55.5

2. Performance of STW and LLP Irrigated Agriculture

A rapid appraisal of the quality of STW and LLP design and installation showed mixed results. In some provinces, more than half of the STWs and LLPs installed are either non-operational or are performing below expectations. In other provinces, most of those installed are performing satisfactorily. The ingredients to quality performance include technically competent and dedicated agricultural technicians or engineers and capable well drillers.

The agronomic and socio-economic surveys of STW irrigated areas in Central Luzon showed rice yield levels of only about 3.8 tons per ha for both wet and dry seasons. This is still below the potential yield level of 6 to 7 tons per ha reported in the techno-demo of Philrice. A summary of the numerous studies in many Southeast and South Asian countries by the IRRI showed a similar yield gap of 87 % between experimental or demonstration farms and farmers' fields. This gap has been attributed to the following production constraints:

Production constraints	Percentage contribution to the rice yield gap
Insect pests and diseases	35
Water management	26
Fertilizer and soil management	21
Weeds	9
Seeds and seedling management	9

Total	100

The experience in many Asian countries also showed that irrigation brings up rice yield level to about 3 tons per ha. Yields beyond this level pretty much depend on how well the above-mentioned production constraints are circumvented by the farmers. As shown in the above figures, there is a considerable margin for yield improvement in irrigated areas associated with proper soil and fertilizer management, water management, insects and diseases control and seeds and seedlings management.

Table 8. Performance indicators of selected World Bank and ADB supported national irrigation systems projects.

	% TIME OVERRUN	% COST OVERRUN	ERR (%)		
			APPRAISAL	COMPLETION	EVALUATION
World Bank					
UPRIIS	43	105	13.0	14.0	8.9(11.7) ^b
Aurora Penaranda	88	44	17.0	8.6	2.6(4.5)
Tarlac ISIP	69	33	15.0	13.0	n.a
MARIIS	56 ^a	-4 ^a	13.0	9.5	n.a
Upper Chico	90	-3	15.0	7.7	n.a
Jalaur	37	-2	20.0	20.0	n.a
ADB					
Cotabato	15	68	14.0	n.a.	n.a
Davao del Norte	30	177	17.2	18.4	n.a
Pulangui	87	25	18.0	11.0	n.a
Agusan del Sur	114	54	19.0	7.0	n.a
Angat-Magat	45	102	24.2	16.6	n.a
Laguna de Bay	63	42	14.2	2.0	n.a

^a Weighted average of three projects

Source: World Bank (1991)

^b Figures in parenthesis estimated based on rice price at completion date.

Table 9. Ex post estimated economic rates of return and service area of selected new and rehabilitation communal irrigation projects.

	SERVICE AREA (ha)	ERR (%)
New		
Santol, R.A.	85	14.7
Kabilukulan	489	17.6
Bugaan	100	12.2
Camagsang.	85	10.0
Sodog	137	4.2
Rehabilitation		
Santol R.S.	85	10.8
Taytay-Badian.	295	2.1
Mantayupan	170	9.9
Kilacubong	50	14.3
Kamada-Tagbac	150	12.7

Source: Dy (1989)

Studies also revealed significant interactions among the above-mentioned production constraints. The quality of water management, for example, is known to influence the level of farm inputs such as fertilizer as well as the incidence of weeds and pests. Hence, production constraints should be viewed in terms of their functional relationships. Most of the serious rice production problems in irrigated areas arise from the inability of those concerned to appreciate the cause and effect relationship among water management, dynamics of important soil properties and control of weeds and insect pests. Hence, the lack of coordination and harmony in policy instruments aimed at optimizing the benefits from irrigation development. It is important that agricultural measures designed to improve the performance of irrigated agriculture be integrated or packaged with improved water management practices.

A system of accountability for poor quality materials, design, well drilling and development and performance of STWs under the different governmental credit schemes should be put in place at all levels. This system would show a pressing need to overhaul,

reassign, reorganize and/or strengthen technical manpower at various levels. It is also important to: (1) enhance the technical capacity of public and private institutions for STW irrigation systems design, drilling, development, operation and maintenance; (2) rehabilitate non-functional and sub-optimally performing STWs; (3) package and implement agricultural measures to improve the performance of STW and LLP irrigation systems and (4) strengthen STW and LLP irrigated agriculture support services and functions.

3. *Cost-effectiveness and Suitability of Current Irrigation Technologies*

There is still a strong bias in favour of certain modes of irrigation in the allocation of funds and other resources for irrigation. To remove such bias, the criteria for allocation should be: (1) cost-effectiveness; (2) affordability (low unit area investment cost); (3) sustainability (full repair, operation and maintenance costs recovery); (4) efficiency in water use; (5) simplicity, on the part of farmer-irrigators, of operation and maintenance including on-farm water distribution and management practices; (6) length of gestation period; and (7) potential for increasing unit area productivity.

One important implication of this policy is the need to reassess the present irrigation development priorities (e.g., rehabilitation of existing gravity systems viz-a-viz the development of other modes of irrigation such as shallow tubewells, low-lift pumps, small farm ponds, small inundation schemes, treadle pumps and hand tubewells) in terms of the above-mentioned criteria. Other implications include: (1) the need to delineate or zone areas according to most suitable mode of irrigation; (2) greater participation of farmer-irrigators in the planning, development, operation and maintenance of irrigation facilities and (3) removal of irrigation subsidies.

That there are better alternatives to national irrigation systems (NIS) and communal irrigation systems (CIS) in many instances is best demonstrated by the technical and economic feasibilities of shallow tubewells (STWs), low lift pumps (LLPs) and hand tubewells (HTWs) in the command areas of many major irrigation systems (e.g., Upper Pampanga River Irrigation System). Collectively called minor or small scale irrigation, these modes of irrigation would meet most of the criteria for priority investments in irrigation development. The investment per unit area for an STW, for example, is only about 20% the average cost of rehabilitating NIA communal irrigation systems. STWs, LLPs and HTWs have the added advantages of having very short gestation periods (usually less than a week) and higher water use efficiency (65 % or more). They are simple to operate and maintain. They give farmers greater control over their crop production environment including the choice of crops and cropping systems.

Properly drilled and developed STWs and HTWs pumped within aquifers safe yields are also more sustainable. They are less vulnerable to natural calamities (e.g., volcanic eruptions, typhoons and earthquakes) and man's manipulation of environmental resources (e.g., degradations of watersheds). Most importantly, these modes of irrigation are amenable to privatization, thus requiring no subsidy on investment and on operation and maintenance. In contrast, the NIA systems usually require full subsidy on investment and partial subsidy on operation and maintenance.

It has been estimated that the Philippines has more than 5.0 M ha underlain with shallow aquifers. Seven (7) regions (1, 2, 3, 4, 6, 11 and 12) were reported to have at least 0.4 M ha shallow well areas each (NWRC, 1982). To date, only a very small portion (less than 10 percent) of our total shallow aquifer resources is used for irrigation through STWs and HTWs.

Many of our alluvial plains and valleys of our country are crisscrossed by natural waterways which could serve as water sources for low-lift pumps. In some places, there are also opportunities for inundation schemes and small water impoundments for combined irrigation and fishery purposes. The development of these modes of irrigation is also well within the capabilities of small communities and local entrepreneurs. Where technically feasible, these modes of irrigation could be more economically viable and sustainable alternatives to larger scale gravity systems.

In spite of the economic attractiveness of the different minor irrigation technologies, their promotion was hindered by: (1) total neglect of some minor irrigation support services by agencies concerned; (2) lack of baseline information on shallow aquifer characteristics, dependable flows of streams and rivers and hydrology of potential areas for inundation schemes (e.g., swamps, marshes and wet season waterlogged flood plains); (3) lack of benchmark information of suitable well development and well drilling techniques; (4) lack of affordable and suitable drilling rigs; and (5) unavailability of cheap pump sets.

4. *High Cost of Irrigation Development*

Table 10 shows the NIA's 1995 cost estimates for constructing new and rehabilitating existing irrigation systems. The average cost per hectare of constructing gravity irrigation system is at least ₱70,000, averaging about ₱100, 000. The rehabilitation cost of communal systems averages about ₱45,000 per ha.

Table 10. NIA estimates of the cost per hectare of constructing new or rehabilitating different modes of irrigation.

TYPE OF PROJECT	DESCRIPTION	PESO PER HECTARE	
		AVERAGE	RANGE
NIP	Area: 5,000 to 20,000 ha	100,000	(70,000-180,000)
NIS (rehab)	Area: 5,000 to 20,000 ha.	10,000	(8,000-12,000)
SRIP	Dam Height: >=30 m.	180,000	(130,000-200,000)
Deepwell Pump	Size: 8-inch diameter Depth: >=100 meters Area: 50 hectares	30,000	
Shallow Tube Well	Size: 3 to 4-inch diameter Depth: <20 meters Area: 3 to 5 hectares	25,000	
Shallow Tube Well	Size: 3 to 4-inch diameter Depth: >20 meters Area: 3 to 5 hectares	45,000	
CIP (new)	Area: 100 to 200 hectares	70,000	(65,000-80,000)
CIS (rehab)	Area: 100 to 200 hectares	45,000	(40,000-50,000)

Source: NIA (1995)

Of interest is the investment cost per STW under the NIA STW credit scheme. It ranges from P25,000 to P45,000 per hectare. The investment cost per STW under the DA STW credit scheme is, on the other hand, about P15,000 per hectare. A private entrepreneur could perhaps develop a STW for less than P7,000 per ha using some of the options for pumpsets as shown on Table 11. The differences in investment costs for STWs among the DA, NIA and private entrepreneurs reflect the differences in technology and the added cost due to inefficiencies in management.

Table 11. Cost items for a 40-foot, 4-inch & STW designed to irrigate up to 5 ha. (As of June, 1996)

I T E M S		COST IN PESOS
A.	Materials and labour for STW drilling and development	10,000
B.	Pump (Options)	
	1. Popular brands	3,600
	2. Cheaper Chinese brands	2,000
C.	Prime Mover (Options)	
	1. 5-7 Hp brand new Japanese diesel engine	30,000-38,000
	2. 5-8 Hp brand new Chinese diesel engine	5,000-14,000
	3. Reconditioned 6-8 Hp Japanese diesel engine	8,000-13,000
	4. 4-6 Hp brand new Chinese electric motors	6,000-10,000
	5. Reconditioned 4-6 Hp electric motors	2,000-8,000
D.	Total Investment for Selected Options	
	1. A-B1-C1 (top of the line)	43,600-51,600
	2. A-B1-C2 (Budget 1)	18,600-27,600
	3. A-B1-C3 (Budget 2)	21,600-26,600
	4. A-B2-C5 (Budget 3, in areas with suitable electrical connection)	15,600-21,600

The very high development cost of a NIA STW unit is symptomatic of the inefficiency of the agency. There seems to be very little motivation within the agency to search for more suitable and more cost-effective technologies. This is also true to the NIS and CIS where investment costs are even higher. These costs will continue to rise and the NIA efficiency in planning and implementing irrigation projects will continue to go down unless far-reaching reforms, reorganization and reorientation are instituted within the agency.

Despite the economic attractiveness of minor irrigation technologies, the government is still bent on financing the construction of large gravity systems (NIS). Political expediency, donor driven priorities and bureaucratic biases all come into play in making decisions on the nature of irrigation investments.

5. Subsidy, Irrigation Service Fee (ISF) and Sustainability

The overriding issue in irrigation development today is sustainability. It is directly related to the issues of subsidy, cost-effectiveness, efficiency and cost recovery. To achieve efficiency and sustainability, irrigation subsidies must gradually be removed. This implies that irrigation investments must be fully recoverable.

The present policy on subsidy is biased in favour of national irrigation systems (NIS). The government fully subsidizes the construction and about half of the O & M costs of national irrigation systems. In the case of communal irrigation systems (CIS) farmers are required to finance the operation and maintenance as well as contribute 10 percent of the cost of construction and repay the balance without interest within 50 years.

The DA STW loan scheme requires farmers to pay an interest free STW construction loan within five years. The NIA STW scheme subsidizes about 70 percent of the installation cost of a STW. The Land Bank, on the other hand, charges a yearly 14 percent interest plus 2 percent service fee on its STW loans.

The heavy subsidy on NIS and CIS has been the primary disincentive to the judicious choice of irrigation technologies. Such inequity in subsidy increases farmers' demands for NIS relative to the more cost-effective irrigation technologies and discourages private sector participation in irrigation development. Obviously, such a policy can not be sustained.

The subsidy on the operation and maintenance of NIS should gradually be removed. The NIA request for an average annual subsidy of P275 M for the O & M of NIS under the AFMA should be carefully reviewed.

The ISF collection from NIS for the period from 1991 to 1995 averaged only 58 % of the total collectible. It is interesting to point out that this was approximately the same as the percentage of the service area actually irrigated during the dry seasons of the same period. It is quite clear that the NIA should improve the efficiency and performance of its NIS if it has to increase its ISF collection.

The NIA should also strive to reduce the O & M costs of its NIS. One way of doing this is to reduce the NIS service areas down to realistic levels (e.g., down to command area levels or areas that can be irrigated during both wet and dry seasons). This will cut down the NIS service areas by an average of about 30% and will enable the NIA to focus its repair, O & M, rehabilitation and other activities on smaller but realistic service areas.

The NIA should exert more effort towards increasing its irrigation service fee collection. This may be done by equitable, adequate and timely delivery of irrigation water and improved delivery of irrigated agriculture support services for higher yield and cropping intensity. Redelineating the NIS irrigation service areas down to realistic levels will go a long way towards increasing unit command area water supply and improving irrigated agriculture support services. Strengthening water users associations (WUAs) by giving them better incentives to take control over the repair, operation and maintenance of secondary and tertiary canals will also help reduce O & M costs and improve ISF collection.

The present policies governing ISF rates should be carefully reviewed. The present ISF rates which were approved in 1974 and implemented starting 1975 now fall short of the cost of repair, O & M and rehabilitation. These rates were partly based on the capacity of farmers to pay. During times of poor harvest (less than 2.0 t/ha) farmers are exempted from the payment of ISFs. The same farmer-beneficiaries are not, however, charged higher fees during period of good harvests.

6. *Water Rights and Water Pricing*

In irrigated areas adjacent to urban centers, there are increasing demands for water from competing users. In the Angat River Irrigation System, for example, there are increasing pressures to divert irrigation water to supplement the water supply of the Metropolitan Manila area. There is a much higher premium for water for domestic and industrial uses and users are willing to pay a much higher price for water than irrigators.

There are no coherent policy guidelines and regulations on water rights, water pricing and water control. There should be a review and reassessment of water rights policies and regulations with the end view that such policies and regulations are fair, effective and implementable. Such policies and regulations should take into consideration resources capabilities such as dependable surface water supplies from rivers and safe yields from aquifers as well as demands for water from competing users.

Irrigation water prices should be set, at the very least, at full operation and maintenance cost recovery with the irrigation service fees going to public or private entities managing the irrigation system. The practicality of implementing the concept of tradable rights on water resources should be pilot tested in areas where there are increasing competition for domestic and industrial water uses (e.g., Metro Manila and Metro Cebu).

In not a few cases, STWs, HTWs and deep tubewells are installed without water rights. If water rights are ever issued, their issuance is usually not based on an assessment of dependable water supplies and projected total withdrawals from water sources. Hence, there are dangers of deep tubewells (DTWs) for other utilization objectives encroaching on STW areas and rendering them inoperational. The cost of converting STWs into DTWs will be staggering. There has to be strict implementation and compliance with water rights so as to safeguard the interest of all parties concerned. However, there has to be a provision for trading or selling water rights for economic efficiency and equity.

7. *Policy Framework for Water Resources*

Many areas of the country are now experiencing water shortages due to increasing demands for water for various utilization objectives. This early, the competition for water triggered a call for a water crisis act. Hence, the need for a comprehensive water resources policy framework whereby the demands for water from all sectors are fully taken into consideration.

A national water commission or task force with representatives from the various sectors/subsectors concerned should be established for the task of developing the comprehensive water resources policy framework. The commission should have an adequate water resources data base with linkages to other monitoring and evaluation network on water resources. In due time, the commission would either be institutionalized or its increasingly vital functions subsumed by another organization.

8. *Credit for Small Scale Irrigation Development.*

Presently, there is very little credit available to finance the acquisition of STWs and LLPs by farmers. Institutional weaknesses, inadequate loan supervision, insufficient number of field staff and cumbersome loan disbursement procedures are contributory factors to the inability of agricultural credit institutions to reach individual small farmers. The LBP credit scheme for agricultural machines, for example, requires a farmer to be a member of a cooperative of good credit standing in order to qualify for a loan. The effective interest of the loan is rather high. The scheme is beyond the reach of most farmers.

At present, informal credit channels are insufficiently linked to formal sources of credit (e.g., LBP, DBP, etc). The role of NGOs as informal credit conduits and as viable links to farmers of formal credit institutions should be enhanced.

In the distant past, the DBP had a credit window for pumpsets (engine and pump for STWs and LLPs) for individual farmers. In spite of serious constraints in the then available STW technologies, this credit scheme was very successful in terms of promoting STWs and LLPs in some parts of the country. The merits of this scheme are worth evaluating for possible incorporation into the STW credit programs of the government.

9. *Tariffs on Irrigation Equipment*

The present tariff rates are biased against the irrigation subsector. While most agricultural machines are assessed a duty of 3 percent, centrifugal pumps and their prime movers (mostly small diesel engines) that are used as pumpsets for STWs and LLPs are assessed a duty of 10%. The duty, for example, for a single cylinder engine used for a power tiller is 3%. When coupled to a centrifugal pump, the same engine is assessed a duty of 10%. Pipes, tubings and valves are assessed even higher tariff rates ranging from 10 to 30 percent.

10. *Institutional Arrangements/Mechanisms*

An assessment (David, 1996) on the adequacy of the existing institutional mechanisms and arrangements for timely and effective delivery or performance of essential minor irrigation development activities, support services and functions revealed critical gaps and overlaps. Far reaching institutional reforms are urgently needed to (1) fill the voids in and/or strengthen essential support services and functions and (2) reorient and existing organizations for stronger linkages and greater synergy in the functions, services and activities of policy analysis and planning; programming; monitoring; research and development; extension; credit and marketing and inputs supply. The lines of responsibilities and accountabilities for these services and functions are not clearly defined at present. The essential support services and functions that urgently need strengthening include: (1) policy formulation, planning, programming and monitoring at the upstream level; (2) research and technology generation, mature technology identification and packaging; institutional development, packaging of credit and marketing facilities and resources capability assessment at the midstream level; and (3) extension and demonstration at the downstream level.

The needed institutional changes may include establishing new institutions and/or restructuring, strengthening, downsizing and dismantling existing institutions for efficient and effective delivery of essential agricultural support services and functions and enhanced participation of the private sector in irrigation development activities. A cause for alarm at present is the apparent weak linkage between the DA and the devolved provincial and municipal agricultural services staff. This adversely affected the delivery of essential support services for irrigation. The DA should exert greater efforts at strengthening this linkage and, if possible, re-establishing technical supervision. Among others, this would require manpower development at the provincial and municipal levels.

Among others, the proposed changes include strengthening the BSWM, the RFUs and the LGUs in terms of capability and number of technical staff and facilities; restructuring and reorienting the NIA for greater efficiency and effectivity; strengthening the DA's capacity for irrigation policy analysis, formulation and planning; establishment of an irrigation subsector monitoring and evaluation system within the DA and transformation of the Department of Land and Water Resources of the College of Engineering of UPLB into a Water Resources Research and Training Institute which will implement, in coordination with the DA, NIA and other SCUs, a comprehensive Irrigation R & D umbrella program.

Continuing policy adjustments are needed to reinforce the institutional reforms. Routine adjustments in policies supportive of strengthening institutional arrangements will enable the government to eliminate unnecessary administrative costs, bureaucratic delays and duplication of efforts.

11. Public Sector's Capacity to Perform Upstream Support Services and Functions

Efforts aimed at accelerating the pace of irrigation development and improving the performance of irrigated agriculture suffered periodic setbacks partly because of inadequate monitoring and ineffective policy planning. Examples of policies and policy instruments that had negative impacts on irrigation development include the following: (1) emphasis on large, multipurpose irrigation systems leading to neglect of small irrigation systems; (2) heavy bias towards irrigation hardware at the expense of irrigation software and essential baseline information; (3) high tariff rates on irrigation equipment; (4) non-tariff barriers to the importation and trade in irrigated agriculture production inputs; (5) high subsidy on irrigation investment as well as on repair, operation and maintenance of irrigation facilities; (6) highly fragmented institutional arrangements for the development of irrigation facilities and delivery of irrigation support services and (7) under investment in the development of irrigated agriculture technologies aimed at increasing irrigated agriculture productivity and enhancing production incentives.

There is an urgent need to strengthen the DA capability for irrigation subsector policy planning both in terms of staff number and technical depth. These staff will also have to be supported with improved information and information systems (preferably an irrigation subsector M & E system anchored at the Bureau of Agricultural Statistics) and, initially, with expanded technically-based analytical support (technical assistance from external sources). Presently, there are no reliable information on the command areas of various modes of irrigation. There is also a need for timely information on the performance of irrigated agriculture from agronomic, socio-economic, hydrologic and engineering standpoints; adequacy of irrigation support services; performance of irrigation programs and projects; and

private sector trade and servicing of irrigation equipment. Effective formulation and routine adjustments in policies and policy instruments would require such information.

12. *Private Sector Participation*

The public monopoly over irrigation development and well-meaning but inappropriate policy and policy instruments prevented the timely introduction of more suitable, sustainable and cost effective irrigation technologies, imposed added costs on irrigation facilities and services, and allocated scarce public resources to activities and technologies that are either unnecessary, unsustainable or inefficient. These precluded the increased participation of the private sector in irrigation development.

The government should devolve into the private sector as much essential irrigation services, functions and activities as possible. As the experiences in many Asian countries (e.g., India, Bangladesh, Korea, Taiwan and Thailand) have shown, the private sector is more efficient and effective than the public sector in promoting certain irrigation development activities. This devolution will enable the public sector to focus its resources and energy on enhancing the incentives for irrigated agriculture production through improved irrigation support services (e.g., agro-industrial extension, R & D, monitoring and evaluation, policy planning and provision of technical assistance to the private sector) and promoting more productive investments in agriculture. The procurement, trade, installation and servicing of small irrigation equipment (e.g., STWs, LLPs and HTWs), for example, should be fully privatized. To further enhance the role of the private sector in irrigation development, the government should deregulate the irrigated agriculture subsector by eliminating or streamlining unnecessary and/or distortionary regulations and public interventions such as the impositions of non-tariff barriers to irrigated agriculture production inputs and restrictions over the introduction of various modes of minor irrigation other than those due to sound hydrologic and environmental reasons.

13. *Role of Farmers, Water Users Associations (WUAs) and LGUs*

As a matter of policy, the government encourages greater farmers' participation in the planning and implementation of irrigation development activities. It promotes ownership and control of STWs and LLPs by individual farmers and private entities. It also mandates the control and ownership of CIS and Small Water Impounding Projects (SWIPs) by WUAs as per the provision of the Magna Carta of Small Farmers (RA7607) which states that "the Government shall assist the farmers in establishing self-help organizations and empower them in the ownership or management of production resources". RA 6978, an Act to promote rural development through accelerated small scale irrigation development, stipulated that (1) farmer-beneficiaries of a CIS shall participate in all stages of planning, development and implementation of the project and (2) that the water users or irrigators association which will be organized for the project shall manage the CIS.

The Local Government Code of 1991 (RA 7160) devolved to the LGUs the implementation of locally-funded CIS. The appropriations for CIS projects have been included in the internal revenue allotments of LGUs since 1992.

The implementation of communal irrigation projects by LGUs has not been going well for a variety of reasons. These include inadequate technical capability to implement irrigation projects, emphasis on less capital intensive projects and lack of interest on CIS development on the part of some LGUs. To partly circumvent these constraints, there should be increased collaboration among the DA agencies, LGUs, SCUs and the private sector in irrigation development and clearly defined roles of LGUs and SCUs in irrigation development and in the delivery of essential irrigation support services and functions vis-a-vis those of the NIA, the DA and the private sector.

14. Fragmentation of Irrigation Development Activities

Many government agencies are currently engaged in various irrigation development activities. Within the DA, for example, there are two parallel STW irrigation development programs. One is the STW Irrigation Program under the Gintong Ani. This is being implemented by the DA Field Operations Group through the Regional Field Units. The NIA initiated a STW development program for the Mt. Pinatubo affected provinces. This program was expanded nationwide this year with a GAA funding support which is even bigger than that of the Gintong Ani STW program. The two programs are being implemented independently under different sets of policy guidelines (the Gintong Ani credit scheme is interest free and payable in 5 years while the NIA STW credit scheme has a 70% subsidy).

Without the proposed integration of activities under one roof, it will be difficult to chart a course for STW development that is cost effective, efficient, sustainable and environmentally sound. For how can the hydrologic and environmental impacts of STW development be monitored and evaluated without integrated planning, programming, monitoring and coordination of STW activities?

15. Irrigation R and D and Technological Base for Planning, Design, Development and Operation of Irrigation Systems

There has always been very little support for irrigation R&D despite the fact that the bulk of the available information worldwide show very high rates of return of agricultural research especially in developing countries like the Philippines which had under invested in the development of agricultural technologies in favour of investments in infrastructures. For example, there are ample indications from recent studies that the rates of returns for investment in irrigation R and D are much higher than those for infrastructures. In fact, with correctly focused R and D efforts, the wastage of huge financial resources for the development of inefficient and nonfunctional irrigation infrastructures could have been avoided. Considering that the Philippines is a poor agrarian country with a large rapidly growing population but with very limited lands to exploit and, as such, must depend on continuing expansion of irrigation for sustained agricultural growth, there is a very strong case for increasing public investments in irrigation and water management research.

A review of the research in irrigation, water management and irrigated agriculture in the country would reveal the absence of significant R and D efforts in support of irrigation development. As a result, there has been very little useful outputs in terms of appropriate irrigation and water management technologies. Moreover, the very limited research in

irrigation and irrigated agriculture is underfunded, incorrectly focused, fragmented, crop oriented and rarely taking into account the social and economic constraints faced by the farmers. Hence, most of the results are inconclusive and are of little relevance to real irrigated farming situations.

The sad state of irrigation research led to the complete neglect of STW irrigation development although it has long been known that the country has vast areas with good shallow aquifers. The lack of R and D on suitable drilling rigs, well drilling and well development technologies as well as information on shallow aquifer characteristics precludes significant utilization of shallow aquifers for irrigation.

The very high and still escalating cost of NIS and CIS development and rehabilitation is, in part, due to the lack of research leading to the development of appropriate technologies for more accurate, efficient and cost-effective gravity irrigation systems design, construction, repair, operation and maintenance. The very poor agronomic performance (low yield level and cropping intensity) of existing irrigation systems is largely due to the very little research efforts aimed at developing irrigation software (e.g., suitable irrigation methods, on-farm water management packages for diversified crops and improved irrigation systems operation and maintenance). Along with relevant socio-economic and policy concerns, these productivity enhancing research agenda deserve higher priorities.

There are compelling reasons to reorient and refocus irrigation research not only to develop and promote cost-effective, appropriate and efficient irrigation and water management technologies but also to strengthen the support services to irrigated agriculture, to foster a policy environment conducive to sustained irrigation development and in harmony with a comprehensive water resources policy framework and to strengthen research and extension linkages. There is a need to immediately address the following weak points of the research system on water resources planning and development, irrigation and irrigated agriculture: (1) weak planning, programming, prioritization and packaging; (2) weak management, accountability and coordination; (3) inadequate regular government funding; (4) inability of agencies concerned to effectively monitor, evaluate and coordinate the research activities of various agencies and institutions; (5) highly fragmented; and (6) weak linkages with extension services. Many of these shortcomings can be overcome by establishing a National Water Resources and Irrigation Research Institute for concerted, coordinated and well managed research activities.

16. Research and Extension Orientation and Linkages.

There are compelling reasons not only to increase the level of funding but to reorient research from crop or commodity focus into a farming system, or better still, integrated production system orientation. With the present commodity orientation, research on non-commodity areas as irrigation and socio-economic concerns is fragmented, uncoordinated and not properly focused. A farming systems approach (e.g., irrigated, diversified cropping systems) minimizes gaps and overlaps in research development activities. It naturally takes into consideration interactions among crop mixes in a dynamic crop production environment.

An integrated production system research and extension orientation supports the vertical integration of agricultural development activities. Intensive and diversified irrigated

agriculture will require irrigation, good quality seeds and other inputs, suitable farm mechanization, primary processing (e.g., drying and storage) of farm products and secondary and tertiary processing of farm products and by-products (e.g, food and feed processing). This vertical integration of activities in crop agriculture (from intensive and diversified irrigated agriculture to suitable farm mechanization to agro-processing and development of related agribusiness) offers the best opportunities for increasing farm incomes, generating employment and livelihood for the rural poor and bringing women and other underprivileged groups into the mainstream of agricultural development.

There are no easy and uniform pathways or processes for the effective transfer of irrigation technologies from R & D centers to farmers' fields. The irrigated crop subsector is not homogeneous as the country has many different agro-ecological zones with varying water supply conditions, crop mixes and farm groups having different needs and farming constraints. The intervening processes or linkages between research and extension include monitoring of existing as well as newly developed technologies; identification, evaluation, suitability assessment and adaptive modification of promising technologies; and eventual packaging of mature technologies for dissemination. For the extension messages to be attuned to the specific needs of the different farming groups and agribusiness concerns, testing, suitability assessment, modification and packaging of technologies must be location specific and specific problem oriented.

Technology monitoring and identification, testing, suitability assessment, adaptive modification and packaging are the vital linkages or processes between research and extension. These processes are, in fact, indispensable parts of an effective, integrated research and extension system. It is only by strengthening these vital linkages that research and extension services can be made sensitive to the changing needs of individual farmers and agro-industries.

17. *Potential Irrigable Areas*

There are no available information on the areas potentially irrigable by various modes of irrigation. The NIA estimates of potential irrigable area includes all contiguous areas of 100 ha or more with slopes not exceeding 3 percent. Such areas were delineated using old Bureau of Coast and Geodetic Survey topographic maps and total some 3.1 M ha nationwide. Included are areas that have been converted into non-agricultural uses. Excluded are irrigable areas with over 3% slope but can feasibly be irrigated and small (less than 100 ha) patches of flat lands with good shallow aquifers and/or surface water sources. The NIA definition of irrigable area ignores dependable water supply for irrigation, feasibility of small scale irrigation and feasibility of irrigating crops other than rice. On regional and provincial levels, the NIA estimates may be in error by as much as 100 percent. Using the BSWM base maps on land suitability, land use and slope, the World Bank estimated the total potential irrigable at 4.7 M ha, about 51 % more than the NIA estimate. The World Bank estimate still ignored some areas potentially irrigable by shallow tubewells. Hence, the need to accurately delineate the areas potentially irrigable by various modes of irrigation. It is also important to zone the potentially irrigable areas on the basis of certain set of criteria such as cost-effectiveness, length of gestation period and sustainability of irrigation systems.

18. *Water Resources Supply Dependability*

There is a dearth of information on water resources supply dependability. There are pressing needs for comprehensive action programs for shallow aquifer characterization, assessment of surface water potentials for irrigation and other utilization objectives for the proper identification and zoning of potentially irrigable areas by various modes of irrigation.

19. *Enhancing Land and Water Resources*

Our watersheds are subject to continuing manipulations. Some are for land and water resources development such as irrigation. Others are for purposes not directly related to water resources utilization but with associated hydrologic side effects. The conversion of forests cover into urban areas or grasslands, for example, resulted in shifting hydrographs (increasing flood peaks and decreasing dependable streamflows) and water quality degradation. Land use transformations may also have adverse effects on the recharge and safe yields of shallow aquifers.

The traditional methods of protecting critical watersheds and aquifer recharge areas by reforestation and agro-forestation have to be augmented with mechanical methods in order to conserve as well as enhance vital land and water resources.

20. *Environmental Impacts of STW Expansion*

The potential environmental impacts of declining groundwater levels due to increasing STW population are many and varied. Most of them are interrelated as they are basically influenced by the hydrologic side effects of changing ground water flow characteristics. This is perhaps the main reason for the confusion among laymen and even among experts on the extent and impacts of groundwater declines from STW irrigation.

STW expansion could lower the groundwater level down to a maximum of about 7.5 m in the vicinity of pump wells. It will be much less further from the well. Such lowering of the groundwater level may result in the following:

1. Increasing number of inoperative STWs and HTWs at certain hours during the dry months. This is more in the case of tubewells located upstream of major aquifer systems. A widening area of deep water levels will have negative impacts on irrigation development and on village water supply and sanitation.
2. Decrease in the dry season flows of natural waterways. Some aquifers (e.g., unconfined aquifers) are hydraulically connected to river systems. They feed the river system with water during the dry months. The lowering of groundwater levels will reduce the base or dry season flows of natural waterways. There will be adverse effects on water quality (e.g., concentrations of agro-chemicals and animal wastes), on water supply for low lift pump and gravity irrigation systems downstream, on navigation and on aquatic life.

3. Decrease in groundwater flow towards mangroves and other coastal area ecosystems. The groundwater gradient toward coastal areas is usually very small. Decline in groundwater levels during the dry months will further reduce this gradient and will cause a reduction in fresh water inflow into the coastal areas. This may result in increase salinity of brackish water ecosystems which may trigger a chain reaction within the marine resources food chain.
4. Increased salt water intrusion in coastal areas. A reversal of hydraulic gradient due to decline in groundwater levels may lead to salt water intrusion in coastal areas. In fact, a decrease in the dry season flows of waterways may induce salt water intrusion much further inland through river networks.
5. Induced recharge and possibility of groundwater pollution. Where groundwater aquifers are hydraulically connected to the river systems, a reversal in groundwater gradient near the river system will induce inflow or recharge from rivers. Hence, there are potential risks of groundwater contamination from polluted rivers.

21. Siting Restriction on Tubewells

There are misconceptions even among technical people on the potential environmental impact of STWs. There are those who voice concern that too many STWs will result in declining groundwater levels and subsequent groundwater mining and possibly land subsidence. Groundwater level decline should be differentiated as to: (1) temporary overdraft or (2) groundwater mining (sustained withdrawal beyond the aquifer's safe yield). Under temporary overdraft conditions, the mean annual groundwater abstractions are within the safe yields or recharge rates of the aquifers. In such cases, the groundwater levels return to their normal levels at the end of the wet season. Under conditions of groundwater mining, the groundwater levels continue to subside as groundwater withdrawals are in excess of aquifer recharge rates.

The fact of the matter is that STWs operate by suction lifting and can not extract water beyond the suction lifting range of about 7.5 m (below the ground surface). Hence, STWs can not possibly mine groundwater. The groundwater extracted by shallow tubewells is usually replenished during the wet season. Restriction over the number or siting of tubewells may, however, be necessary in order to keep the water level within the suction lifting range throughout the dry months irrigation season in order to prevent partial crop failure due to water shortage as a result of temporary groundwater overdraft. The threshold level whereby STWs become inoperable should be defined for all major aquifer systems. This threshold level or limit to groundwater utilization by suction lifting should be allowed to be reached or exceeded as the only alternative to sustaining groundwater irrigation is to shift to deep tubewells.

Deep wells can extract water beyond the suction lifting range and their unrestricted development may lead to groundwater mining and other adverse environmental side effects. Siting deep tubewells for irrigation in STW areas should only be allowed if their operation will not adversely affect the operation of STWs.

22. *Farming Systems Diversification and Crop Mixes*

One of the advantages of minor irrigation is the great degree of control farmers exercise over the distribution and application of irrigation water. As a result, minor irrigation is more amenable to farming systems intensification and diversification. Farmers with shallow tubewell irrigation should be encouraged and supported in their efforts to diversify towards high value crops and farming systems (e.g., rice-fish farming systems) so that they can take advantage of favorable market and environmental conditions..

23. *Irrigation Machinery Testing and Evaluation*

The test and evaluation procedures of Agricultural Machinery Testing and Evaluation Center (AMTEC) are not based on random samples and, as such, are subject to misinterpretation and manipulations by interest groups. AMTEC also does not evaluate the durability and long-term operating efficiencies of irrigation machinery. To meet the need of the STW and LLP programs, AMTEC should test and evaluate, on a random sample basis, the following:

1. Irrigation machinery to be included in open bids and canvasses.
2. Newly introduced irrigation machinery in the Philippine market.
3. Irrigation machinery delivered under the DA procurement schemes.
4. Performance of reconditioned machinery for the general information of farmers.
5. Field performance with time of engines and pumps to generate baseline information on durabilities and long term operating efficiencies of different irrigation devices and their accessories.

24. *Standardization of Irrigation Machinery*

There is a tendency to equate standards of performance with models and brands of engine and pumps. In many public biddings, a Japanese-made engine is often specified as a standard. The trade offs between engine price and technical performance are not fully scrutinized. It is, therefore, essential to base irrigation machinery standards on technical performance and economic parameters and not on brands and models.

IV. OPTIONS IN IRRIGATION

It has been shown that irrigation increases yield in cropping intensity. On the average, irrigated rice outyields rainfed rice by about a ton per ha. The availability of water all year round enables some farmers to have a second or third crop. Hence, the Philippines has always looked at irrigation as a potential engine of growth for agriculture. Unfortunately, the emphasis in irrigation since the mid 1960s has been on national and communal irrigation projects (medium to large scale, gravity projects) that have mostly proven to be unsustainable and costly to develop, operate and maintain.

Presently, the Philippines has an estimated 4.7M ha of potentially irrigable agricultural lands (based on most recent estimate by the World Bank). Yet only about 1.4M ha is currently irrigated by all modes of irrigation.

The bulk of the available information presented earlier show that the country is realizing less than half of potential benefits from irrigation development. At approximately 132%, the average cropping intensity in irrigated areas is very low compared to potentials of 160 to 220%. At about 3.4 t/ha, the average rice yield level in irrigated areas is low compared to yield potentials of 5 to 6 t/ha.

There are very alarming indications of decreasing efficiency in the planning and implementation of national irrigation systems (NIS) and communal irrigation systems (CIS) as attractive schemes get fewer and fewer and vital watersheds are increasingly subject to exploitation by an ever increasing population. On the average, the area actually irrigated by these systems during the dry season is only about 52% of their designed serviced area. This implies that if NIS and CIS irrigation facilities are designed and developed for 100 ha, only about 52 ha, on the average, will actually be served during the dry season. As a result, many of the existing CIS and NIS are not self-sustaining.

On the average, irrigation service fee collection only amount to about 58% of the assessed fees. The percentage of the irrigation fee collection to the total amount required for adequate repair, operation and maintenance is much less than 50%. Hence, the need for frequent rehabilitation.

Fortunately, the country is blessed with abundant shallow groundwater resources. The National Water Resources board estimated an aggregate of 5.1 M ha shallow well area nationwide. These potential shallow tubewell (STW) areas are mostly in rice and corn growing alluvial plains. These could be tapped to irrigate new areas or supplement the limited surface water supplies in the existing NIS and CIS command areas. In addition, the country is crisscrossed by natural waterways which are good sources of water for small portable low-lift pumps (LLPs). These cost-effective, efficient, farmers controlled minor irrigation technologies offer the best growth opportunities for Philippine agriculture in the short and medium-terms.

Table 12 shows the options for new irrigation systems development. The potentials/opportunities/advantages and the disadvantages/constraints for the various irrigation modes are also shown. It is quite clear that the minor irrigation technologies are the most appropriate technologies for the future. The Agriculture and Fisheries Modernization Act (AFMA) of 1997 clearly recognized this fact when it called for a shift in the focus in developing new irrigation facilities to STWs, LLPs and similar low-cost, farmers' controlled, privatized and sustainable irrigation facilities. Moreover, it called for expanded and concerted R&D efforts, which are almost non-existent at present, and the development of appropriate policy and institutional environment conducive to improving the performance of irrigated agriculture.

It is also imperative that considerable rehabilitation efforts will be required to arrest the decline in the command area and performance of NIS and CIS. It has been estimated that the country should rehabilitate an average of about 70,000 ha of NIS and CIS irrigation service area in order to maintain the present level of development by these modes of irrigation.

4.1. Irrigation Development Strategies

1. New Irrigation System Development

It is quite clear from Table 12 that the most attractive options for new irrigation system development are the minor irrigation technologies such as shallow tubewells (STWs) and portable low-lift pumps (LLPs). These modes of irrigation are easy to install and operate, are owned and operated by individual farmers, and are amenable to privatization. Where these technologies have been aggressively promoted (e.g., in Regions 1, 2 and 3), the private sector has taken over much of the development and investment activities. Collaborative studies carried out by the UPLBFI Shallow Tubewell Irrigation Project, and the Field Operations Services and Bureau of Agricultural Statistics of the DA showed that there were more than 100 and 50 thousand STW (including LLP) units in Regions 1 and 3, respectively, in 1998. The private sector installed more than 90% of these units.

The minor irrigation technologies have very short gestation periods (2 to 10 days for STWs and LLPs) and very low investment costs (P5000 – P20,000/ha as compared to over P100,000/ha for the NIS). With these irrigation technologies, farmers exercise a great degree of control over their farm production environment and farming systems including crops and crop mixes. Hence, they meet the requirements set forth by the AFMA for the investment of public funds for irrigation.

The rightful role of the public sector in minor irrigation development is to provide support services (e.g., credit; marketing; research and development; technology demonstration, packaging and dissemination), foster a policy environment conducive to privatization of irrigation and enhance institutional capacity for accelerated minor irrigation development. The ongoing DA-UPLBFI STW Irrigation Project has been formulating guidelines and recommendations for enhancing the roles of both the public and private sectors in minor irrigation development. These should be fully considered in the preparation of the national minor irrigation development plan called for by the AFMA.

2. Rehabilitation of Existing National and Communal Irrigation Systems

From the viewpoint of food security and poverty alleviation, there is a strong case for subsidizing the cost of rehabilitation, operation and maintenance of gravity irrigation systems (58% O & M irrigation service fees collection rate at present). Such subsidies, should, however, be time-bound and should be conditioned on far-reaching institutional reforms and policy changes within the agencies and institutions concerned so that the mistakes of the past are not repeated and that the rehabilitated systems will be self-sustaining. For better results, certain guidelines must be followed. These should include the following:

a) Reducing the irrigation service areas down to realistic levels of the Irrigation systems to be rehabilitated

On the average, the existing national and gravity irrigation systems can only irrigate 52% of their designed service areas during the dry season. Even during the wet season, only about 78% of the service areas of these irrigation systems are actually served. It is, therefore, not surprising that only about 58% of the assessed irrigation fees are actually collected. Hence, there is a need to cut down the service

area of each system to be rehabilitated down to a realistic level (which should be established on the basis of average area actually irrigated or on the actual dependable water supply and demand situation). There are advantages to doing this. The more obvious ones include lower rehabilitation as well as operation and maintenance costs, more sustainable irrigation systems as the chance of full O & M cost recovery after rehabilitation is improved, more focused irrigation support services and higher unit area productivity due to increased water supply dependability. To address the resulting inequity in access to irrigation facilities, the excised area should be irrigated by other more efficient alternative modes (e.g., STWs and LLPs are usually feasible in such areas).

b) Full O & M cost recovery

The beneficiaries must be willing and able to shoulder the full cost of future repair, operation and maintenance.

c) Cost-effectiveness, greater degree of farmers control and high Potential for increasing productivity as mandated by the AFMA

2. Improving the performance of irrigated agriculture

The goals of optimizing the benefits from irrigation development and improving the welfare of small agrarian reform communities, other small farmers and underprivileged groups through irrigation development can only be realized with high performance irrigation systems. Some of the needed measures for improving the performance of irrigated agriculture include the following:

a. Improving the planning, operation and maintenance of irrigation systems

Well-focused and location-specific research leading to accurate formulation of design criteria and development of cost-effective irrigation technologies are indispensable to efficient and effective planning and management of irrigation systems. The Comprehensive Irrigation R&D Umbrella Program which the DA launched recently has been designed to generate such information. The timely and successful implementation of the program (CIRDUP) should be relentlessly pursued. The CIRDUP aims to generate baseline information (e.g., aquifer properties, dependable water supplies) for planning; generate irrigation technologies to improve the operation and maintenance of irrigation systems; operationalize an irrigation subsector monitoring and evaluation system and develop suitable policy and institutional frameworks for accelerated and sustainable irrigation development.

Irrigation service fees for NIS and CIS should be reviewed with the end view of setting such fees at full O & M cost recovery. This should, however, be carried with equal emphasis on improving irrigation and water management services and cutting down on O & M costs including far-reaching institutional reforms for timely and effective irrigation support services. The Government, through the NIA and the concerned agencies should continue to ensure the proper operation and maintenance of the NIS and CIS during the interim period of five years prior to transferring their control to the local government units.

The concerned agencies shall carry out operational monitoring of the implementation of irrigation development activities. The DA shall regularly monitor the operational status and other operational aspects of irrigation projects implementation.

There should be an independent strategic monitoring (impact monitoring and evaluation) of the performance of irrigated agriculture, irrigation policies and policy instruments and the extent of private sector participation, among others, to support continuing policy adjustments and planning of future development activities.

b. Effective and timely performance and/or delivery of essential irrigated Agricultural support services

Irrigation brings the yields of field crops to about 50-60% of their potential levels. Thus the average yield of irrigated rice is only about 3.3 t/ha. To realize potential yields of 5-6 t/ha would require parallel developments in terms of improved and integrated water, seeds, seedlings, pests, soil and fertilizer management packages and suitable farm mechanization technologies. These improvements require adequate agricultural support services such as policy planning, R&D, extension, credit, inputs supply and distribution, and post-harvest handling of farm products and marketing.

To fully harness the opportunities for accelerated and sustained transformation into irrigated agriculture, the timely and successful implementation of the CIRDUP is necessary as this program also establishes a national network linking irrigation extension and research services. The implementation of the STW Irrigation Program and the demonstration of improved STW technology demonstration should also be intensified.

To improved the delivery of support services and functions to irrigated agriculture, there should be a shift from traditional commodity-specific focus into an integrated production systems or resource-based orientation. This will make possible the vertical integration of agricultural production activities (from irrigation to appropriate farm mechanization to primary post-harvest operations up to tertiary processing of farm products and by-products). A production systems orientation allows for the optimum and multiple uses of farm equipment and facilities (engines to power irrigation pumps, hand tractors, farm trailers, threshers, shellers and dryers) and the introduction of multi-crop dryers which may be more economically viable than single crop dryers. Vertical integration of agricultural development activities improves the performance of agriculture, and generates value-adding and employment creating agro-industries which help increase the market value of the asset (mainly labor) of the underprivileged and other target groups and bring them into the mainstream of agricultural development.

The linkages between research and extension will be strengthened by establishing an irrigation R, D & E network. The processes linking research and extension will also be strengthened. These processes include technology identification, field testing, modification and demonstration and, packaging for large scale dissemination.

c. Farming systems diversification and intensification

In drafting the Agriculture and Fisheries Modernization Act of 1997, the Congressional Commission on Agricultural Modernization (AGRICOM) identified the following three essential and interrelated features of a modern Philippine agriculture: (1) it is

a dynamic sector that welcomes innovation and change; (2) it is highly productive and competitive because it uses modern production and management technology and (3) its emphasis is on small-holder agriculture and on the enterprising tiller who exercises his right to choose what technology to apply, what crop or commodity to raise and when, and to whom to sell his produce to get the highest returns. This definition's main theme is that the farmer is given the opportunity to choose from a range of options available to him in terms of crops, crop mixes and farming systems and that his or her choice must be an informed one, not forced by circumstance. This further implies that all parties concerned including the farmers are fully aware of potentials or opportunities and constraints to farming systems diversification. Appendix 1 lists the opportunities and constraints to farm systems diversification in irrigated areas.

It is obvious from Appendix 1 that there are excellent opportunities and potentials for increasing food production and alleviating poverty through farming systems diversification. Unfavorable policy environment, development strategies and allocation of resources across policy environment and other constraints precluded the development of these potentials. It is imperative that such constraints be addressed to enable the farmers to take advantage of the opportunities.

d. Enhancing institutional capacity

As mandated by the Agricultural and Fisheries Modernization Act of 1997, minor irrigation will be private sector led. Communal irrigation activities will be devolved within 5 years to local government units. The operation and maintenance of secondary and smaller canals of national gravity irrigation systems will be turned over to irrigators associations. In other words, the Government will devolve into the private sector as much irrigation activities, support services and functions as possible.

Far-reaching institutional reforms are needed for timely and effective irrigation support services. Such reforms should be carried out after a careful analysis the mandates of institutions engaged in the delivery of essential irrigated agriculture support services and functions and the existing of the gaps, overlaps and inadequacies in the performance and/or delivery of such services and functions.

Of immediate concern is the improvement in the capability of DA and its agencies to plan, monitor and implement its rightful activities in support of the sustainable growth of highly productive irrigated agriculture. The present capability may at best be described as inadequate.

The concerned agencies shall carry out operational monitoring of the implementation of irrigation development activities. The DA shall regularly monitor the operational status and other operational aspects of irrigation projects' implementation. The strategic monitoring (impact monitoring and evaluation) of the performance of irrigated agriculture, irrigation policies and policy instruments and the extent of private sector participation in irrigation development should be carried out by independent entities.

4.2 Proposed Annual Budgetary Allocations in Billions of Pesos.

1.	Installation or rehabilitation of STWs and LLPs ----- About one-half in loans to farmers, local drillers and machinery manufacturers. The rest will be for technical and financial assistance in well drilling and development and techno demo of high performance irrigation systems. This will directly support the development of irrigation facilities for about 20 thousand ha and indirectly of a much larger area.	1.20
2.	Construction of inundation schemes, small farm reservoirs, SWIPs, pressurized irrigation systems -----	0.40
3.	Rehabilitation of NIS and CIS ----- Rehabilitation of about 70 thousand ha	1.60
4.	New CIS and NIS area generation -----	0.70
5.	Subsidy to Operation and Maintenance of CIS and NIS -----	0.30
6.	Research and development for irrigation -----	0.25
8.	Extension, manpower development and other irrigation support services -----	0.40
9.	Upstream services, policy analysis and planning, monitoring and evaluation, coordination and management -----	0.10
	Total	----- 4.95

Table 1. Options in Irrigation

Irrigation technology/ Nature of activity	Potentials/opportunities/ Advantages	Constraints/disadvantages
<p>1. Shallow Aquifer Utilization Motorized Shallow Tubewells (STWs)</p>	<ul style="list-style-type: none"> • Extensive shallow well area underlying most arable lands (Total shallow well areas of 5.1 m ha). • Cost-effective and low investment cost (P5,000-P12,000 /ha). • Control by individual or group of 2-3 farmers. This greater degree of water control by farmers makes crop diversification and intensification feasible. • Amenable to privatization. Does not require O+M subsidy and, hence, is sustainable. • Short gestation period taking only a few days to install. • Easy to operate and maintain by individual farmers and does not require communal effort or institutional arrangements. • The pump prime mover or engine which constitutes about 2/3 of the cost of an STW can be used to power boats, hand tractors, trailers and other farm machines. • The pumpset can also be used for drainage in waterlogged areas. • Benefits can be widely shared as the technology is available to individual farmers. • Discharge can also be used for domestic water supply. 	<ul style="list-style-type: none"> • Inadequate information on shallow aquifer properties for the proper design, drilling and development of STWs. • Inadequate number and technical capability of well drillers in many areas. • Poor water quality in localized areas. • Lack of credit for local drillers and farmers. • Inadequate well drilling and well development equipment and technologies in areas with problem geologic formations. • Lack of pumpset distribution outlets and after sales servicing in some areas. • Inadequate information on irrigation machinery test and evaluation results. • Lack of trained groundwater hydrologist for monitoring groundwater levels. • Lack of technical capability for proper repair, operation and maintenance of pumpsets on the part of the farmers in many areas.

Irrigation technology/ nature of activity	Potential/opportunities/ Advantages	Constraints/disadvantages
2. Small, Portable Low-Lift Pumps (LLPs)	<ul style="list-style-type: none"> • Cost-effective and low investment cost (about P3,000 - P8,000 per ha) • Abundant surface water sources for supplemental wet and dry seasons irrigation in areas with large, deeply incised rivers. • Easy to install, very short gestation period and farmers controlled. • Certain types of pumps (e.g., axial flow pumps) are manufactured locally. • Pump can be used for both irrigation and drainage. • Like STWs, small LLPs are amenable to privatization. • Avoids the need for communal efforts and problems relating to constructing extensive canal system and land consolidation. • Like STWs, LLPs will enable farmers to diversity and intensify their cropping systems. • Enhance water distribution and control when used in conjunction with inundation or flood recession schemes. • Pump prime movers can be used to power boats, trailers, hand tractors and other farm machines. • Available to the majority of farmers and fisherfolks. 	<ul style="list-style-type: none"> • Lack essential support services such as technical guidance on pumpset specifications and installation in many areas. • Possible conflicts between irrigation and fishery when LLPs draw water from storage reservoirs and inland water bodies. • Inadequate after sales services of pumps and their prime movers in some areas. • Lack of credit for their acquisition by farmers. • Lack of baseline information on the dependable water supplies from small streams and ponds. • Lack of technical capability for proper repair, operation and maintenance of pump sets on the part of farmers in many areas. • Siltation of rivers and reservoirs.

Irrigation technology/ nature of activity	Potential/opportunities/ Advantages	Constraints/disadvantages
<p>3. Small Water Impoundments (SWIPS, Small Farm Reservoirs)</p>	<ul style="list-style-type: none"> • In some areas, farmers are familiar to these schemes and, hence, can operate and maintain them properly. <p>The headworks of the small farm reservoirs can easily be repaired by farmers.</p> <ul style="list-style-type: none"> • Shallow bunded reservoirs with gates are appropriate in inundation or flood recession areas. • Within the capability of some LGUs to design and construct. • Can be multi-purpose in nature (e.g., flood control, gully erosion control, etc.). • Rehabilitation and renovation of some existing systems that are within the capability of farmers groups and/or local government units may be economically attractive. • Can be in harmony or supportive of inland fishery. 	<ul style="list-style-type: none"> • High investment cost (The investment cost in SWIPs range from P130,000 - P200,000 per ha) • Vulnerable to siltation and sedimentation. • Inflow hydrograph can be adversely affected by man made watershed modifications. • High operation and maintenace cost • In areas with unfavorable topography such as flat terrains, the reservoirs are shallower with large surface areas. Hence, there are more percolation and evaporation losses. • Open to disputes between farmers and fishermen. • Requires community effort for repair, operation and maintenance which may be difficult to mobilize in some areas. • Basically designed for rice irrigation as individual farmers have very little conrol on the timing, head, velocity and discharge of irrigation water. • Relatively poor agronomic and hydrologic performance of existing systems.

Irrigation technology/ Nature of activity	Potential/opportunities/ advantages	Constraints/disadvantages
4. Run-of-the-River Gravity Systems (e.g., communal irrigation systems)	<ul style="list-style-type: none"> • Cheaper operation and maintenance cost. • Less reliance on pumping units and fuel. • Farmers in many areas are familiar with these systems • It may be economically attractive to rehabilitate some CISs that have viable water users associations and high actual over designed dry season service areas. • Compared to the national and communal irrigation systems, these systems require less subsidy for O & M costs. 	<ul style="list-style-type: none"> • High investment costs (P 65,000 to P85,000 per ha for new systems construction and about P50,000 per ha for rehabilitation in 1995). • Severe problem of siltation of canals. • Beyond the capability of farmers groups and local government units to properly design, construct, repair, operate and maintain. • Require the formation of viable water users, associations which are very difficult to establish in the country. • Very poor agronomic and socio-economic performance (e.g., irrigationcropping intensity is only about 130%). • Greater degree of irrigation water control by farmers is very difficult and, hence, is basically for rice irrigation.
5. Large Fixed Station Pumping Units.	<ul style="list-style-type: none"> • Can extract large quantity of water from big rivers, lakes and from the dead storage of reservoirs. • Short-gestation period. • Low unit area investment cost. 	<ul style="list-style-type: none"> • Relatively high operation and maintenance cost compared to LLPs and run-of-the-river irrigation systems. • Requires technically sound water conveyance and distribution system. • Require an adequate organization for repair, operation and maintenance. • Difficulty in siting and installation in case of deep and/or meandering rivers and in rivers with large fluctuations in flow stage. • Vulnerable to siltation problems. • Farmers control is difficult and, hence, not supportive of crop diversification

Irrigation technology/ Nature of activity	Potential/opportunities/ advantages	Constraints/disadvantages
<p>6. Large Storage Dams (e.g., many of the existing NISs)</p>	<ul style="list-style-type: none"> • Technically feasible on many sites with large service areas. • Rehabilitation of some existing multi-purpose storage dams may be economically feasible. • Multi-purpose, some potential schemes are also for flood control, power generation and fish production. 	<ul style="list-style-type: none"> • Very high investment cost (ranging from P70,000 to P180,000 per ha in 1995 and averaging over P100,000 at present . Not economically attractive unless combined with hydropower generation and flood control. • Very long gestation period (at least 10 years from project planning to full project development). • Require complex institutional arrangements and mechanisms that proved very difficult to put in place in the medium term. • Very difficult for the government to recover investment and operation and maintenance costs. • Poor agronomic performance. On the average, only about 54 percent of the designed service area is irrigated during the dry season. Rice yield level and cropping intensity are below potential at about 3 t/ha and 130%, respectively. • Basically designed for rice monoculture and not amenable to crop diversification as farmers have very little control over irrigation water. • Not sustainable. On the average, only about 60% of the O & M costs are recovered from irrigation fees. • Very low water use efficiency (about 30%) • Beyond the capability of farmers groups and local government units to properly design, construct, repair, operate and maintain.

Appendix 1

Opportunities and Constraints to Farming Systems Diversification and Intensification

A. Opportunities and Potentials for and Advantages of Farming Systems Diversification

In areas where farmers exert a greater degree of control over the physical aspects of their production environment (e.g., with farmers' controlled STW and LLP irrigation systems irrigation and field drainage), there are excellent opportunities and potentials for farming systems diversification. The opportunities and potentials for and advantages of farming systems diversification include the following:

1. Offers farmers a wide range of options in terms of technology, farming systems, crops and crop mixes, and cropping patterns so they can take advantage of favorable production environment, farm gate prices and new technologies.
2. Allows joint or multiple use of water (e.g., for inland fishery and irrigation). Water used for one purpose can be re-used for another. In many areas in Central Luzon, farmers use STWs for fish and rice production. The most popular scheme is to construct one or more fish ponds upstream of an STW irrigation service area. During the wet season, nutrient-laden surface water from creeks and streams is diverted into the pond and then flows freely into the rice paddies. As the surface water supplies diminishes towards the end of the wet season, water that is pumped from tubewells is coursed through the pond first before conveying it into the irrigation service area. With supplemental feeding with concentrates, this practice assures a very profitable year round production of fish.
3. Helps improved nutrition. In addition to fish, farming systems diversification promotes the production of other nutritionally important crops such as field legumes and vegetables.
4. Increases irrigation water use efficiency. Rice is an aquatic crop that grows best under flooded condition. Hence, its associated evapotranspiration rate is high and its irrigation water use efficiency is very low, averaging only about 33% in tropical Asia. Secondary food crops such as corn, mungbean and peanut require much less water for evapotranspiration (about 70% that of rice). Their associated irrigation water use efficiencies are also higher.
5. Spreads out the production of certain food and feed crops within a crop year. This not only will smoothen out the seasonal fluctuations in supply and farm gate prices but will also reduce the requirements for post-harvest facilities. The level of utilization of post-harvest facilities will increase thus making such facilities economically attractive.
6. Offers excellent opportunities for diversification of processed farm products and by-products. Crop diversification opens up opportunities for value adding and employment and livelihood generating secondary and tertiary processing industries.

7. A two-prong approach of farming system diversification and development of associated and appropriate products and by-products processing industries will eventually lead to a production system orientation. Such an orientation will, in turn, lead to a vertical integration of agricultural production activities (from irrigation to appropriate farm mechanization to primary post-harvest operations to secondary and tertiary processing of farm products and by-products up to utilization of farm products and by-products by related agro-industries). A good example is a community (e.g., cluster of barangays or a municipality) of agrarian reform beneficiaries (ARBs). Farming systems diversification will make possible the production fish, corn, cowpea, sweet potato and other feed ingredients. The processing of animal feeds and fish meal is encouraged with the availability of these raw materials and the provision appropriate facilities and equipment (e.g., dryer, hammer mill, mixer, etc.) as well as adequate agro-industrial extension services. The feeds and fish meal can, in turn, be used by the community to raise fish, hogs and poultry. Some of these products can, in fact, be processed further.
8. It is amenable to privatization because the system is market driven, productive and competitive.
9. High potential for import substitution (e.g., corn and soybean). Field trials have shown corn yields up to five times the existing national average are feasible with irrigation and use of HYV seeds and improved technology.
10. Enhanced ecological stability and soil productive capabilities. The threat from pests and diseases built-up that are associated with rice monocultures are minimized. Certain crops and crop cultural practices minimize the danger from depletion of major and minor soil elements.

B. Constraints, Threats and Weaknesses.

1. Inadequate or almost non-existent agro-industrial extension services. These include technical assistance on the design and specifications of processing facilities and processes. Such services have been neglected. At present, neither the DA nor the DTI can provide such services effectively and on a timely basis. This is more so with the devolution of the extension services into the local government units. This partly explains the lack of small and medium-scale diversified farm products and by-products processing facilities.
2. Lack of suitable processing equipment and technologies. Cheap, small-scale but appropriate feed and food processing equipment are not available in many areas. This problem may be traced to the lack of relevant R & D activity. As a result, only the large national and multi-national corporations which can import equipment and technologies are now engaged feed and processing industries.
3. Inappropriate irrigation facilities and water management technologies. The traditional national and communal irrigation systems of the NIA are basically designed for rice irrigation (continuous submergence without field drainage facilities). Farmers have very little control over the operation such discharge and head control and timing of the releases of water. This force them into rice monocultures since other field crops like corn, peanuts and vegetables have more stringent drainage and on-farm water management requirements than rice.

The lack of control of farmers over irrigation water, the slow phase of minor irrigation development and the almost total absence of useful R & D outputs on irrigation and water management for non-rice crops have been some of the major disincentives to farming systems diversification in irrigated agriculture.

4. Inability of the concerned public and private sector entities to inject good quality seeds of diversified crops on a timely basis into farming communities where farmers are receptive to crop diversification.
5. Inadequate agricultural extension services. This is partly due to the commodity orientation of the research and extension services. Also the focus of most extension services is rice. As a result, there has been a low level of farmers knowledge, experience and skill in the use of modern technology and the traditional farming systems are characterized by low yields.
6. Relatively poor inputs and outputs distribution and marketing systems. This is partly due to inadequate infrastructures such as farm-to-market roads.
7. Inadequate and incorrectly focused R & D activities. There is very little funding for R & D activities. Research on irrigation and on-farm water management for farming systems are practically non-existent. Moreover, the very limited R & D activities do not reflect actual farming conditions. The intended end users have little inputs into R & D and extension delivery systems.
8. Very weak research and extension linkages. Technology identification, verification, demonstration and packaging are supposed to be processes linking research to extension. The fact of the matter is that, the various technology demonstration activities under the Gintong Ani Program are all commodity oriented. There are no technology demonstration for diversified farming systems.
9. No clear policy framework and investment strategies for the development of resource-based production systems including agro-based industries.
10. Inadequate credit for production, land improvement and investment in downstream processing activities.
11. Inability by those concerned public sector entities to focus, effectively deliver on a timely basis essential services, activities and functions in support of highly productive, intensive, diversified and sustainable farming systems. For example, STW irrigation will remove water constraints face by a farmer and will give him greater degree of control over the physical aspects of his production environment. It would enable him to realize a rice yield level of about 3.5 t/ha and a cropping intensity of about 190%. Without good quality seeds, access to market facilities, production loan, effective extension services and availability of post-harvest and processing facilities, he may not be able to further increase his yield and cropping intensity, diversify his farming systems to take advantage of weather, soil and market conditions and participate in downstream value adding processing activities.