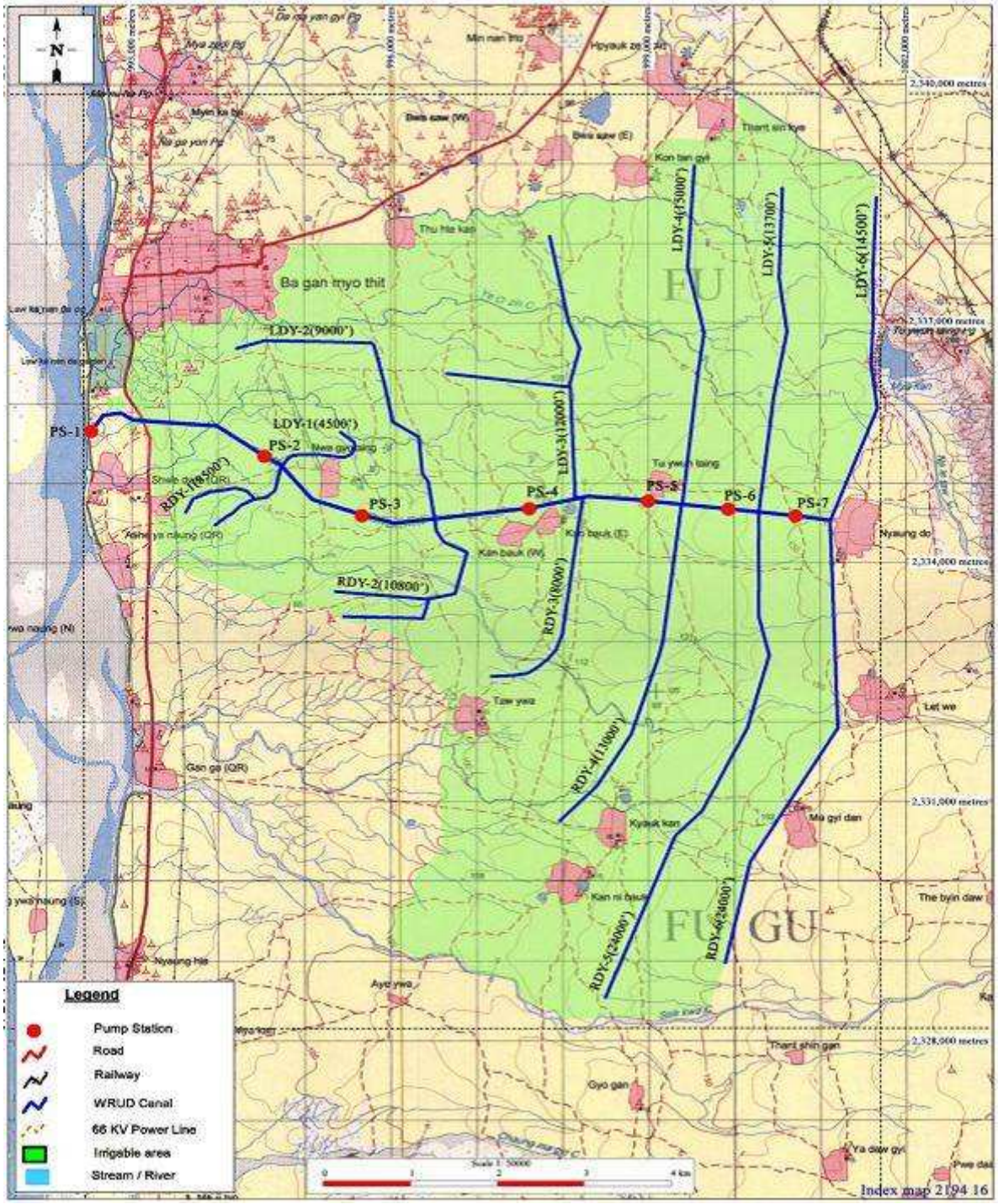
ANNEX M. FIELD VISIT NOTES ON EACH PUMPED IRRIGATION PROJECT (PIP) SITE VISITED

PIP site:	**1. Law Ka Nandar**
Location:	**Nyaung U Township; Nyaung U District; Mandalay Region**
Date of Construction:	**2001 to 2004**
Status of Construction:	**Completed except for tertiary**
Development scenario:	**Operational, but only about 50% used for pumped irrigation.**

Location Map.



1. Existing Situation

General and Engineering

- Located south of Nyaung U town.
- The scheme covers 11,000 acres and although the main and distributor canals have been completed along with the pump stations, the on-farm works t(ertiary and Watercourse canals) have not been finished as these are the obligation of the farmers.
- Construction of the scheme was carried out by WRUD from 2001 to 2004
- The cost at that time was 3,216 million Kyat ($3.2 million) plus US dollars 1,776,247 giving a total of about $5 million.
- The design of the canals was carried out using Manning's "n" and the Guidelines For Pump Irrigation Design prepared by WRUD. This gives roughness values which need to be checked of 0.025 for Earth and canals, and 0.015 for brick and plaster. These seem to be a bit smooth for the condition seen in the field.
- The slope of the main canal is 1 in 3000 feet
- There are four categories of canals which are main canal, distributary canal, tertiary or lateral canal and watercourse (Quaternary canal). The first two are the responsibility of WRUD and the latter the responsibility of the farmers.
- Water Users Associations exist based on the village and the village tract with about 500 members for the village tract out of a total of about 1000 households. That is to say 50% of the village members are farmers.
- Average size of farm holding is about 3 acres but there is a large variation
- Along canals there are water areas for drinking and these are square ponds of about 20' x 20' x 5' with a total volume of 12,000 gallons. These are supplied by the canal system as there is no piped in the water in the area.
- The guideline for the design of the irrigation system is based on Paddy and other crops. For Paddy the water duty is 4 acre-feet for the monsoon season and 6 acre-feet for the dry season. No detailed crop water requirements are calculated and the designers have relied upon the assumption of their manual which applies throughout Myanmar. (The manual has more details on how to calculate crop water requirements, but this does not seem to be used).
- Water charges are based on a flat rate for the crop per acre and is based on 1500 Kyat for each acre-feet of crop water requirement. Thus for Paddy the charge is 9,000 Kyat per acre-feet, groundnut 7,500 kyat per acre-feet for and green gram and for other crops 4,500 player per acre-feet.
- Above pump station 4, there is no irrigation in the dry season as there is insufficient power and water. This is reflected in the condition of the infrastructure
- No maintenance is carried out as there is insufficient funding for this and what funds WRUD have are spent on the River intake trying to get the water across the sandbar to the intake. They have tried an excavated channel but have found that the simplest way is to make a sump around the pump station and this permits water to seep through the sandy bed of the river to be pumped into the canal.

Agriculture

- There is a heavy emphasis on engineering, with agriculture and soils considerations almost as afterthoughts. One crop per year before the project, now 3 (but only on the areas now irrigated year round). Before the project, crops were as follows as reported by WRUD:

Before project crop areas, ha	Monsoon
Sesame	1441
Groundnut	1458
Cotton	310
Green gram	789
Total	3998

- Soils are 30% heavier (nearer the river), 70% lighter further away from it. The priority for the water is the heavier soils.
- Watercourse canals serve 10-15 ac. Average farm size is 1-3 ac. WUAs are based on a village tract = about 500 farmers = one tertiary block. Land levelling is big problem that farmers face, and this was not considered in project design. Farmers do what they can each year. It will take them several years, how many is not known.
- 50% of 11,000 ac is irrigated in the monsoon season, the rest is rainfed. 6 ac ft are applied to the monsoon crop, and 8 acre ft are applied to the summer crop. These seem to be standard national values that bear little relation to changing climate, the soils, or the irrigation methods.

- consumptive use of water is divided into paddy and other. For the summer crop they can only manage to irrigate 2,000 ac. Water requirements have been seriously underestimated. Power is main limiting factor, but even getting water out of the river in the summer is a problem.
- Crops planned by the PIP authority are as follows:

Planned crop areas, ha	Monsoon	Winter[1]	Summer	Total	CI
Paddy	40		40	81	
Cotton	607		607	1214	
Oilcrop	3804		1578	5382	
Total command 4452	4452	554	2226	6678	150%

[1] Winter crops not identified, probably groundnuts

- Actual crop areas now as reported by the PIP authority are as follows:

Actual crop areas, ha	Monsoon	Winter	Summer			A	M	J	J	A	S	O	N	D	J	F	M
Irrigated paddy	1209		163	1372		'---------->			<----------								<-
Rainfed paddy	1209																
Sesame	1142		73	1214.9			<----------										
Groundnut	408	554	10	972		'--->										<----------	
Cotton	136			136				<----------									
Green gram	347	563	0	910									<----------				
Total irrigated	2226		246	2472													
Total rainfed	2226		0	2226													
Total	4452	1117	246	4698	106%												

- First farmer interviewed is located at Section 1 between PS1 and PS2 not far from the river. Clearly he's a lead farmer, but agreed to speak for all farmers. His land is on heavier soils but only 3 of his 5 ac are suitable for paddy. His average yield at 50 to 80 baskets/ac (2.1 to 3.36 t/ha) is low compared to SE Asia regional (e.g. Vietnam 5.22 t/ha), and to national averages (3.72 t/ha). He grows only 1 ac of paddy in the monsoon and also 1 ac of paddy in the summer. Figures for his farm model are shown below. He was farming here before irrigation arrived. At that time he grew only paddy in the monsoon. Now he has enough water for summer and winter crops (paddy and groundnuts respectively). The margin on paddy is low, but it is low risk and provides food security, so he will keep his paddy area the same. He makes his cash from 5 ac of groundnuts as a winter crop, it is generally a highly profitable crop.

Gross margin (per ha) and returns to labour (Ks'000)								
PIP site:	**Lawkanander**							
Location:	**Section 1**							
Soil type:	**Heavy**							
Irrigation situation:	**Irrigated**							
Development scenario:	**Actual**							
Description	Unit	Crop						
		Monsoon paddy	Summer paddy	Groundnuts				
Price	Ks'000/kg	0.294	0.294	0.28				
Yield	kg/ha	2100	2415	4670				
Farmgate value	Ks'000/kg	617	710	1308				
Variable costs:	Ks'000/kg	483	454	442				
-ploughing		62	62	62				
-land preparation		37	37					
-seeds		25	44	259				
-fertiliser		161	179	0				
-crop protection		22	0	74				
-hired labour		161	110	25				
-harvesting & threshing								
-bags								
-transport to market								
-water charge	Ks'000/kg	15	22	22				
wc as a % of total vcs		3%	5%	5%				
Gross margin		134	256	866				
Return to family labour[1]		45	85	289				
1. Family labour is 3 full time pds equivalent per farm								

- Second interview is with a group of farmers from Kampan village, in sections 3 and 4. There have 100 hhs, 120 families, of which half are farming families. One of the group is head of a tertiary level WUA, and he agreed to speak for all.
- One woman has monsoon paddy, summer paddy, followed by pulses. Paddy yields are even lower at 40 to 50 baskets/ac (1.7 to 2.1 t/ha). The WUA head gets 80 baskets (3.36 t/ha) because he uses more fertilizer and cow manure, but he is on the same soils. Conclusion is that there is scope, particularly among the poorer farmers, for increasing average yields using existing seed, but all farmers, rich and poor, have poor paddy seed, and this is the principal reason behind low average paddy yields.

- Irrigation water availability is reasonable, but the head of the WUA says that even in this comparatively good area, only 8 of his 10 members have enough water for two crops of paddy.
- Even though half the HHs are not farming HHs and are landless, there is still a shortage of labour for some tasks, e.g. for transplanting. So any improvement to those with land will have an immediate beneficial effect on the landless, and to those who have only a small acreage. Lead farmers also hire labour to do their canal maintenance obligations (Ks 10,000/yr per member regardless of acreage). They regard water charges and maintenance charges as token amounts. They can afford to pay more, provided the service is improved, such as (they suggest) brick lining of the canals.
- Just below PS 7 there are a lot of groundnuts planted at the beginning of the monsoon season. Soils here are too light for paddy. There is also sesame at flowering stage but showing signs of poor water distribution where an enterprising farmer has improvised to try to make inadequate infrastructure work for him.
- The whole of this PIP is severely affected by the invasive shrub/tree Acacia nilotica indica. It needs to be controlled.

Gross margin (per ha) and returns to labour (Ks'000)								
PIP site:	**Lawkanander**							
Location:	**Kampan village**							
Soil type:	**Lighter**							
Irrigation situation:	**Irrigated**							
Development scenario:	**Actual**							
Description	Unit	Crop						
		Monsoon paddy	Summer paddy	Green gram				
Price	Ks'000/kg	0.29	0.29	0.37				
Yield	kg/ha	1680	2100	1014				
Farmgate value	Ks'000/kg	487	609	375				
Variable costs:	Ks'000/kg	348	355	243				
-ploughing								
-land preparation								
-seeds		44	44	35				
-fertiliser		179	179	65				
-crop protection		0	0	49				
-hired labour		110	110	94				
-harvesting & threshing								
-bags								
-transport to market								
-water charge	Ks'000/kg	15	22	0				
wc as a % of total vcs		4%	6%	0%				
Gross margin		139	254	132				
Return to family labour[1]		46	85	44				
1. Family labour is 3 full time pds equivalent per farm								
2. Ploughing, land preparation, harvesting, threshing, transport, are subsumed into hired labour								

- **Cotton** (mainly Law Ka Nandar, but also relevant to other sites visited). Almost all cotton grown is traditional varieties. Quality is low with short staples and stained bolls, and commands a low price at the single local ginnery. Consequently the area under cotton at Law Ka Nandar, originally planned at 100 ac., is 29 ac only. Other sites visited also have very low areas planted to cotton. Average yields are low at 100-150 vis/ac.
- The Cotton and Sericulture Department of MOAI has an Industrial Crop Development Enterprise (ICDE) and has seconded a dedicated cotton extensionist who visits 10 selected farmers twice a week. Each farmer has one acre of improved cotton. The ICDE has been promoting improved cotton at Law Ka Nandar since 2007 and it has been difficult to attract even these 10 farmers for the 2011 season. Incentives may seem high including a 100% seasonal credit at zero interest for all cash inputs including hired labour up to Ks 100,000/ac and a theoretical good gross margin if the crop is successful. But the reluctance of farmers to join the scheme is due the following factors:
  - Farmers are required to plant only an improved variety which is highly susceptible to sucking insects and the crop needs weekly insecticide spraying which is expensive and time consuming
  - There is only one local buyer who has no competition except the ICDE, which also pays low prices
  - Soils, which are mainly sandy and of low fertility, are not suited to cotton
  - Poor and variable rainfall which has not been fully mitigated by irrigation which is unreliable
  - If the air temperature exceeds 40^{o}C at flowering then the boll does not form and the crop fails with zero yield. Recent records indicate that the chance of this happening is one year in five. This in turn shows that the farmer has a 20% chance of incurring an unacceptable debt because the ICDE is required to recover the Ks 100,000/ac seasonal loan. The mission interviewed some farmers who had lost their entire crop and were required to repay their cotton crop loans in full. There is no crop insurance in place. Crop

insurance based on prior selected weather conditions is now easily obtainable internationally and is not expensive. Until crop insurance is put in place there seems little chance of improved cotton succeeding in the project areas.

2. Constraints and Issues

- The soils of the Law Ka Nandar pump scheme are extremely sandy and the proportion of Sandy material increases away from the riverbank. The soil looks like a derivative of the sandstone mountains that surround the area. Irrigating these soils has led to very high losses in the tertiary and Watercourse canals and only those farmers located relatively near to the distributary canals are in a position to get unimpeded water supplies
- The pumps are supplied by electrical power and this is subject to frequent cutting in suppliers during the dry season and before the start of the rainy season. The power is on a regional network basis and for this area it is supplied by both hydropower and gas turbines. Thus in the monsoon season there is generally sufficient power available to pump the required amount of water. However as has been noted, the amount of water needs to be pumped because these isles are very sandy is much higher than was calculated. Although government at design assumed 60% application efficiency, 65% conveyance efficiency for Earth canals (tertiary and Watercourse), and 85% for lined canals, the actual efficiency must be in the order of 20% due to the permeability of the trials and the nature of the un lined canals. Thus a great deal of water is being pumped that is lost to the system and this puts up the annual pumping costs of the scheme to level III or four times what should be.
- About 2000 acres of the irrigation scheme have complete conveyance network down to Watercourse level. Thus in the dry season only this area can receive irrigation water. In the monsoon season about half the scheme can receive water although 2000 acres of this are formally supplied by the scheme and about another 3000 acres are supplied informally. There is scope for farmers to be encouraged to develop more tertiary and Watercourse canals for which they are responsible, but this remains to be seen whether the farmers will do this.
- The area irrigated by this pumped irrigation scheme is very undulating and this combined with the sandy soil means subsurface irrigation is both inefficient and difficult. The scheme would be well suited for sprinkler irrigation particularly considering the soils.
- The scheme was built rather quickly with instructions from the governor at the time that the scheme should be built within 1 1/2 months. The main canal and distributary canals were excavated by machine and lined by hand. Lining comprises brick plastered lining which is the common form of lining here.
- All of the main canals have a 10 foot bottom width with the left bank are being 12 foot wide and the right bank berm being 6 feet wide. The site slopes of the canal of one-to-one.
- There is quite a prevalence of Mesquite along water canals but this has not invested the irrigated area as farmers are cultivating this for rain fed crops.
- The pattern of the rainfall in the area is with two peaks and a dip in July. The role of the pumped irrigation system is therefore to provide supplementary irrigation in the monsoon season and full irrigation in the dry season
- in general structures are quite well built although as the construction period increased, it appears that the quality of construction deteriorated. The pump stations and canals above pump station for our not in such good condition and some have deteriorated much more then there's further down the system.
- Cropping pattern is largely determined by restricted irrigation water, particularly in the summer and winter seasons when higher margin crops can be grown, and also by a focus on “policy crops” that are also high water consumers. With these constraints removed, the cropping pattern will change to a more rational and profitable use of land.
- Yields are low and below the national average as exemplified by paddy. The most important constraint is improved paddy seed, something that farmers are keenly aware of but have no access to. Other constraints (after irrigation) are extension for which there is high demand by farmers, and seasonal credit. Fertiliser is largely imported and is subject to import tax up to 25%. This has maximised domestic resources such as local phosphate and animal manure, but makes imported fertiliser expensive; this also restricts average crop yields.
- The area under cotton is well below planned target because of farmers’ awareness of unacceptable agronomic and financial risk that is outside their control. The mission interviewed farmers who had sometimes lost 100% of their crop.
- The market for some crops is volatile, presenting a risk for farmers. For example, the farmgate price for pulses and oilseeds are largely determined by exports, already subject to a 10% export tax, and have been affected by recent strengthening of kyat. More robust value chains would boost these crops that farmers are otherwise

keen to grow. HVH prices are also volatile due to weak urban-rural value chains.

3. Scope for Improvement

- This is a particularly difficult scheme as it is was planned without properly considering alternative crops and the nature of the soils. In addition to this, the siting of the pump station make supplies in the dry season to the intake difficult.
- Farmers were told to grow rice on the scheme when it was first built even though there was very little rice grown in the area before the irrigation schemes were planned. This is mainly due to the fact that the soils are very permeable and the farmers recognised the problems.
- Different high-value crops need to be considered and if prices gain to be grown in the area it has to be grown on the heavier soils thereby reducing the water requirement.
- The types of crops grown need to have a lower water requirement and much higher value such as vegetables etc in order to justify the high costs and to reduce the amount of water pumped.
- By concentrating firstly on the improvement of the supply in the monsoon season, the returns to the farmers would be achieved.
- It is possible that are 90 to 95% cropping intensity could be achieved this season but there is probably only enough water available for 20% cropping intensity during the dry season.
- Careful consideration needs to be given to how the water should be shared out during the dry season as at the moment is benefiting only a few farmers were living close to the supply channels.
- The water users associations carry out basic functions and these involve cleaning of their own tertiary and Watercourse canals and policing the water abstractions. Water charges are paid strictly to WRUD on an individual basis. The leader of the village tract water users Association is also the village headman. Each sub water users Association has about 10 to 15 members. This seems to be a good building block that at the moment they do not democratically elect a leader that they do have finance officer. The water users Association each contribute about 10,000 Kayt per season for basic maintenance. This is collected from the members and awarded to a local contractor to execute. This is generally related to canal cleaning.
- The relationship between agriculture and engineering in the design is very poor and is based on the general norms for Myanmar. This needs to be addressed with agriculturalists being assigned to WRUD to deal with proper water requirements, selection of crops different types of soils, relating crops grown to available markets and market prices. A lot more needs to be done on this.
- Although water users associations have been established and are working at a basic level, there is a need to bring them up to a higher level so that their responsibility can be increased and that they become more involved in the annual maintenance both in implementation and in finance.
- A decent engineering manual needs to be prepared that relate properly to the current situation.
- It would seem that government policy towards irrigation has changed and that it is getting good emphasis without the farmers being told which crops they can and cannot grow. This has definitely changed the working environment in a positive way and also encourages the Department
- The Department is very short of funding and this extends from capital investment required at the construction phase and current expenditure to keep the system in the condition that it needs for fully functioning.
- Much more details are needed to assist WRUD with the establishment of water users associations and the collection of appropriate water charges. This would have the benefit of increasing the annual maintenance of the systems especially to maintain the reclining canals and the damage structures.
- The overall water management needs to be improved especially relating to the impact of power outages on the ability of the canals to convey the water. In practice, the water will gradually drain out of the canals and the first period of pumping when power is resumed is required to rebuild storage in the canals for reach the field.

(a) Short Term

- Improved delivery of irrigation water, plus easing of the directive on policy crops (already formally approved in an MoAI policy paper but not yet put in place at farmer level) would immediately rationalise the existing cropping pattern towards higher value crops, particularly oilseeds and pulses in the winter and summer seasons.
- From as early as Year 3 improved seed would impact yields of paddy as well as allowing paddy to fit better with winter and summer crops. See Annex on seed.

- Groundnuts are a consistently high margin crop while risk is moderate, and this was confirmed in several other farmer interviews at other PIPs. The oilseeds sesame and sunflower have a moderately good margin and low risk under irrigation. They are probably also grown here on residual moisture, as they are at other PIPs. All these crops are likely to increase substantially in the short term.

(b) Longer Term

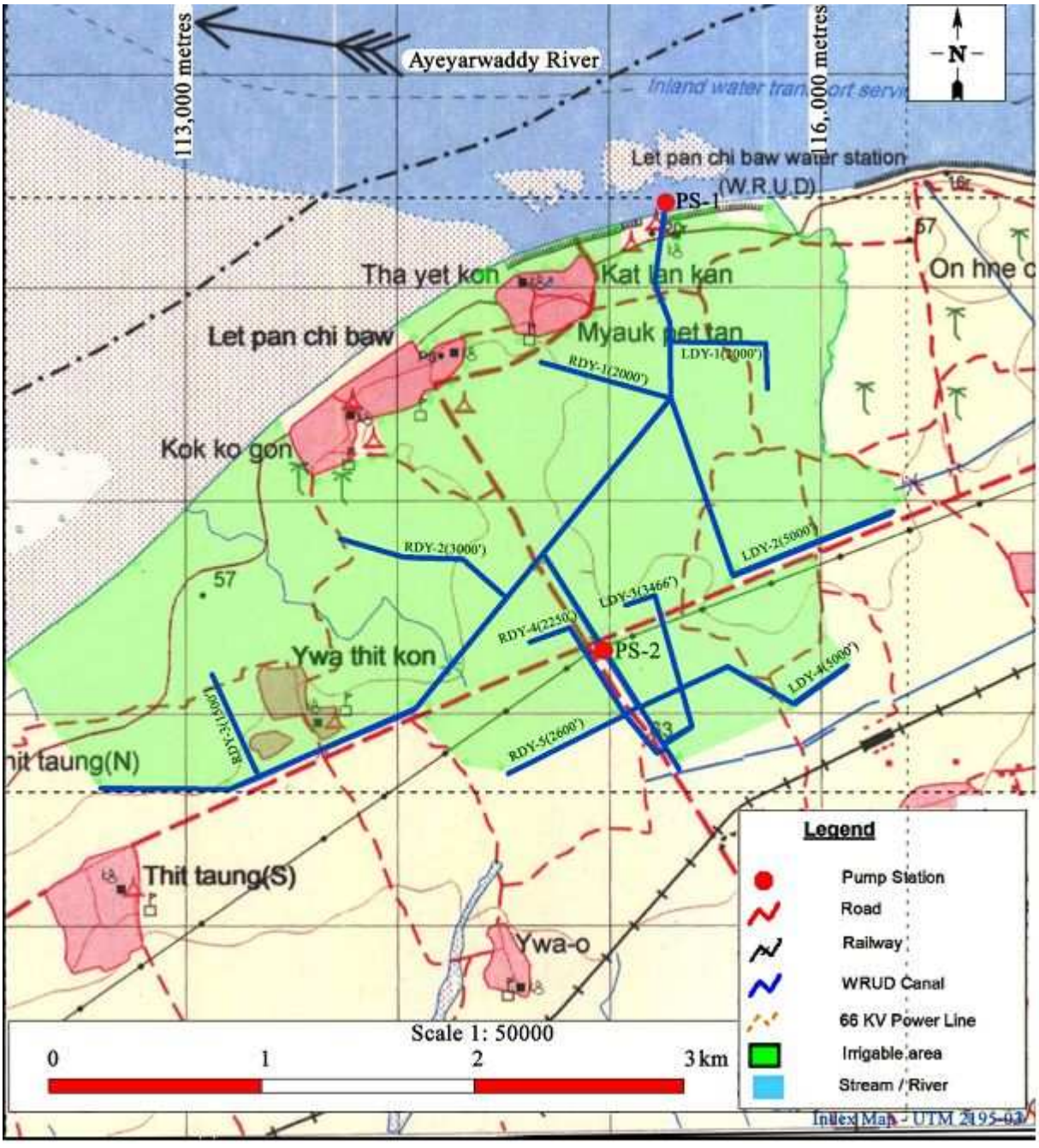
- Cotton is unlikely to progress until the financial risk of a failed crop, potentially once in five years, and over which a farmer has no control, is assumed by government. This is elaborated in the main report.
- HVH, including chilli, onions, sweet corn, winter vegetables and fruit, will increase slowly as marketing constraints are removed.
- The farmgate price for pulses is largely determined by exports that are presently restricted by a 10% export tax plus a strengthening of the kyat. Improved terms of trade will allow the market for pulses to improve.

Crop Yields Assumptions, kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	2100	1575	1250
Summer paddy	2400	1800	1450
Groundnuts	4675	3500	2800
Green gram	1250	1000	800
Yellow gram	3600	2900	2300
Sesame	630	430	350
Cotton	1600	1200	1000
Sunflower	1500	1200	900
Maize	4000	3750	3500
HVH	7000	5000	3000

PIP site:	**2. Lat Pan Che Baw**
Location:	**Nyaung U Township; Nyaung U District; Mandalay Region**
Date of Construction:	**1995 to 2001**
Status of Construction:	**Completed but lateral and watercourses not complete for PS-2**
Development scenario:	**Operational with water shortages in Summer season**

Location Map.



1. Existing Situation

General and Engineering

- The Mandalay region is one that has 25% of the total pumped area in Myanmar. The other region with the same amount of pumping is north-west of Mandalay on the right bank of the Ayeyarwaddy River. The strategy therefore of this mission is to look at specific projects within the seven districts of Mandalay which are considered a good cross-section of the types of scheme in the region and can then be utilised to build up the bigger picture
- The area for Lat Pan Che Baw PIP is on much better soils. It comprises the alluvial deposits which have much higher moisture holding content and slower infiltration thereby being much more suitable for rice cultivation in the monsoon season. This is the area that has supplied by pumping station 1 from the river.
- Pumping station 2 supplies a small area but is more permeable and verging towards the type of soil that was on the Law Ka Nandar pump irrigation project.
- This pump irrigation scheme started off as an irrigation scheme being built and run by the Irrigation Department. When WRUD was formed in 1995 this scheme was handed over to it and the area supplied was extended through the provision of large pumps. The irrigation network seems to have been well laid out and the design of the structures has been good. The compaction of soil around some of the structures needs to be improved but in general it is in reasonable condition and operates well.
- The area to the north-east near to the pump station benefits from being close to the water source particularly in the summer season when power is short and river flows are low.
- The pump station in a good location and although there is an island in the river to the north of the intake, the main flow of the Ayeyarwaddy passes by the pump station and thus it does not suffer from problems of sandbanks as was the case with the previous pump irrigation scheme.
- The farmers are very much involved in the choosing of the cropping pattern and the matching of planned water supplies with actual water supplies. There is government pressure in the choice of crops but in this case that there seems to be relationship to crops grown and availability of water.
- In the monsoon season, there is about 90% cultivation of the land with the remaining areas suffering from depressions etc. Rice predominates but there is maize and sorghum. In the dry season, there is only about 26% cultivation with Paddy occupying about 259 acres, green gram 106 acres, cotton 29 acres and other crops 135 acres.
- Insufficient power is a major problem in the dry season and WRUD tends to irrigate the better areas so that they get better returns for the high irrigation costs. This is generally true throughout the district and those parts of the built irrigation system on the higher sandy soils are not readily irrigated.
- This project provides a good example of how to build up the design in a better way. It has probably been developed from smaller individual irrigation areas within the plain and the farmers are clearly experienced with the growing of rice in these conditions.
- Quality of seed is one of the major problems that they experience and as was seen in the field, the planting dates have got out of synchronisation and the summer crop is now interfering with the planned monsoon crop.
- It was indicated that this delay in planting they may be an attempt by some farmers to avoid growing rice which they do not fully support.
- The pump station is of a standard design with five units on a floating pontoon on the river. Access to the station is precarious as this has to be achieved by walking along the flexible pipe.
- The upper pump station suffers from foot valve problems which has damaged the impeller and therefore the summer crop had not been grown in the area with just the part very near to the road receives some water from elsewhere.

Agriculture

- Engineering works are completed, on the south bank of the Ayeyarwaddy River near Bagan, near site of new bridge to Pakokko town on the opposite bank. 1500 ac irrigated, construction started 1995, completed 2001, a less rushed period than Lawkananda.
- Intended cropping pattern is: paddy 1000 ac., cotton 100 ac., oilcrops 400 ac.
- (Much in evidence are Jatropha bushes, reportedly the remnants of a former failed biodiesel programme, and an indication that energy shortage is not new. The bushes are vigorous and bearing well, so the failure was due to some other factor, technical or economic. This to be borne in mind when we look at biomass gasifiers.)
- Power requirement is lower, but again there is heavy emphasis on engineering, with farmers and agriculture a

second consideration only. There are 750 farmers divided into 75 WUAs (or "10 farmer groups") in two main village tracts: Thait and Lat Pan Che Baw. Each has five individual villages of 300 hhs and 500 hhs respectively, average 5/hh.

- The c urrent cropping situation as reported by WRUD is as follows:

Crop	Monsoon		Summer	
	Ac	Ha	Ac	Ha
Paddy	768	311	259	105
Cotton	8	3	29	12
Green gram	86	35	106	43
Sorghum	125	51		
Tobacco	125	51		
Maize	90	36		
Other: sunflower, cowpeas, ground nuts, sesame	48	19		
Total	**1250**	**506**	**394**	**160**
% of command area	90		26	

- Of the 1250 ac monsoon crops, 250 ac are entirely rainfed. Crops that grow on residual moisture here are: tobacco, pulses, pigeon pea, sesame, sunflower, groundnuts and mung bean. Fodder sorghum is grown partly as a cash crop for sale outside the PIP. The market for all crops is local, not Pakokko, and the new bridge will make little difference, according to the MAS District Manager. There is a cotton ginnery in Pakokko.

Soils

- Soils are heavier than at Law Ka Nandar and are divided into roughly two main areas: the western half with more fertile, heavier silt/clay soils, but with no irrigation in the summer; the eastern half with lighter soils but closer to the pump stations and receiving water in all seasons. The extreme south served by PS 2 has the poorest soils, and although the PS receives water in both seasons, it is not sufficient in summer to cover all areas.
- The interviews and farm models are divided by dominant to soil type: Ywa Thit Kon village in centre west on the heavier soils, and Myauk Pet Lan village in the Centre south on the lighter soils. The DM of MAS reports that soils are not good for cotton.

Letpanchebaw, Myauk Pet Lan village		
Monsoon paddy, 25+120–145 days	2.0	<---------->
Summer paddy, 25+120=145 days	0.5	----------> <-------
Green gram, 120 days	0.4	<---------->
Groundnuts, 120 days	0.2	---> <----------
Fodder millet, 180 days	0.5	<----------
Sesame, 90 days	0.2	<---------->
Annual HVH, 120 days	0.1	---------> <-------
Perennial HVH, 12 months	0.1	<----------
Farm area	2.0	

Letpanchebaw, Ywa Thit Kon village		A	M	J	J	A	S	O	N	D	J	F	M
Monsoon paddy, 25+120=145 days	1.2				<---------->								
Yellow gram (rainfed), 120 days	1.2							<---------->					
Farm area	1.2												

Cropping patterns and crop budgets based on farmer interviews

Gross margin (per ha) and returns to labour (Ks'000)							
PIP site:	**Letpanchebaw**						
Location:	**Myauk Pet Lan village**						
Soil type:	**Lighter**						
Irrigation situation:	**Irrigated all seasons**						
Development scenario:	**Actual**						
Description	Unit	Crop					
		Monsoon paddy	Summer paddy	Green gram	Groundnuts	Fodder millet	Sesame
Price	Ks'000/kg	0.294	0.294	0.37	0.28	0.012	0.9
Yield	kg/ha	3361	3865	1014	4670	11000	636
Farmgate value	Ks'000/ha	988	1136	375	1308	132	572
Variable costs[1]:	Ks'000/ha	589	245	320	435	160	207
ploughing[4]	Ks'000/ha	62	62	62	62	62	62
seeds[5]	Ks'000/ha	44	30	35	259	34	27
fertiliser[6]	Ks'000/ha	358	0	65	0	49	83
crop protection[7]	Ks'000/ha	0	0	49	74	0	0
family labour[3]	days	280	75	50	100	50	80
hired labour[8]	Ks'000/ha	110	131	94	25	0	20
hired labour (days)	days	73	87	63	17	0	13
water charge[2]	Ks'000/ha	15	22	15	15	15	15
wc as a % of total vcs		2%	2%	4%	1%	11%	3%
Gross margin	**Ks'000/ha**	**399**	**891**	**56**	**872**	**-28**	**365**
Return to family labour	Ks/day	1424	11887	1111	8724	-565	4566
Notes:							
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour							
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks 7500/ac							
3. Family labour based on 3 full time equivalent							
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews							
5. Based on per acre costs and farmer interviews							
6. See Assumed Price of Inputs table, Ks 10,000/pass							
7. Daily labour rate assumed at Ks 1,500							

Gross margin (per ha) and returns to labour (Ks'000)			
PIP site:	**Letpanchebaw**		
Location:	**Ywa Thit Kon village**		
Soil type:	**Heavier**		
Irrigation situation:	**monsoon crop has supplementary irrigation,**		
	summer season is rainfed		
Development scenario: Actual			
Description	Unit	Crop	
		Monsoon paddy	Yellow gram, rainfed
Price	Ks'000/kg	0.294	0.57
Yield	kg/ha	3361	1162
Farmgate value	Ks'000/ha	988	663
Variable costs[1]:	Ks'000/ha	589	223
ploughing[4]	Ks'000/ha	62	62
seeds[5]	Ks'000/ha	44	30
fertiliser[6]	Ks'000/ha	358	0
crop protection[7]	Ks'000/ha	0	0
family labour[3]	days	280	75
hired labour[8]	Ks'000/ha	110	131
hired labour (days)	days	73	87
water charge[2]	Ks'000/ha	15	0
wc as a % of total vcs		1.50%	0%
Gross margin	**Ks'000/ha**	**399**	**440**
Return to family labour	Ks/day	1424	5866
Notes:			
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour			
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks 7500/ac			
3. Family labour based on 3 full time equivalent			
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews			
5. Based on per acre costs and farmer interviews			
6. See Assumed Price of Inputs table, Ks 10,000/pass			
7. Daily labour rate assumed at Ks 1,500			

2. Constraints and Issues

- energy costs are high amounting to about hundred and 140 million Kayt per annum compared with an allocation of 10 million Kayt for staff and 6 million Kayt for other maintenance works.
- Poor yields and longer growing periods causing the planting dates to get out of phase with the season

- areas with technical problems of getting water that cannot be dealt with under routine budgets
- changing rainfall period within the bimodal pattern that results in more variables start and end of the rainfall and declining amounts in both total and the way it occurs. The traditional monsoon heavy rain is not so common as it used to be and as in other areas.
- Water users associations are not contributing very much towards the cost of maintenance. They pay water charges but these go straight back to the ministry of finance and not returned directly.
- The return on irrigating the heavier soils is likely to be better that the return on the soils now irrigated which are the lighter soils. Even on these lighter soils, farmers say their cropping pattern is not sensible and that they would change if they could, as follows:

Crop	Current %	Future %
Monsoon paddy	100	90
Monsoon groundnuts	0	10
Summer paddy	25	10
Green gram	20	10
Summer groundnuts	10	20
Fodder millet	25	10
Sesame	10	20
HVH	10	10
Pigeon pea	0	5
Maize	0	5

- The scope for yield increase is high, particularly on the heavier soils. This is agreed by the extension staff and farmers. Average yields of paddy 5,250 kgs/ha are achievable, and 6,300 kgs/ha is not uncommon here. But the average now is much lower (see farm models above) and these are from lead farmers. Average yields on these better soils, even the lighter soils, are higher than at Law Ka Nandar for some crops (see table below).
- The need for improved seed is keenly felt, and farmers already change their seed frequently. The fault with seed is clearly not at farmer level, nor at seed grower level, but much higher, probably at elite or breeder seed level, i.e. with the Seed Department of MAS.
- There is resistance to cotton here. It is unlikely to be a soil problem as the MAS person and farmers say. To a certain extent it seems to be an extension problem in that quality is low because of insects, but farmers say they spray insecticide every five days. Improved crop protection chemicals may be needed. Farmers complain of cotton's high consumptive use of water; in other words that water could be better used on other crops.
- HVH will not increase in total area, but because of climate change they want to move from annual HVH to perennial crops like mangoes, bananas, jack fruit.

3. Scope for Improvement

- In improved involvement of water users associations together with descriptions of functions that they should fulfil and how they contribute to operation and maintenance costs.
- Better selection of seeds to improve yields and to reduce length of growing period
- Better equipping of engineers to be able to deal with problems during implementation and also to be able to rectify problems during operation and maintenance.
- Support could be provided through technical support unit in LIFT equipped with appropriate irrigation and design engineers as well as agriculturalists. The could comprises a series of short-term inputs supported by some longer-term advisers.
- Production of improved design manuals which go through the process of implementation and do not just concentrate on engineering issues but also on agricultural, social and economical aspects and water users associations.
- Small equipment such as EC metres to assist with checking and monitoring of water during implementation and possible pollution upstream.
- Larger and more realistic operation and maintenance budgets from government linked to improved contributions from water users Association which in turn derived from higher and more consistent yields.
- Support to smaller scale pumping units in the areas that have smaller water supplies and that are targeted

under lift as being areas that are vulnerable and the likelihood support

- By linking payments with service provided, the farmers can see more clearly where their money is going.

(a) Short Term

- With irrigation on the better soils, the area under paddy will fall, but yield increases as a result of improved seed and extension will more than compensate. (The annex on Seed shows that improved seed could be delivered to farmers by local seed growers in Year 3). Higher margin pulses and oilseeds will increase in area, and with improved water management, yields will also increase as farmers have confidence in applying more crop inputs.

(b) Longer Term

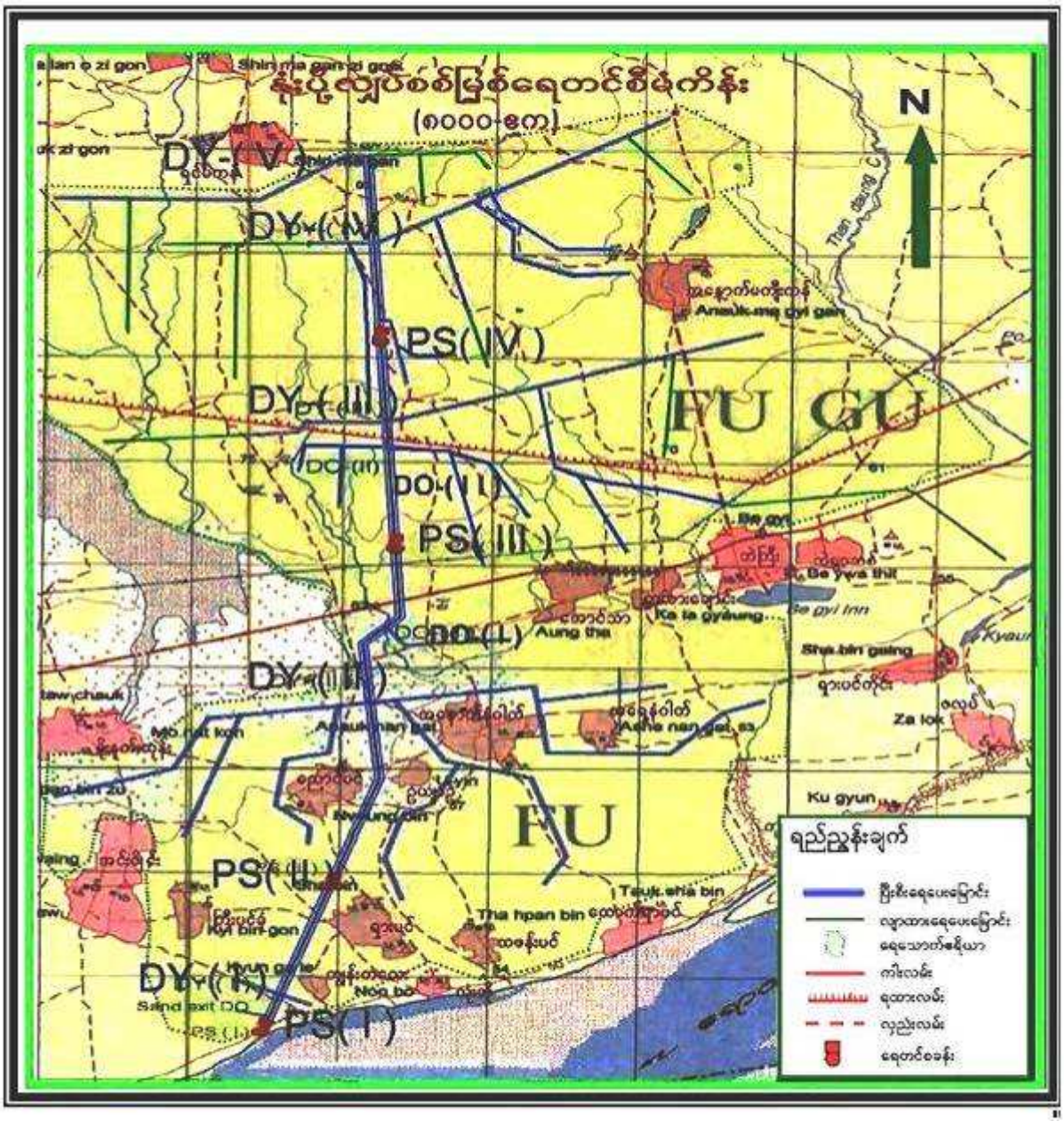
- Farmers' shyness of cotton in the face of apparently good government incentives is well entrenched. Probably a combination of improved extension, better adapted varieties, improved crop protection chemicals and how to use them, plus crop insurance will overcome it only in the long term.
- Perennial HVH will increase slowly.

Crop Yields Assumptions (with irrigation), kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	3250	2700	2150
Summer paddy	3600	3000	2400
Groundnuts	4675	3750	3000
Green gram	1250	1000	800
Yellow gram	3600	2900	2300
Sesame	630	430	350
Cotton	1600	1200	1000
Maize	4000	3750	3500
HVH	7000	5000	3000

PIP site:	**3. Hnone Poe**
Location:	**PakokkoTownship; Pakokko District; Magwe Region**
Date of Construction:	**2004 – 2011 +**
Status of Construction:	**Pump Stations not equipped and so no water is pumped. Main canal completed in 2007**
Development scenario:	**No operational.**

Location Map.



1. Existing Situation

General and Engineering

- This pump irrigation project is located on the right bank of the Ayeyarwaddy River. It has not yet been completed although the main canal has been built almost to the end which includes four pump stations. These four pump stations have been completed but the pumps have not been installed and the electricity has not been connected.
- For pump stations 3 & 4, the pumps are already on site in store. They do not have the budget however to install them yet. The pumps for the pump stations 1 have been installed on the floating barge on the river but the connection has not been not completed to the canal. The pumps for pump station 2 without which the majority of the irrigated area will not be supplied, are still in store in the Division.
- The scheme is located about 45 min by road south of Pakokko. This is the district headquarters and is the main village on this side of the Ayeyarwaddy River. It is the location at which the new bridge is being built across the river.
- Magwe Region – Districts: Magwe, Pakokko, Gantaw, Minbu, Thayet.
- Hnone Poe is a village tract.
- In Magwe District there are 15 large pump stations, 6 on the Ayeyarwaddy River, 1 on the Yaw River and 8 on the Chindwin River.
- In the area below pump station 2, farmers cultivate vegetables after the monsoon season on the lands that are generally flooded by the Ayeyarwaddy River. As the water levels recede, they plant vegetables and obtain supplementary irrigation from Wells driven into the sandy substrata.
- Water levels vary from 15 to 30 feet through the winter irrigation season (October to the end of January)
- Pumping in these areas is achieved by 6 hp diesel driven centrifugal pumps.
- The design is for four main crops and the water duties are given:
  - Paddy = 12 acre-feet per acre
  - Cotton = 3 acre-feet per acre
  - all crops = 3 acre-feet per acre
  - other crops = 3 acre-feet per acre
- The fields in the upper area of the PIP are laid out quite evenly in blocks of about 1 acre to 3 ha. Farmers report that individual family cultivation is about 15 acres but this does not look reasonable.
- The farmers in the upper area come from two villages, one being Anauk Magyikan and the other ???
- The south of the area is very sandy although farmers report that the Northern area has lower permeability than the other areas.
- Farmers were interviewed in three areas: those farmers cultivating near to the river, those farmers cultivating vegetables in the area between pump station 1 and pump station 2/3, and from two villages in the areas supplied by pump stations 3 and 4.
- The scheme covers in that area of 8000 acres
  - Pump Station- (4) Stage - 30% completed
  - Electrical Works - (7.5) MVA - 36% completed
  - Irrigable Area– 8000 Acres (3252 Hectares)
  - Main Canal - 26400 ft/(8.66 kilometres)
  - Distribution Canal – 97050 ft/ (29.54-Kilometres)
  - Water Source - Ayeyarwaddy River
  - Civil Work -Main canal and Distribution canal are (78%) complete
  - Project cropping Patten
    - Paddy - 1000-Acres
    - Cotton - 2000-Acres
    - Oil Cop - 3000-Acres
    - Other - 2000-Acres

Agriculture

- Two main sets of farmers were interviewed: rainfed, and those irrigating using residual flood waters and supplemented by pumping from groundwater using small pumps (6-10 hp) and own wells.
- At the Hnone Poe Pumping Station meeting hall, six farmers from A Naut Magyi Kan village at the NE end of the project were interviewed. Farm sizes average about 15 ac as indicated below:

Farmer's name	Acres owned
U Bo Aung	12
U Kyin Naing Win	18
U Ye Htut	15
U Aung Shwe	16
U Than Swe	3
U Than Kyaw Htay	15

- As at most other locations visited, an estimated 50% are landless. Soils are sandy. Up to now, only monsoon crops have been grown, an early and a late monsoon crop, there is no irrigation. Even these monsoon crops are risky as shown in the following table:

Crops rated by farmers as Good, Poor or Failed in last 10 years

Crop	Good	Poor	Failed	Total	Comment
Green Gram	2	5	3	10	Good = 8 bskts/ac. Poor = 1 bskt/ac i.e. just enough to replace seed used
Ground-nuts					No g-nuts grown for 20 years up to 2010 (because of climate change, they say) but good crop in 2010 and looking good in 2011 so far
Pigeon Pea	5	0	5	10	Good = 15 bskts/ac. Grown as an inter-crop
Cotton	0	10	0	10	Poor/average = 100-150 vis/ac. Now they have learned that 8 month variety cotton is less risky than 3 month variety cotton
Sesame, early monsoon	1	0	9	10	Good = 10 bskts/ac
Sesame, late monsoon	7	0	3	10	

- Contributing to this discussion were four farmers from Shin Makan village at the NW end of the project area. They said their soils were heavier and less sandy than those of the six farmers above. Average farm size is similar as shown below:

Farmer's name	Acres owned
U Min Zaw Oo	10
U Kyank Kol	15
U Zaw Htun	20
U Maung Myint	15

- These farmers from both villages also anticipate changed cropping patterns after new irrigation water is delivered as shown in the following table:
- Changed cropping patterns as anticipated by farmers

Crops grown now:	Current %	Future %
Green gram	30	20
Groundnuts	20	10
Sesame	20	15
Pigeon pea	10	5
Cotton	10	10
Fodder (millet)	10	10
New crops:		
Yellow gram	0	10
High value horticulture (HVH)	0	5
Paddy	0	25
Total	100	100

- They do anticipate more yellow gram, HVH and growing paddy for the first time. The idea of paddy on the more sandy soils is not suitable – see Overall Conclusions below. But, even if misguided, is an indication of the value they put on HH Food security.
- These farmers' operations are summarised in the following two tables on Cropping Patterns and Crop Budgets:

Hnone Poe, Analk Mayikan village at the top end of the scheme, rainfed													
	ha	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Green gram, 120 days	1.5			<----------									
Groundnuts, 120 days	1.0				<----------								
Pigeon pea, 180 days	0.5				<----------								
Cotton, 180 days	0.5			<----------									
Sesame, 90 days	1.0		<----------										
Fodder millet, 180 days	0.5		<----------										
Farm area	5.0												

Gross margin (per ha) and returns to labour (Ks'000)						
PIP site:	**Hnone Poe**					
Location:	**Analk Mayikan Village at top end of the scheme**					
Soil type:	**Light**					
Irrigation situation:	**No irrigation**					
Development scenario:	**Rainfed**					
Description	**Unit**	**Crop**				
		Green gram	Groundnuts	Pigeon pea	Cotton	Sesame
Price	Ks'000/kg	0.37	0.4	0.61	0.6	0.9
Yield	kg/ha	1014	3113	652	1621	424
Farmgate value	Ks'000/ha	375	1245	398	973	382
Variable costs[1]:	Ks'000/ha	305	507	114	520	189
-ploughing[4]	Ks'000/ha	62	62	0	62	62
-seeds[5]	Ks'000/ha	35	148	14	37	27
-fertiliser[5]	Ks'000/ha	65	74	25	220	80
-crop protection[6]	Ks'000/ha	49	25	25	161	0
-family labour[3]	days	50	100	75	300	75
-hired labour[7]	Ks'000/ha	94	198	50	40	20
-hired labour (days)	days	63	132	33	27	13
-water charge[2]	Ks'000/ha	0	0	0	0	0
wc as a % of total vcs		0%	0%	0%	0%	0%
Gross margin	**Ks'000/ha**	**70**	**738**	**284**	**453**	**193**
Return to family labour[3]	Ks / day	1404	7382	3783	1509	2568
Notes.						
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour						
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-						
3. Family labour based on 3 full time equivalent and 80 days per person per ha.						
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews						
5. Based on per acre costs and farmer interviews						
6. See Assumed Price of Inputs table, Ks 10,000/pass						
7. Daily labour rate assumed at Ks 1,500						

b) Small Scale Pump Irrigation Farmers

- These are smaller farms, ranging from 3 ac to 6 ac. Each has a diesel pump set and 3-5 wells. Soils are sandy. Crops are sweet corn, chilli, tobacco, yellow gram and winter vegetables such as onion and tomatoes, i.e. high margin crops. They are all grown between October and February, but there is not enough water from the wells to irrigate a summer crop from March to June. The annual river flood arrives July/August. So if WRUD can deliver summer water, these farmers will benefit and cropping intensity will increase. These farmers' operations are summarised in the following two tables on Cropping Patterns and Crop Budgets:

Hnone Poe, Kyipin Khone village, (farmers with own wells/pumps at flood level)														
	ha	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
Flood, 120 days		<----------											
HVH (sweet corn), 120 days	0.3								<----------				
HVH (chilli), 140 days	0.3							<----------					
Tobacco, 150 days	0.2							<----------					
Yellow gram, 120 days	1.0								<----------				
Winter vegetables, 120 days	0.2								<----------				
Farm area	2.0												

Gross margin (per ha) and returns to labour (Ks'000)									
PIP site:	Hnone Poe								
Location:	Kyipin Khone Village								
Soil type:	Lighter								
Irrigation situation:	Farmers with own wells/pumps at flood level								
Development scenario:	Not irrigated by the PIP authority								
Description	Unit	Crop							
		Sweet corn	Chilli	Tobacco	Yellow gram	Winter veg			
Price	Ks'000/kg	0.23	1.22	0.09	0.48	0.3			
Yield	kg/ha	4172	745	12157	1162	3242			
Farmgate value	Ks'000/ha	960	909	1094	558	973	0	0	0
Variable costs[1]:	Ks'000/ha	543	494	599	253	614	0	0	0
-ploughing[4]	Ks'000/ha	62	62	62	62	62			
-seeds[5]	Ks'000/ha	30	62	24	30	70			
-fertiliser[5]	Ks'000/ha	110	128	297	50	99			
-crop protection[6]	Ks'000/ha	124	10	0	0	49			
-family labour[3]	days	260	400	300	75	400			
-hired labour[7]	Ks'000/ha	150	200	200	67	267			
-hired labour (days)	days	100	133	133	45	178	0	0	0
-water charge[2]	Ks'000/ha	67	32	16	44	67			
wc as a % of total vcs		7%	4%	1%	8%	7%	#DIV/0!	#DIV/0!	#DIV/0!
Gross margin	**Ks'000/ha**	**417**	**415**	**495**	**305**	**359**	**0**	**0**	**0**
Return to family labour[3]	Ks / day	1602	1037	1650	4063	897	#DIV/0!	#DIV/0!	#DIV/0!
Notes.									
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour									
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft – Ks 6000/ac; summer paddy 6 ac-ft – Ks 9000/ac; other crops 4 to 5 ac-ft – Ks 7500/ac									
3. Family labour based on 3 full time equivalent and 80 days per person per ha.									
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews									
5. Based on per acre costs and farmer interviews									
6. See Assumed Price of Inputs table, Ks 10,000/pass									
7. Daily labour rate assumed at Ks 1,500									

2. Constraints and Issues

- The project was started in 2004 and the main canal and pump stations were finished in 2007 without the pumps and electrical connections. Progress since then has been slow due to a lack of available budget. A diagram in the presentation showed the status of construction.
- The rate of development of construction has been guided by engineering issues, political visibility and available budget. With the changing approach of the current government, it is important for future project interventions that economic and financial viability is more clearly understood and reflected in interventions and in this respect the delayed arrival of benefits will severely restrict benefit cost ratio.
- Only the main canal is lined and about 80% of the distributors have been built using the similar soil to that will be used for cultivation. The soil is sandy to very Sandy in places and this will result in large water conveyance losses particularly in the distributary and tertiary canals.
- None of the tertiary and Watercourse system have been built and in fact have not been discussed with the farmers. This will be done when water pumps have been installed and water is available. The designers have limited field information on the division of the farm blocks that actually exist on the ground and how these will be integrated with the already built distributary canals and offtakes. The area has quite uniform slopes and therefore will not require much land formation. However, tertiary canals will need lining at some stage and frequency of turn out to the watercourses canals will need to be related to potential conveyance losses at this level of canal.
- The choice of irrigation method of surface irrigation pays little attention to the sandy nature of the soils. Irrigation methods are assumed to be basin (for Paddy) and furrow (row and other crops). The first method is not suitable for these types of soil. The second method can be used but the length of furrow needs to be related to the soils and the water delivered. This will give an indication of the frequency of the Watercourse canals.
- The planned crops are unreasonable considering that farmers in the area have limited experience in rice growing (none of the area planned for irrigation development is under rice irrigation in the monsoon season) and no experience on surface irrigation other than those who have been fortunate enough to practice vegetable irrigation near to their houses (in the areas closest to the Ayeyarwaddy River).
- In the meeting with the farmers from the two main villages within the main command area between pump stations 2 & 4, farmers expressed an interest in growing rice. This did not seem to reflect an understanding of market demand, cost of production and experience with cultivation, but more on the fact that this was a priority crop of the government. Although the village leaders wanted this crop, they did not seem to be aware

of the amount of water that such crops would need on these soils using basin irrigation when compared to the cultivation of row crops on the same soils. It would be much better to take the existing crops of pulses and oilseeds and vegetables, which is the farmers are currently growing in the monsoon season in this area, and to build the planned irrigated cropping pattern around these crops.

- This project has taken 7 years to build so far and is incomplete at the moment. Benefits to irrigation schemes are largest within the first 10 years after the initial investments and any losses in these years is likely to have a major impact on the economic viability of the project. Therefore, the failure to provide enough funds even to complete pump stations 1 & 2 means that benefits that could have been accrued in 4 years have not been achieved.
- The location of the pump station is fine for the monsoon season but will experience the same problems as currently experienced by the Law Ka Nandar PIP whereby water cannot reach the pumps at the lower river stages necessitating dredging around the pumps and reducing the amount of water available for pumping.
- Small-scale Pumping in the area affected by seasonal flooding from the Ayeyarwaddy River is only achievable in the winter months when the water table resulting from the recharge from the River is still within the suction range of the centrifugal pumps (~6m).
- Fundamentally we are interested in delivering improved livelihoods and household food security. Several farmers believe they can achieve these objectives by growing paddy on sandy soils after the new irrigation water arrives. For two reasons they need persuading that this is difficult to achieve, and even if it is achieved, it is wasteful of expensive water: first, if paddy cannott be grown in the monsoon season on these soils, supplementary irrigation will not much change this; second, income from the sale of higher value crops such as oilseeds and pulses, (and in the long term cotton), plus some HVH, can deliver more purchased rice, i.e. household food security. Extension is needed to guide farmers towards more sensible cropping patterns and solutions.

3. Scope for Improvement

- discussion should take place at least one year and probably two years before the pumps are installed to ensure that:
  - the tertiary and Watercourse canals are located in areas that are favourable to irrigate the areas,
  - farmers are fully aware of their obligations and WRUD is informed where the farmers would like the offtakes to be located
  - the local NGOs can be used to facilitate the future developments by working to involve them in the actual adopted design and in the development of water users associations to manage, operate and maintain the tertiary and Watercourse systems. This could be an EU intervention area with assistance provided through lift to improve the capacity of the NGOs. A technical group should be located within LIFT to provide improved guidance in the development of the schemes that are aimed at improving livelihoods of the farmers.
- the irrigation system should be removing the risk associated with growing crops in the monsoon, winter and summer seasons. Although the report notes that the rainfall in the area is 900 mm, the data shows that it is about 600 mm. It is also extremely variable with early rains falling in April and extending through to September in good years but with failures in both years and months within the poor years. Irrigation will therefore ensure the ability to grow crops in say 9 out of 10 years. This is unlike the current situation where failure is expected in eight years out of 10 years.
- Implementation plans need to be established for phased development so that benefits can accrue more easily and any improvements, correction of mistakes etc., can be implemented in the remaining phases.
- Irrigation developments, irrigation methods and crops grown must be related to the available water and the water holding capacity of soils.
- To improve the implementation of this project, the following is required:
  - obtain the soil survey map of the area to determine those areas to be developed and to identify the land suitability in the command area
  - the crops to be grown should be related to ability of the farmers, suitability of the soils, market demand, irrigation requirements, etc. The cropping pattern should then be established considering the crops recommended and considering the net returns as developed in the crop budgets.
  - A balance between irrigation in the monsoon season and irrigation in the winter and summer seasons needs to be considered in relation to funds available to pump irrigation water, the availability of water and the economic design of the systems.

- In the short term, there is a strongly felt need for extension, and this is essential to manage the transition to the proper use of irrigation water.
- The HVH crops (sweet corn, chilli, and winter vegetables such as onions and tomato) now grown by farmers with pumped well water are an indication of what farmers will do when irrigation arrives in all areas of the PIP. Proximity to Bagan town may support HVH. Farmer interviews confirmed a wish to grow more HVH under new irrigation.
- Additionally, the current pump irrigation farmers do not get sufficient water from their wells for an early summer crop before the flood arrives in July/August, so irrigation water provided by the PIP authority can be expected to have an impact on cropping intensity.
- Yields for paddy on these sandy soils are likely to be as low. Most other crops such as oilseeds and pulses have similarly low yields according to farmer interviews.
- As with other PIPs, improved irrigation and farmers' freedom to move away from "policy" crops will mean a move towards higher margin oilseeds and pulses, plus greater cropping intensity from greater emphasis on these summer and winter crops.
- In the longer term, cropping intensity will increase further as WUAs and extension are strengthened in water management. Cotton may also increase in area for these and other reasons.

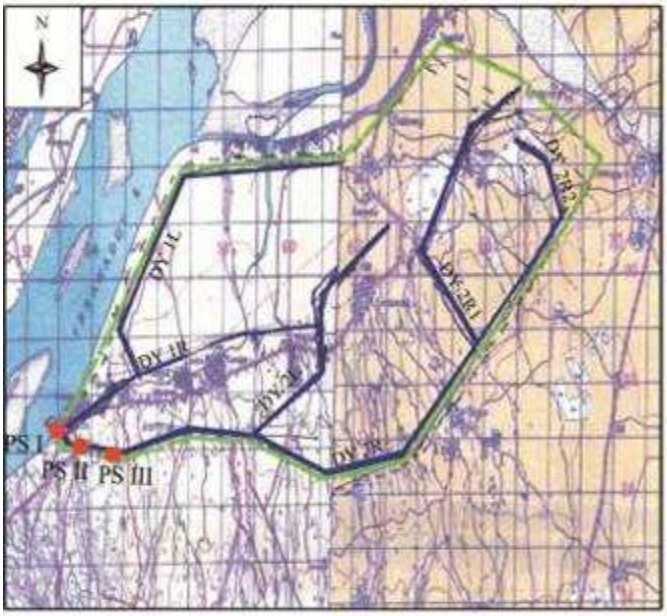
Crop Yields Assumptions, kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	2100	1575	1250
Summer paddy	2400	1800	1450
Groundnuts	3100	2500	2000
Green gram	1000	800	650
Yellow gram	1150	950	750
Sesame	425	340	275
Cotton	1600	1200	1000
Sunflower	1500	1200	900
Maize	4000	3750	3500
HVH (incl sweet corn, chillie and winter veg)	6000	4000	2000

PIP site:	**4. Kyaw Zi**
Location:	**Myingyan Township; Myingyan District; Mandalay Region**
Date of Construction:	**2001 to 2003**
Status of Construction:	**Completed but only about 50% of scheme is operational due to damage and lateral and watercourses not complete for PS-3**
Development scenario:	**Operational but water shortages in both main seasons**

Location Map.

KYAW ZI PUMP IRRIGATION PROJECT
TAUNG THA TOWNSHIP



SR No.	Name of Canal	Length of Canal (mile)	Command Area (Acre)	Canal Size
1	MC	1.14	-	6.5 X 8
2	DY-I	0.88	50	5.5 X 6
3	DY-I R	2.84	2447	5.5 X 6
4	DY-I L	2.84	753	5.5 X 6
5	DY-II	1.67	-	6.5 X 6
6	DY-II R	2.84	1338	5.5 X 6
7	DY-II L	6.08	277	5.5 X 6
8	DY-II R1	2.84	1022	5 X 4.5
9	DY-II R2	2.84	2113	5 X 4.5
TOTAL			8000	

Refrence
Pump Station
Canal
Command Area
River (or)Stream

1. Existing Situation

General and Engineering

- The gates that were fitted to some of the structures were wooden and they are not watertight and thus a lot of water is going to an area is not intended even though it is shut.
- At the main pump station, the pipes are being repaired but there is a shortage of funds to do this at the optimum time. Maintenance of the canals and structures is weak and this is due to a lack of funding of the activities.
- The canal has a poor cross section and a lot of weeds and no sign of regular maintenance. Capacity of the canal has been considerably reduces due to silting and weed growth.
- The works of the distributary canal has been completed but the connection with the farmers land and distribution was poor and could have been improved.
- The losses on the system are extremely high because most of the gates are closed and but the water is still flowing.
- They have the same make up of water users associations with the basic unit being 10 farmers and the average area 25 acres. The Department is responsible for collecting the water fees and the rate charged is the same as elsewhere but only about 60 to 70% of the charges are collected. Farmers value of irrigation water is very low in the pumping schemes as they treat it in a similar way to gravity schemes and they do not pay for volumes, only fixed costs.
- On the area between DY 1L and R, the farmers land is lower and traditionally flooded. There is a flood bund along the Ayeyarwaddy River and when it gets to a high enough level, the flood gates on the river are opened and water enters into the paddy fields. Traditionally this area has alwaya been flooded and so the soils are heavier having clay and silt content and this has also acted as a fertiliser as much of the silt has been dropped onto the land.
- This scheme has been going since 2003 and is now showing signs of past lack of maintenance due to the problems of a lack of farmer involvement in the costs and not appreciating the cost of water.
- The design of some of these structures could be improved as there is leakage along the pipes for the outlets from the distributary canals, which are pipes, and the material that was around them and maybe compacted has gone. This material is quite sandy in the first place and this has not facilitated compaction. In addition to this, the structures along the distributary canal do not allow easy passage of animals and a slight modification could improve that.
- The gates for the structures are with the man who is responsible in the village, but there is no evidence that the gates are actually used and in fact most of them are blocked with available material.
- The rice growing in the area now should have been harvested and it seems to be rather late. This area is treated differently from the conventional paddy flooded areas as water is introduced through gated inlets when the height of the river is high enough. Up to 2 months later than irrigated paddy.
- About 60% of the bottom part of the second rice area is flooded during the monsoon period using the same system as above with gates on the Ayeyarwaddy River being open to let the water in. The tertiary canals are designed by the Department but built by the farmers. The structures and location of the check structures looks as though they were agreed with the farmers but there are random outlets and proportional dividers along the way indicating that the farmers have agreed amongst themselves how to distribute the water. This needs a little bit more discussion to see how they integrate the two but it does look better than I first thought.

Agriculture

- Total command area is 8,000 ac (3238 ha). Soils are 90% sandy though 10% of soils are heavier and can grow summer paddy. But original plan was 4000 ac (1619 ha) paddy, 1000 ac (405 ha) cotton, and 3000 ac (1214 ha) oilseeds.
- The current situation is as follows:
  - Monsoon paddy, up to 20% i.e. 809 ha
  - Summer irrigation planned for 2011 is 324 ha, same as 2010
- Groups of farmers were interviewed from three locations within the PIP (Kyaw Zi, Minju, and Tamiktha villages). These have been amalgamated into one representative farm model because they were growing the same crops (monsoon paddy, summer paddy, yellow gram and green gram) and all had their own pumps and wells for their onion crop only. Yields vary somewhat as soils get lighter away from the river, but the difference is not great and values have been averaged. Farmers said that the particular characteristic of these

soils is their high silt content which is why they are suited to onions.

- Average farm sizes are small at 0.8 ha. They are represented in the following tables on Cropping Patterns and Crop Budgets:

Kyaw Zi PIP, Minju, Kyaw Zi and Tamiktha Villages													
	ha	A	M	J	J	A	S	O	N	D	J	F	M
Monsoon paddy	0.8						<----------						
Summer paddy	0.5	<----------											
Onion	0.2	---->									<----------		
Yellow gram	0.1	---->									<----------		
Fodder/ green gram	0.0	----------											<--------
Farm size	0.8												

Gross margin (per ha) and returns to labour (Ks'000)						
PIP site:	**Kyaw Zi**					
Location:	**Representative (Minju, Kyaw Zi & Tamiktha villages)**					
Soil type:	**Lighter**					
Irrigation situation:	**Irrigated, but also have own pumps and wells**					
Development scenario:	**Actual**					
Description	**Unit**	**Crop**				
		Monsoon paddy	Summer paddy	Onion	Yellow gram	Green gram
Price	Ks'000/kg	0.29	0.29	0.31	0.64	0.37
Yield	kg/ha	2400	3700	11350	1400	800
Farmgate value	Ks'000/ha	706	1088	3519	896	296
Variable costs[1]:	Ks'000/ha	632	640	1267	214	215
ploughing[4]	Ks'000/ha	62	62	62	62	62
seeds[5]	Ks'000/ha	21	21	247	30	35
fertiliser[5]	Ks'000/ha	294	294	220	0	0
crop protection[5]	Ks'000/ha	0	0	124	0	49
family labour[3]	days	280	280	400	75	50
hired labour[7]	Ks'000/ha	241	241	525	104	50
hired labour (days)	days	161	161	350	69	33
water charge[2]/cost	Ks'000/ha	15	22	89	19	19
wc as a % of total vcs		2%	3%	7%	9%	9%
Gross margin	**Ks'000/ha**	**73**	**448**	**2252**	**682**	**81**
Return to family labour[3]	Ks / day	261	1600	5630	9094	1629

Notes.

1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks
3. Family labour based on 3 full time equivalent and 80 days per person per ha.
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews
5. Based on per acre costs and farmer interviews
6. See Assumed Price of Inputs table, Ks 10,000/pass
7. Daily labour rate assumed at Ks 1,500
8. Water cost in the case of onions only is based on diesel used for farmers' own pump

2. Constraints and Issues

- The biggest problem for farmers is the unreliability of irrigation water. This is mainly used on paddy (monsoon and summer), yellow and green gram if available. For a valuable crop like onion they cannot rely on it. Their own pumped water is twice the price of WRUD water but as the farm models show, this is only 7% of total variable costs for that crop. If they had water in the winter season they could grow a second crop. They have to supplement the water provided by WRUD for their summer paddy with their own pumped water. But even the higher yielding summer paddy barely makes this financially attractive and most farmers said they would reduce summer paddy in the future and grow onion instead. If, on the other hand, WRUD provides reliable summer water, then they would continue to grown some summer paddy.
- Specifically, farmers said they would grow more onion and yellow gram (even double their present areas of these crops) and would eliminate summer paddy to do this.
- Their second main problem, consistent with all other PIPs visited, is extension. This would be not only for crop management, but also for water management.

3. Scope for Improvement

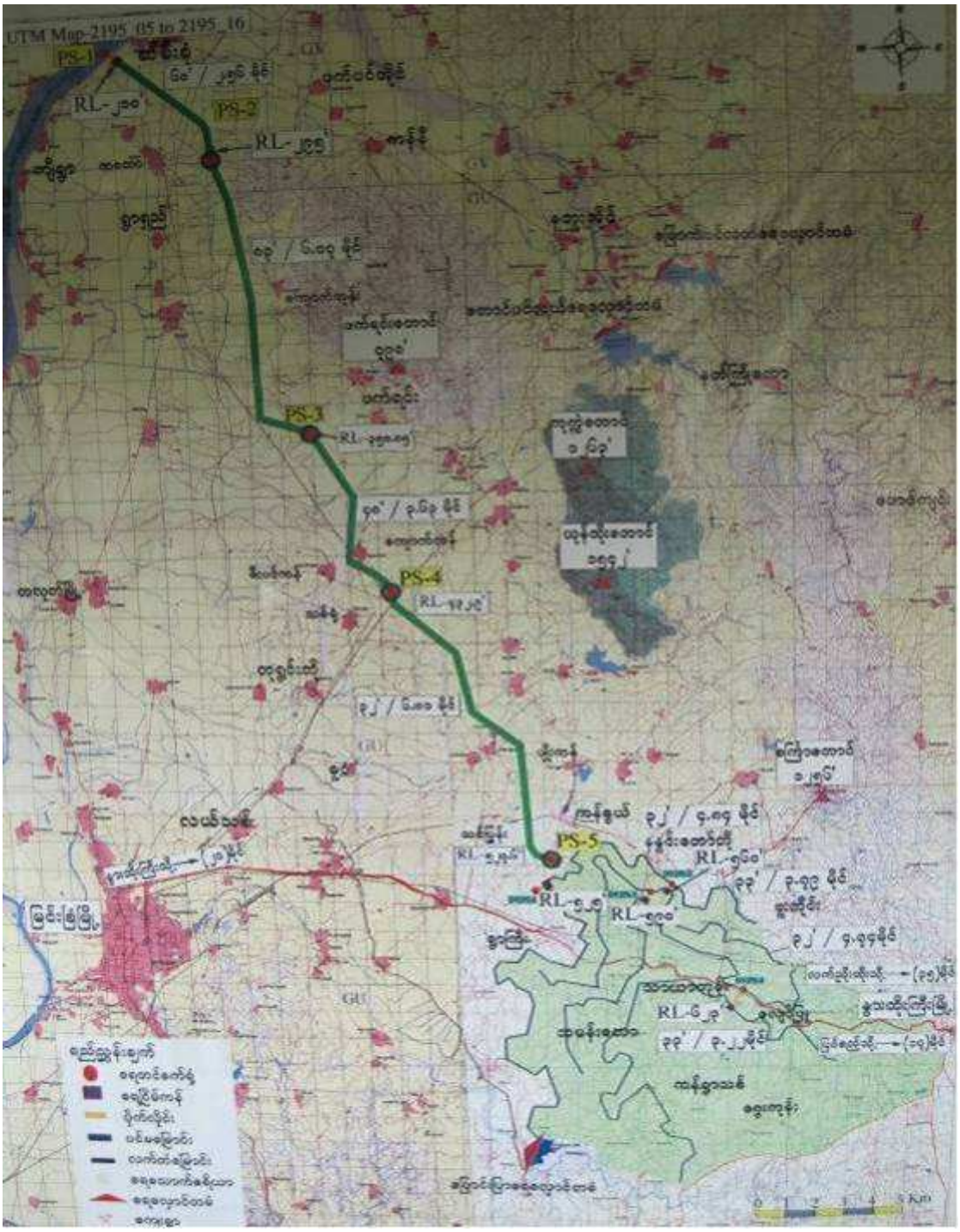
- The unreliability of water is driving farmers towards higher value crops that can bear the cost of their own pumped water. The provision of more reliable water in the future would allow farmers to have a sensible mix of high value crops like onion but also to keep some summer paddy. (Onions grown too often can build up soil borne diseases such as white rot.) The provision of water in the winter season would immediately lead to increased cropping intensity.
- Extension for crop improvement and improved water management is needed, and wanted by farmers not only for paddy but for other crops as well.

Crop Yields Assumptions, kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	3000	2400	1950
Summer paddy	4600	3700	3000
Onion	14000	11350	9000
Yellow gram	1750	1400	1100
Green gram	1000	800	600

PIP site:	**5. Simeekone-3**
Location:	**Natogyi Township; Natogyi District; Mandalay Region**
Date of Construction:	**2010 - 2013**
Status of Construction:	**Main canal at River to about 1+000, but much work remaining. No work yet done on Distributary and below canals or on the pump stations**
Development scenario:	**Not operational.**

Location Map.



1. Existing Situation

General and Engineering

- The Simeekone-3 PIP is the last stage of the irrigation development by WRUD south of Sameik kon village. The objective of the project is to move water 23 miles south-east of the pump station to irrigate mostly sandy silty soils and to supply the town of Natogyi with drinking water.
- The pump station is located just south of Sameik kon town at a good location where the width of the river is half a mile. Four pump units will be used and they would have a total capacity of 50 cusecs. This water will be conveyed to the higher location using five pump stations with the total head of about 150 m.
- The project is in its early stages at the moment with construction having started in September 2010. Prior to this, detailed check surveys were carried out and these involved locating structures and alignment of canal. Detailed farm layouts connecting to the conveyance system does not yet seem to have been completed and the alignments of the distributary canals have yet to be determined. This will be a major exercise and will involve quite considerable cost as he distributary canals are quite long and the distance between them relatively short.
- The total pumping head including the five pump stations is about 150 m.
- Construction is being carried out by WRUD with its own construction unit and equipment. They have subcontracted haulage of earthworks and other materials to local contractors who may just be lorry owners.
- Construction has been limited by the available budget and it is planned for completion by 2012. The previous plan for completion was 2013.
- The main canal has only been finished for about 1 km and most of the works for the intake from the river have been completed except for the floating pontoon, connecting pipes and power supplies.
- The costs have been determined using local unit rates and these are adequate. In fact as the contracts are long-term contracts and are implemented effectively under force account, this should not be a major issue except where major changes or sudden cost rises occur. The current contingency for physical works is 3%.

Agriculture

- There is doubt that it will be completed because of the high cost, there is no assured budget, and the decision to implement was taken by the last government. The areas in the immediate command of the canal were already irrigated in phases 1 and 2.
- Two sets of farmers were interviewed:
- The first set is outside the command of the PIP in the middle of the area irrigated by Phase II command area, south of PS 1 at Ya Shwe Village.
- These Ya Shwe village farmers have similar crops and can be represented by one model. They say that they are typical of their area. Soils are moderately good alluvial. Average farm size is 2 ha of which 0.2 ha is irrigated (not from the PIP) and the rest rainfed. Irrigated land has monsoon paddy, summer paddy, and yellow gram (on residual moisture). The other crops (pigeon pea [.6 ha], millet fodder [0.2 ha], more yellow gram [0.6 ha], chilli [0.2 ha] and red pulse [0.2 ha]) are rainfed. The Ya Shwe farmers' cropping pattern and crop budgets are shown below:

Simeekone-3 Phase 1, Ya Shwe village, part irrigated													
		A	M	J	J	A	S	O	N	D	J	F	M
Monsoon paddy (irrigated) 25+115=140 days	0.2				<----------				---------->				
Summer paddy (irrigated) 25+115=140 days	0.2	---------->											<------
Yellow gram (rainfed) 120 days	0.8							<----------				---------->	
Chilli (rainfed) 120 days	0.2							<----------				---------->	
Pigeon pea (rainfed) 180 days	0.6		<----------						---------->				
Fodder millet (rainfed) 180 days	0.2		<----------						---------->				
Red bean, 120 days	0.2							<----------				---------->	
Farm area	2.0												

Gross margin (per ha) and returns to labour (Ks'000)							
PIP site:	**Simeekone-3**						
Location:	**Ya Shwe village, East of PS1**						
Soil type:	**Heavy**						
Irrigation situation:	**Part irrigated, part rainfed**						
Development scenario:	**Actual**						
Description	**Unit**	**Crop**					
		Monsoon paddy	**Summer paddy**	**Pigeon pea**	**Chilli**	**Yellow gram**	**Red bean**
Price	Ks'000/kg	0.29	0.29	0.67	1.22	0.26	0.28
Yield	kg/ha	2350	3350	460	1600	3100	2100
Farmgate value	Ks'000/ha	682	972	308	1952	806	588
Variable costs[1]:	Ks'000/ha	567	343	176	371	233	215
-ploughing[4]	Ks'000/ha	62	62	62	62	62	62
-seeds[5]	Ks'000/ha	20	15	14	10	49	49
-fertiliser[5]	Ks'000/ha	360	124	25	74	40	49
-crop protection[6]	Ks'000/ha	0	10	25	25	15	5
-family labour[3]	days	280	280	240	400	75	100
-hired labour[7]	Ks'000/ha	110	110	50	200	67	50
-hired labour (days)	days	73	73	33	133	45	33
-water charge[2]	Ks'000/ha	15	22	0	0	0	0
wc as a % of total vcs		3%	6%	0%	0%	0%	0%
Gross margin	**Ks'000/ha**	**115**	**628**	**132**	**1581**	**573**	**373**
Return to family labour[3]	Ks / day	410	2244	551	3953	7640	3730
Notes.							
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour							
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft – Ks 6000/ac; summer paddy 6 ac-ft – Ks 9000/ac; other crops 4 to 5 ac-ft – Ks							
3. Family labour based on 3 full time equivalent and 80 days per person per ha.							
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews							
5. Based on per acre costs and farmer interviews							
6. See Assumed Price of Inputs table, Ks 10,000/pass							
7. Daily labour rate assumed at Ks 1,500							

- The second set of farmers are at Tha Man Daw village at the SE end of the 23 mile canal. Soils are rather poor grey sandy. Average farm size is 10 ha, rainfed. Crops are: sesame 8 ha; groundnuts 1.5 ha; and pigeon pea 0.2 ha; plus fodder millet 0.3 ha. The Tha Man Daw farmers' cropping pattern and crop budgets are shown below:

Gross margin (per ha) and returns to labour (Ks'000)							
PIP site:	**Simeekone-3**						
Location:	**Tha Man Daw village, at the end of 23 mile canal**						
Soil type:	**Lighter (grey sandy)**						
Irrigation situation:	**Rainfed, not yet irrigated or part of the project**						
Development scenario:	**Actual**						
Description	**Unit**	**Crop**					
		Sesame	**Groundnut**	**Pigeon pea**			
Price	Ks'000/kg	0.82	0.4	0.61			
Yield	kg/ha	605	2500	460			
Farmgate value	Ks'000/ha	496	1000	281			
Variable costs[1]:	Ks'000/ha	198	507	240			
-ploughing[4]	Ks'000/ha	62	62	62			
-seeds[5]	Ks'000/ha	10	148	14			
-fertiliser[5]	Ks'000/ha	89	74	25			
-crop protection[6]	Ks'000/ha	0	25	25			
-family labour[3]	days	80	100	75			
-hired labour[7]	Ks'000/ha	37	198	114			
-hired labour (days)	days	25	132	76			
-water charge[2]	Ks'000/ha	0.0	0.0	0.0			
wc as a % of total vcs		0%	0%	0%			
Gross margin	**Ks'000/ha**	**298**	**493**	**41**			
Return to family labour[3]	Ks / day	3726	4930	541			
Notes.							
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour							
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft – Ks 6000/ac; summer paddy 6 ac-ft – Ks 9000/ac; other crops 4 to 5 ac-ft – Ks							
3. Family labour based on 3 full time equivalent and 80 days per person per ha.							
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews							
5. Based on per acre costs and farmer interviews							
6. See Assumed Price of Inputs table, Ks 10,000/pass							
7. Daily labour rate assumed at Ks 1,500							

Simeekone-3 Phase 1, Tha Man Daw village, rainfed														
Sesame, 75 days		8.1		<---------->										
Groundnuts, 150 days		0.8					<---------->							
Fodder millet, 150 days		0.8				<---------->								
Pigeon pea, 160 days		0.3				<---------->								
	Farm area	10												

2. Constraints and Issues

- the pump station will have problems meeting the agricultural water demands in an efficient manner as it has not been designed considering the variation in crop water demands over the season. In addition to this no telerimetry has been included.
- In the area to be planned, the plots are very fragmented with quite high local slopes and would need terracing. This would be a considerable work for the farmers as the burden of land levelling is put on them.
- Although there is a range of soils in the area, most are very permeable and more suited to sprinkler or short furrows.
- To transport the water so far under such conditions would make the unit cost extremely high and local problems of waterlogging may well occur due to the underlying bedrock.
- Detailed soil and suitability calculations do not seem to have been made nor has the layout of the farmers fields been taken into consideration.
- It would appear that the design has been completed at this level and that this has not been ground truthed. If it has, due consideration has not been given to the location of the tertiary canals and watercourses.
- The conveyance by open channel with such large earthworks instead of by pipeline has to be questioned. It is reported that Myanmar has a surfeit of cheap labour however the construction work is mainly done by machinery.
- Ya Shwe soils are good and seem to be worth irrigating. Farmers say that if they get water they would grow sugar cane (which is common in the area), sunflower, and cotton. These soils, they say, are good for cotton and quite a lot is already grown in the area, both improved and local varieties. After water their biggest need, is for extension. They had extension for paddy only in the last six months.
- Tha Man Daw soils are not as poor as at some PIPs, but not good enough to justify bringing water 23 miles, and they are rolling to hilly and so would have to have a dense network of distributary canals. Average yields are moderate, e.g. sesame, the main crop, has an average yield of 480 kgs/ha which is only slightly more than rainfed sesame on other PIPs, e.g. Hnone Poe where average yield is 420 kgs/ha.

3. Scope for Improvement

- To irrigate such permeable soils by pumping water over such a long distance seems to be very much in question. The distances are long, the height over which the water has to be raised is much higher than is considered economic for pumping (70 m), the soils to be irrigated are permeable and would not be suitable for basin irrigation and could only be irrigated using furrow irrigation if carefully planned.
- The land in the area to be irrigated is extremely undulating and this would result in problems of canal alignment for the distributary and tertiary systems, linking with the farmers watercourse systems (as planned) and identifying the alignment considering the contour maps have wide intervals (3 to 5 m that will mask any micro changes in topography).
- The development of the area needs first to relate soils, crops and water requirements to the topography of the area to be irrigated. Soils considerations are important as it seems that quite permeable soils may overlay sandstone with depths of topsoil being quite limited in places.
- A better solution would be to increase the intensity of irrigation in the area below pump stations 1 and 2 that suffer from insufficient water supplies at the moment. The site staff indicated that they considered ending the development at pump station 3 and using the water to irrigate that part of Simeekone 1 & 2 currently suffering from inadequate water in all months except the monsoon season.
- This would require the design of the number and sizes of pumps to be adjusted to meet the peak irrigation demands and the lower demands with one put on standby.
- What has not happened on the irrigation schemes that have been viewed is that detailed crop water requirements have not been planned realistically for the irrigated area nor have the conveyance and application efficiencies and irrigation methods been related to the soils actually experienced on the ground.
- To integrate with the existing network will need a certain amount of ground truthing and careful planning with the farmers to ensure that full use is made of existing systems and that the works for the farmers are

minimised.

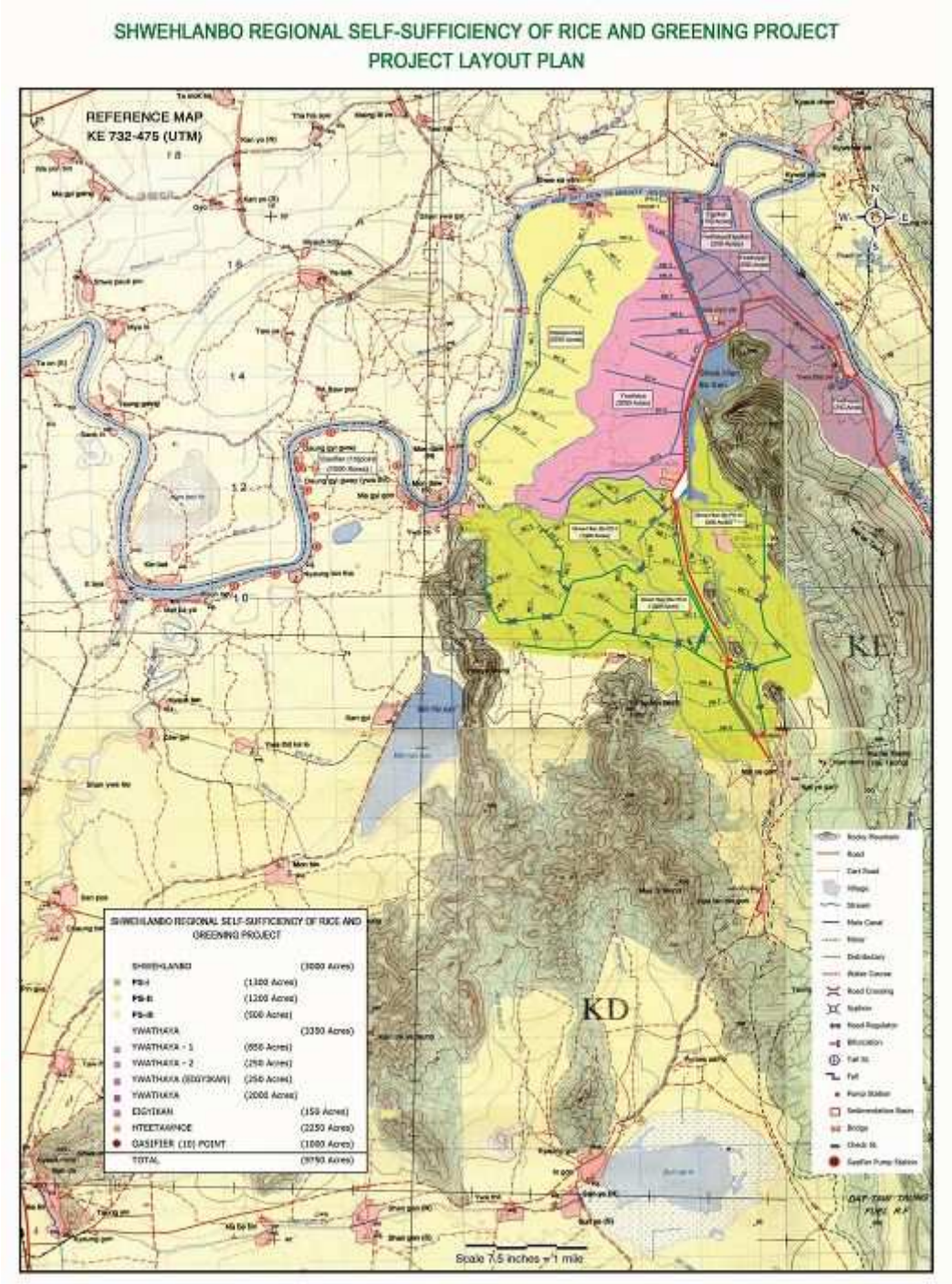
- One of the main reasons for delay on the other PIPs has been the completion of tertiary and watercourse canals and land levelling by the farmers. In areas where the projects are considered viable, consideration should be given to assisting farmers in land preparation and construction of canals either through food for work or cash with materials for cross regulating and offtake structures also being provided.
- WUAs exist as in other areas but they only pay the flat rate for irrigation water. The lack of contribution to the actual costs of irrigation together with the very minimal budget provided from government to the local implementers of MOM, results in limited amounts of maintenance and the gradual deterioration and mining of the system.
- There is no doubt that the engineering works can be built well and that the implementation engineers can make adjustments on-site for routine problems. For additional structures or major changes they have to revert to the designers in WRUD. Thus it can be assumed that construction techniques are OK and that the site supervising engineers are well equipped to deal with problems that they are faced with. The main problem that arise is the lack of agriculturalists, soil surveyors and agricultural economists within the WRUD. These are necessary to overcome the problems that have been identified.
- There is a need to introduce measuring structures as there is no means of checking the flow actually being delivered or relating flow to irrigated crops and hence water charges.
- With pumped water, attention has to be paid to the type of crop to be irrigated, its crop water requirements and the returns that it receives as generally they need to be high-value crops. The aim must be to reduce the current volume of water pumped so that the cost of water is directly related to the value of the crop yield.
- Dry season flow is a constraint for power production as much of the new power supply comes from hydropower. This combined with the higher water demands in the summer season has meant that many pump schemes have been unable to meet the planned cropping intensity. It has not helped that the land supplied has been more permeable than has been anticipated by the designers.
- There is no doubt that the approach to these type of irrigation schemes is changing and that the environment that people are working in is more likely to encourage improvements and avoid such expensive and unrealistic projects. It is necessary to build on these revised approaches and take advantage of the chink in the armour.
- Training is a very important aspect of this improved approach and a variety of avenues are needed including short-term specialised courses in-country, targeted training of trainers, links with overseas universities with appropriate courses and a few staff attending postgraduate (MSc level) courses abroad in countries like Thailand, Australia and maybe Europe.
- Irrigation of the alluvial flood plain soils close to the river, as typified by Ya Shwe, seems justified. Irrigation of soils typified by Tha Man Daw is not justified, mainly because of distance and pumping height.
- Benefits of irrigating soils typified by Ya Shwe would be a switch to higher margin crops, plus an increase in cropping intensity. These could be further enhanced by improved extension.

Crop Yields Assumptions, kg/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	2900	2350	1900
Summer paddy	4200	3350	2700
Pigeon pea	600	460	365
Chilli	2000	1600	1300
Yellow gram	3850	3100	2475
Red bean	2675	2100	1700
Sesame	600	480	380
Ground nuts	3100	2500	2000

PIP site:	**6. Shwe Hlan Bo**
Location:	**Sint Kaing Township; Kyauk Se District; Mandalay Region**
Date of Construction:	**On Going**
Status of Construction:	**1st Stage completed, next stage due 2012**
Development scenario:	**Operational, but some watercourses still need to be completed in Phase 1. 2nd Phase has main canal part completed with other canals remaining.**

Location Map.



1. Existing Situation

General and Engineering

- The Shwe Hlan Bo Region is located in Sint Kaing Township, North-Eastern part of Kyauk Se District, Mandalay Region and is situated in the arid zone of central Myanmar.
- Rainfall data collected at the site near the pump station indicate that this is actually above the annual rainfall in the dry zone of Myanmar.
- The site has considerably benefited from the construction of the 780 MW power station upstream (name?). This power plant feeds into the national grid and has already started to make local improvement in the availability of power during the dry season and the monsoon season. It has resulted in the reduction in the variation of flood levels from 15 feet to 5 feet during the course of the year. This maintenance of minimum flow in the river will result in reduced pumping costs and as has already has been seen and the possibility of introducing small pumping units further down the river for small-scale farmers.
- In addition to the maintenance of the minimum flow, more regular power supplies has enabled the scheme to increase the pumping hours in the dry season particularly when the flows are needed and hydropower generation reduced.
- This site has benefited from the experience of practical irrigation engineer who has introduced measurement of canal flows which has been lacking on the other sites visited.
- 100% repayment of water charges by the farmers is achieved here
- Only the equivalent of about 10% of the money paid for water charges comes back to the scheme in terms of budget received for O&M from the State.
- Canal flow is divided before it enters the old storage reservoir so that use can be made of the storage to supplement flow in the dry season and to increase unit flows and provide irrigation during power cuts. There is a two way flow arrangement so that water can enter the lake or be drawn off from the lake.
- There is a good set up on this project for measuring water flows and climate. A class a pan and a rain gauge are located at the pump station site; a broad crested weir has been provided at the end of the main canal; some of the gates seem to be calibrated and there is a volume-area-stage relationship for the water stored in the lake at the foot of the hills.
- The condition of the tertiary system is not as good as it should be as there is no funding for annual maintenance although operational costs are met more or less from government allocations
- In general, about one fifth of the area (Phase I) comprises good soils and receives adequate water in all seasons.
- During times of low flows and drought, preference is given to government preferred crops and in some years even these areas have to be reduced due to low river flows.
- The cultivation carried out on the scheme indicates that the farmers appreciation of water is high. It is well utilised but there are still signs of over irrigation. However, when farmers do not have to pay for water, other than fixed land charges, they will over irrigate rice.
- Land that is out of command or not suitable for paddy cultivation is used for other crops including sunflower, cotton, beans, some vegetables and other gram crops.
- On-farm water is supplied on a more or less continuous basis with the farmers managing the allocation at quarterly level amongst themselves.

Agriculture

- 1,214 ha (3,500 ac) is planned for irrigation adjacent to earlier irrigated areas, some of which date back to 1872. The Hteetawmde area (west of the current irrigated area) is planned for irrigation in the future.
- Farmer groups were interviewed from three areas separately.
- Soils in general are the best seen of all seven PIPs. This is to be expected given the history of the area and its early irrigation. The area to the south of the existing irrigation has red earth and black cracking clay soils often referred to as “cotton soils”. These soils, which were too far from the water source 140 years ago, are within reach now. Water retention of these soils is good to the extent that some crops such as wheat and sunflower are grown on residual moisture as winter crops. In the area planned for the Phase II, the soils are generally as good as in the existing area, except for the northern one third that is reported to have lighter and sandier soils (and have different crops as a result as explained below).
- In the existing irrigated area, farms average size is 3 ha and are irrigated for both monsoon and summer crops. These comprise paddy for both seasons except on higher ground where yellow gram is grown in place of summer paddy. Winter crops of wheat and sunflower are grown on residual moisture.

Shwe Hlan Bo, farmers in pink area, Syke Pyo Yae village														
		A	M	J	J	A	S	O	N	D	J	F	M	
Monsoon paddy (irrigated) 30+105=135 days	3.0			<----------				---------->						
Summer paddy (irrigated) 30+90=130 days	1.5	---------->												<----------
Yellow gram, (irrigated) 120 days	1.5								<----------					---------->
Wheat, (rainfed) 120 days	2.4								<----------					---------->
Sunflower, (irrigated) 150 days	0.6								<----------					---------->
Farm area	3.0													

Gross margin (per ha) and returns to labour (Ks'000)	
PIP site:	**Shwe Hlan Bo**
Location:	**Pink area, Syke Pyo Yae village**
Soil type:	**Heavy**
Irrigation situation:	**Irrigated in monsoon and summer, but not winter**
Development scenario:	**Actual**

Description	**Unit**	**Crop**				
		Monsoon paddy	**Summer paddy**	**Yellow gram**	**Wheat**	**Sunflower**
Price	Ks'000/kg	0.29	0.29	0.48	0.18	0.92
Yield	kg/ha	2700	3350	1450	1450	280
Farmgate value	Ks'000/ha	783	972	696	261	258
Variable costs[1]:	Ks'000/ha	647	779	231	186	119
-ploughing[4]	Ks'000/ha	62	62	62	62	62
-seeds[5]	Ks'000/ha	20	20	10	49	7
-fertiliser[5]	Ks'000/ha	500	600	0	0	0
-crop protection[6]	Ks'000/ha	0	0	40	0	0
-family labour[3]	days	280	280	75	75	240
-hired labour[7]	Ks'000/ha	50	75	100	75	50
-hired labour (days)	days	33	50	67	50	33
-water charge[2]	Ks'000/ha	15	22	19	0	0
wc as a % of total vcs		2%	3%	8%	0%	0%
Gross margin	**Ks'000/ha**	**136**	**192**	**465**	**75**	**139**
Return to family labour[3]	Ks / day	486	687	6206	1000	578

Notes.

1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft – Ks 6000/ac; summer paddy 6 ac-ft – Ks 9000/ac; other crops 4 to 5 ac-ft – Ks 7500/ac
3. Family labour based on 3 full time equivalent and 80 days per person per ha.
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews
5. Based on per acre costs and farmer interviews
6. See Assumed Price of Inputs table, Ks 10,000/pass
7. Daily labour rate assumed at Ks 1,500

- In the area which not yet irrigated, average farm size is 2 ha, no paddy is grown in either monsoon or summer seasons. In the southern two thirds with the better soils, monsoon crops are green gram and summer crops are cotton 30%, sesame 30% and beans 40%. More green gram, pigeon pea and wheat are gown in the northern one third where soils are not so good. Cotton, which is an improved not local variety, is risky and fails two years in 10[1]. Farmers indicate that it is drought resistant and that is why they grow it. One of the farmers interviewed said he had lost his entire crop and still had to repay his loan of Ks 100,000 in full. See crop budgets and cropping pattern below:

Shwe Hlan Bo, farmers in yellow area, not yet irrigated, Kan Out and Mie Thway Poke villages														
		A	M	J	J	A	S	O	N	D	J	F	M	
Green gram, (rainfed) 90 days	2.0		<----------											
Cotton (rainfed) 180 days	0.6					<----------								---------->
Sesame (rainfed) 90 days	0.6						<----------							
Beans (3 types) (rainfed) 90 to 120 days	0.8						<----------							
Farm area	2.0													

[1] This corroborates an interview the mission had with a cotton agronomist/extensionist who said that improved cotton failed once in five years due to excessive temperature (>40^{0}C) at boll formation. He also confirmed that farmers were required to repay their loans in full, even though such weather events are outside their control.

Gross margin (per ha) and returns to labour (Ks'000)					
PIP site:	Shwe Hlan Bo				
Location:	Yelllow area, Kan Out and Mle Thway Poke villages				
Soil type:	Heavy				
Irrigation situation:	Not yet irrigated				
Development scenario:	Actual				
Description	Unit	Crop			
		Green gram	Cotton	Sesame	Beans
Price	Ks'000/kg	0.37	0.6	0.82	0.38
Yield	kg/ha	800	1300	480	1000
Farmgate value	Ks'000/ha	296	780	394	380
Variable costs[1]:	Ks'000/ha	266	749	199	187
ploughing[4]	Ks'000/ha	62	62	62	62
seeds[5]	Ks'000/ha	35	37	10	25
fertiliser[5]	Ks'000/ha	0	300	90	0
crop protection[6]	Ks'000/ha	49	200	0	50
family labour[3]	days	75	150	80	150
hired labour[7]	Ks'000/ha	120	150	37	50
hired labour (days)	days	80	100	25	33
water charge[2]	Ks'000/ha	0.0	0.0	0.0	0.0
wc as a % of total vcs		0%	0%	0%	0%
Gross margin	**Ks'000/ha**	**30**	**31**	**195**	**193**
Return to family labour[3]	Ks / day	400	207	2433	1287

Notes.

1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks 7500/ac
3. Family labour based on 3 full time equivalent and 80 days per person per ha.
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews
5. Based on per acre costs and farmer interviews
6. See Assumed Price of Inputs table, Ks 10,000/pass
7. Daily labour rate assumed at Ks 1,500

- In the planned new area average farm size among farmers interviewed was 1.6 ha. Crops are 100% paddy in the monsoon and mainly yellow gram or sunflower in the summer season, occasionally summer paddy. It seems curious that no cotton is grown on these classic cotton soils but it is reported to be risky here (on any type of soil) with such a low average crop margin. See cropping pattern below:

Shwe Hlan Bo, farmers in green area													
		A	M	J	J	A	S	O	N	D	J	F	M
Monsoon paddy, (irrigated) 30+100=130 days	1.6				<---------->								
Summer paddy, (irrigated) 30+105=135	0.8	---------->										<----------	
Yellow gram, (irrigated) 90 days	0.4									<---------->			
Sunflower (irrigated) 90 days	0.4									<---------->			
Farm area	1.6												

- Yields of monsoon paddy were about 4.2 t/ha.

2. Constraints and Issues

- Inadequate budget for maintenance and farmer involvement.
- Maintenance carried out on an as and when needed basis rather than a regular basis. Constraints are addressed when they arise instead of keeping the water moving according to the design.
- The gasifier has a role but is still in very much an early stage and there are a number of uncertainties relating to supply fuel and also to its output particularly to meet the demands.
- Apart from irrigation water, the main constraints are extension and seasonal credit. Cotton is an issue, but would do well here if the variety is improved.
- Power for pumping is an issue and an experimental rice husk gasifier provides back up power but at present there is no indication that it will graduate from its experimental niche. This is discussed in Appendix K.

3. Scope for Improvement

- Establishment of a maintenance program involving the water users associations with greater funding from the government and part funding from the water users associations
- Assistance with the introduction of an asset management approach to maintenance of the system.
- Introduction of improved drainage into the area as there may be future problems in these soils with the cropping pattern that has developed.
- Utilisation of Cropwat or a similar program to improve the estimates of crop water requirements. This is particularly relating to other upland crops.
- The introduction of the proposed training school on the site is a good idea as it can provide a practical

example to others. However, the role of the proposed training program needs to be considered in the context of what it is trying to do and with whom. The training needs to relate to the reorientation of staff and farmer involvement, the adaptation of the water scheduling approach that they already have towards a combination of paddy crops and other upland crops.

- As a result of good soils and farmer history of more advanced, they are likely to make quick and full use of improved irrigation by switching to higher margin crops and increasing cropping intensity. Investment in an expansion of the irrigated area thus seems justified.
- Cropping patterns and cropping intensity on the already irrigated area are indications of incremental benefits provided by irrigation. The proximity of Mandalay town may provide new marketing opportunities for higher value and fresh commodities.
- The two main expressed needs of farmers : improved paddy seed, and extension.

Crop Yields Assumptions, kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	3350	2700	2150
Summer paddy	4200	3350	2700
Yellow gram	1800	1450	1150
Wheat	1800	1450	1150
Sunflower	350	280	225
Green gram	1000	800	650
Cotton	1600	1300	1000
Sesame	600	480	380
Bean	1200	1000	800

PIP site:	**7. Sin Dat**
Location:	**Sagaing Township; Sagaing District; Sagaing Region**
Date of Construction:	**May 2004 – 2010 +**
Status of Construction:	**Meant to be completed. Design faults re soils. Few tertiary and Watercourses completed as well as a number of distributaries.**
Development scenario:	**Serious conveyance & operational losses. Water supply in Summer season is very restricted.**

Location Map.

1. Existing Situation

General and Engineering

- Located on the right bank of the Ayeyarwaddy River near Mandalay.
- Construction started in May 2004 and was meant to be completed in 2010. Although the project is in principle completed, there are many engineering details that still remain to be resolved and in particular the slippage and piping on the main canal and the losses of water through the soils in the canal.
- The total pumping head is 189 feet (static head), with one main pumping station on the Ayeyarwaddy River with a total pumping head of 54 feet.
- There are three secondary pump stations with pumping heads of 50 feet, 50 feet, 35 feet respectively. The design discharge of the pumps is 30 cusecs, 20 cusecs, 20 cusecs, 9 cusecs respectively.
- The total project cost is Kayts 3045.023 million plus US$ 1.324 million.
- All of the pump stations have been completed and the electrical supply was provided in 2010. They report that supplies are now not constrained although it would seem that there are other problems that are preventing pumping.
- According to the data provided for 2010-11 season, 2,004 acres of paddy were irrigated in the monsoon season and 1,000 acres of paddy in the summer season.
- The total command area is 6,500 acres of which 1,624 acres were planned for paddy with other crops to be grown on the remaining 4876 acres. The area is divided among the pumping stations as follows:

location of area	Distributary Canals	Area supplied (acres)
PS 1 to 2	1 - 4	1848
PS 2 to 3	5 – 8	1657
PS 3 to 4	9 – 10	2237
PS 4+	11 - 15	758
		6500

- The canals and other works were built by machine and it was reported that insufficient equipment was provided and the timescale was too tight and that this resulted in the poor compaction of the soils and the present very deteriorated situation of the irrigation system.
- The length of the main canal is 6.8 miles and only 1.63 miles of lining has been provided.
- 11 Kv supply to the pump station site; brand new transformer two years ago. After the new hydro electric Power station came on line, no problem with the power supply.
- Problems at the intake with sand bars at low flows as the branch of the river closest to the pump station dries up in the dry season flow. The main channel flow is 100 metres towards the centre of the river.
- A suitable site exists about 300 metres down river, but this may not have been the situation when construction of the project was started.
- The arrangement of intakes for the pump station has two levels that are reconnected as the river level rises.
- The difference in river level is 20-25 feet and at the time of the site visit it had risen about 10 ft from its lowest level.
- Compaction layers seem to have been too thick with layers of 1 feet instead of preferably 0.5 feet. Also the experience of the technical staff is not as good as it could have been and maybe this resulted in the poor placement of material in the canal. Now we have the situation that the sides of the canal are slipping and there is significant seepage through the banks. Although they have been designed with 1:1.5 side slopes, this is not sufficient if they are not properly compacted.
- The staff on this site are generally less qualified than elsewhere visited with no engineering degrees and all staff being diploma holders some more experienced than others. It should be considered to rotate the design staff and give them some practical experience in the field so that they can improve their understanding of the designs and the factors for implementation.
- On this scheme there has been less canal lining than desirable and it appears that budget was a constraint.
- The engineer from the project suggested up to PS2 should be the limit of the project. This limits the better areas of soil for rice, a concept that still governs their thinking. As the main road is approached, the areas under rice disappears as the depth and quality of top soil reduces considerably. Rice is being grown on these soils, but it would seem that puddling is difficult and greater fertiliser inputs are needed. Maybe soils need to be checked for acidity and also suitability for crops.
- There is quite a lot of existing rice near to the river banks and in fact the areas near to the poump station are re[orted to be flooded each year in monsoon to a depth of 1-2 feet. This was confirmed by the estimated at

the bottom and as you get to PS2, there station to them is not so much smaller dryland from various irrigation available Mrs again at target area for assistance as a farmers are much worse off and they are much farmers are not so fun and the bit you on one of the relative concept in your hand and formal reprimand for it in 189 and more dynamic and ignored Alexander the physical and without the energy in a dynamic

- There is an area in the irrigated area located near the road and to the south of it that is an outcrop of very poor soils. This should be avoided for irrigation, except perhaps for shallow rooting dryland crops.
- On the scheme the construction was poor and the design inappropriate.

Agriculture

- Sin Dat is one hour by road west of Mandalay town, in Sagaing District. Construction started 2004 and was finished in 2010. Design command is 2631 ha (6500 ac). There have been problems with the soils from an engineering viewpoint, though the engineers report that these soils are good from an agricultural viewpoint.
- Before irrigation was put in place, maize, peas and sesame were grown in the monsoon season together with paddy on the better soils in the monsoon season..
- Soils are heavy clay loam near the river and to PS1, but further away red earth soils with good depths.
- One group of five farmers was interviewed of which four farm on the heavier soils and one farms on the lighter soils. All their farms are now irrigated and all were farming here before irrigation was developed. Four farmers has land on the heavier soils for monsoon paddy and one on the lighter soils grew monsoon cotton. Average farm size is 2 ha.
- Cropping for the heavier soils is: monsoon paddy 60%; sesame 24%; groundnuts 12%; and sunflower 4%; all in the monsoon season. Summer season crops are as follows: paddy 30%; sesame 20%; fodder millet 20%. Winter season crops are: wheat 20% ; and sunflower 10%. Cropping intensity is thus 200%. Cropping pattern and crop budgets are shown below:

		A	M	J	J	A	S	O	N	D	J	F	M
Sin Dat, 4 farmers on clay loam soils, Kone Ywe village													
Paddy 30+100=130 days	1.8	---------->			<----------								<------
Sesame 80 days	0.9	---------->			<---------->								<------
Groundnuts	0.2				<---------->								
Wheat, 120 days	0.4								<---------->				
Fodder millet, 45 days	0.4	<--------->											
Sunflower, 100 days	0.3				<---------->				<---------->				
Farm area	2.0												

Gross margin (per ha) and returns to labour (Ks'000)							
PIP site:	**Sin Dat PIP**						
Location:	**Kone Ywe village**						
Soil type:	**Heavier**						
Irrigation situation:	**Irrigated**						
Development scenario:	**Actual**						
Description	**Unit**	**Crop**					
		Monsoon paddy	**Summer paddy**	**Sesame**	**Groundnut**	**Wheat**	**Sunflower**
Price	Ks'000/kg	0.29	0.29	1.22	0.28	0.18	0.92
Yield	kg/ha	2700	3100	480	2500	3550	280
Farmgate value	Ks'000/ha	783	899	586	700	639	258
Variable costs[1]:	Ks'000/ha	521	528	345	424	443	128
-ploughing[4]	Ks'000/ha	62	62	62	62	62	62
-seeds[5]	Ks'000/ha	44	44	15	260	32	7
-fertiliser[5]	Ks'000/ha	290	290	116	0	215	0
-crop protection[6]	Ks'000/ha	0	0	0	75	0	0
-family labour[3]	days	280	280	80	100	120	80
-hired labour[7]	Ks'000/ha	110	110	133	25	115	40
-hired labour (days)	days	73	73	89	17	77	27
-water charge[2]	Ks'000/ha	14.8	22.2	18.5	1.9	18.5	18.5
wc as a % of total vcs		3%	4%	5%	0%	4%	15%
Gross margin	**Ks'000/ha**	**262**	**371**	**241**	**276**	**196**	**130**
Return to family labour[3]	Ks / day	936	1324	3013	2761	1637	1626

Notes.

1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks 7500/ac
3. Family labour based on 3 full time equivalent and 80 days per person per ha.
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews
5. Based on per acre costs and farmer interviews
6. See Assumed Price of Inputs table, Ks 10,000/pass
7. Daily labour rate assumed at Ks 1,500

- Cropping for the farmer on lighter soils is paddy in the monsoon and summer seasons, followed by wheat in the winter. Cropping intensity is about 200%, but yields are much lower. Summer paddy yields 3.4 t/ha on the heavier land but less than 1.3 t/ha on the lighter land. Wheat yields half of what is achieved on the heavier land. The crop budgets indicate that such a farmer would earn more money working for others.
- Farmers expressed a need for extension advice

Sin Dat, 1 farmer on sandy soils														
Paddy, 30+100–130 days	1.2	---------->	<----------											<------
Fodder, 45-60 days	0.4	<--------->												
Wheat 120 days	1.6								<----------					
Farm size	1.6													

Gross margin (per ha) and returns to labour (Ks'000)				
PIP site:	**Sin Dat PIP**			
Location:	**Kone Ywe village**			
Soil type:	**Lighter**			
Irrigation situation:	**Irrigated**			
Development scenario:	**Actual**			
Description	**Unit**	**Crop**		
		Monsoon paddy	**Summer paddy**	**Wheat**
Price	Ks'000/kg	0.29	0.29	0.18
Yield	kg/ha	1780	1850	1775
Farmgate value	Ks'000/ha	516	537	320
Variable costs[1]:	Ks'000/ha	381	388	278
-ploughing[4]	Ks'000/ha	62	62	62
-seeds[5]	Ks'000/ha	44	44	32
-fertiliser[5]	Ks'000/ha	150	150	50
-crop protection[6]	Ks'000/ha	0	0	0
-family labour[3]	days	280	280	120
-hired labour[7]	Ks'000/ha	110	110	115
-hired labour (days)	days	73	73	77
-water charge[2]	Ks'000/ha	14.8	22.2	18.5
wc as a % of total vcs		4%	6%	7%
Gross margin	**Ks'000/ha**	**135**	**148**	**42**
Return to family labour[3]	Ks / day	483	530	350
Notes.				
1. Some variable costs, e.g. land preparation, harvesting & threshing, transport to market are subsumed under hired labour				
2. Water charges @ Ks1500/ac-ft; monsoon paddy 4 ac-ft = Ks 6000/ac; summer paddy 6 ac-ft = Ks 9000/ac; other crops 4 to 5 ac-ft = Ks 7500/ac				
3. Family labour based on 3 full time equivalent and 80 days per person per ha.				
4. Based on oxen or tractor @ Ks 10,117/ha, per acre costs and farmer interviews				
5. Based on per acre costs and farmer interviews				
6. See Assumed Price of Inputs table, Ks 10,000/pass				
7. Daily labour rate assumed at Ks 1,500				

2. Constraints and Issues

- Pumping for high head
- Poorly built with inadequate compaction of embankment soils for the main conveyor leading to considerable areas of erosion of the banks of the canal, siltation through washed soils, and only limited lining.
- Where there are good soils on this PIP, farmers are clearly making good use of irrigation, have a high cropping intensity, and moderately good yields. They complain as usual about the poor quality of paddy seed, but do all they can to obtain good seed. The problem is one of unavailability and access. Farmers also need extension advice.
- The lighter soils seem not worth irrigating.

3. Scope for Improvement

- The problems with the engineering soils needs to be resolved as the scheme is unable to provide water effectively.
- Agricultural soils are good throughout the scheme except for a small area above PS2. However the scheme design has resulted in deep canals into the pervious, gypsum type substrata that has caused numerous problems of stability an seepage.
- Improved paddy seed should be made available at the earliest opportunity using local seed growers. Extension advice should also be promoted.

Crop Yields Assumptions, kgs/ha

Crop	Good farmer	Average farmer	Poor farmer
Monsoon paddy	3350	2700	2150
Summer paddy	3875	3100	2475
Wheat	3360	2700	1780 (light soil)
Sunflower	350	280	225
Groundnuts	3000	2500	2000
Sesame	600	480	380