Pyawt Yaw Pump Irrigation Project

Irrigation and Nutrient Management of major crops in PYPIP

Technical Bulletin

Prepared by

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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Contents

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1. Introduction

Pyawt Yaw Pump Irrigation Project (PYPIP) is one of more than 300 pump irrigation projects (PIP) established by Government of Myanmar. This project was established in 2004 to irrigate 5000 ac (1300 ac paddy, 3700 ac other crops) by drawing water from Mu River through one primary and two secondary pump stations. The water is used to irrigate a range of crops including paddy, green gram and black gram, chickpea, sesame, groundnut and wheat. Though planned to irrigate 5000 ac, actual area irrigated has consistently been much lower due to a range of operational and agronomic issues, from an inefficient layout to inappropriate crop choices.

The Livelihoods and Food Security Trust (LIFT) is supporting Irrigation and Water Utilization Management Department (IWUMD) to rehabilitate and upgrade the PYPIP scheme to bring it into full operation and improve productivity of the scheme. The rehabilitation works planned include repairing and upgrading the canals and pumps, improving water sharing and management within the scheme and increasing crop production by promoting improved management. ICRISAT along with a team of agronomists from Welthungerhilfe (WHH) were tasked to identify, demonstrate and communicate to the farming community about improved management practices that are aimed both at increasing crop production and enhancing water use efficiency (WUE). This was carried out by the team in two steps. The first step is aimed at identifying potential best bet options by conducting a scenario analysis with system simulation models such as DSSAT, APSIM and CROPWAT using long term climate, soil and management data of the target locations. The second step involved validating the findings of scenario analysis by field testing and demonstration of the same to farmers and their support agents. This technical bulletin presents a summary of these findings from the simulation analysis and field studies along with crop wise operational irrigation and nutrient management recommendations for important crops grown in PYPIP command area.

2. General conditions in the command area

The command area of PYPIP falls in the Central Dry Zone (CDZ) of Myanmar which records the lowest rainfall, ranging from 500 to 1000 mm. The mean annual rainfall in the project area is around 920 mm of which 800 mm or 87% is received during the south-west monsoon period from May to October (Figure 1). The average number of rainy days is about 60 but varies between 40 and 109 days. On an average 16.3 days are observed as consecutive dry days and 8.1 days as consecutive wet days. Average annual minimum temperature varied between 21.5 and 23.7°C with a mean of 22.3 and annual maximum temperature varying between 34.4 and 32.5°C with a mean of 33°C.

Vertisols occupy more than half PYPIP area followed by Ferric Luvisols (20%), Gleysols (11%), Planosols (12%) and Ancient

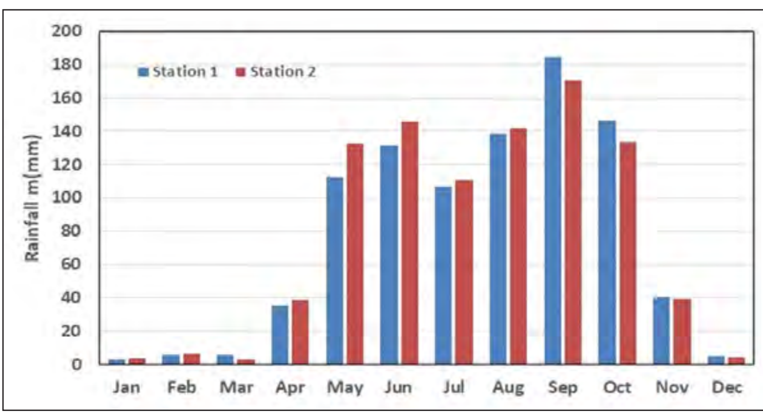

Figure 1. Average monthly rainfall (mm) received in PYPIP location.

Alluvial soils (1%). In general, soils in the project area are alkali to strong alkali in nature with pH ranging from 7.1 to 8.5 (Table 1). The organic matter content in the plough layer is low indicating low water holding capacity and soil fertility status. The Total N content in the soils indicated as low.

3. Current cropping systems and crop water requirements

Crops grown in the PYPIP area according to the soil type were given in Table 2. The main soil types found in the project area are Gleysols (G2), Vertisols (V3), Luvisols (L2, L6) and Planosols (W2, W2p & W5). Paddy is the major crop grown both in monsoon and summer seasons. Green gram, pigeonpea and chickpea are the important pulse crops

Table 1. Key soil properties in the command area

Village	Depth	pH	Ec (mS/cm)	OM	Total N
Pyawt Ywar (Vertisols)	0_15	7.07	0.05	0.06	0.16
	15_30	7.04	0.05	0.15	0.17
	30_45	6.93	0.05	0.21	0.11
	45_60	7.29	0.28	0.12	0.10
Nabe Kyu (Ancient Alluvial)	0_15	7.53	0.09	0.31	0.17
	15_30	7.62	0.12	0.38	0.10
	30_45	7.85	0.08	0.53	0.14
	45_60	8.11	0.09	0.44	0.18
Kan Pyar (Planosols)	0_15	7.4	0.06	0.03	0.12
	15_30	7.55	0.06	0.07	0.15
	30_45	7.61	0.08	0.09	0.16
	45_60	7.15	0.06	0.14	0.15
Muu Wa (sandy soil)	0_15	8.59	0.10	0.22	0.14
	15_30	8.84	0.13	0.18	0.15
	30_45	9.11	0.10	0.19	0.12
	45_60	9.28	0.28	0.15	0.15

Table 2. Current cropping systems in practice in project area			
Soil	**Summer**	**Monsoon**	**Winter**
V3 - Clay	Paddy	Paddy	Chickpea
L2/W2/W5	Green gram	Maize, green gram, pigeonpea	Wheat, groundnut, corn
G2-Marshy Lands	Summer paddy	-	-

Table 3. Crop water requirements estimated using crop simulation models DSSAT and APSIM#					
	Irrigation requirement (mm)				
Crop	Vertisol (V3) (PAWC 188 mm)	Gleysol (G2) (PAWC 229 mm)	Solodic planosol (W2) (PAWC 235 mm)	Planosol (W5) (PAWC 233 mm)	Ferric Luvisol (L2) (PAWC 149 mm)
Summer Paddy*	1051	1031		1275	
Monsoon Paddy*	518			746	
Wheat			370	334	
Groundnut				324	293
Maize			383	348	
Summer greengram/ black gram					60-83
Chickpea**				80	

*Paddy water requirement does not include water required for puddling, need to add around 200 mm extra required for puddling to calculate total water requirement. Also it does not include the rainfall contribution

** Chickpea irrigation was calculated assuming that two irrigations will be provided at 40 & 60 DAS depending on the requirement

PAWC: Plant Available Water Capacity

For green gram APSIM (Keating et al. 2003) and other crops DSSAT (Hoogenboom et al. 2010) was used

Table 4. Crop water requirements estimated using CROPWAT model (mostly winter crops)		
Crop	Net Irrigation requirement (mm)	
	Sandy loam	Vertisols
Sunflower	223	141
Onion	279	216
Tomato	300	238
Melons	218	170
Brinjal	154	94

grown in the project region. Green gram is grown both in pre-monsoon and monsoon seasons. Other important crops grown are chickpea and wheat during the winter season and maize during monsoon and winter seasons.

Water requirements of these crops were assessed using crop simulation models (Tables 3 and 4). Paddy simulations were run for both summer and monsoon seasons in marshy, clay and sandy loam soils. Results indicate that yield of summer paddy are generally higher compared to monsoon paddy. However, water requirement and water use efficiency (kg water per kg grain) were low for the summer paddy. In both seasons, paddy cultivation on sandy soils required more water (1275 mm in summer and 746 mm in monsoon seasons) than other soils.

4. Agronomic management options

Using a combination of crop rotation analysis in the simulation models and latest best practice, a set of management options are suggested for further evaluation. Below is a crop wise summary of best bet options identified.

Chickpea

Chickpea is an important food and cash crop grown in the PYPIP area. It is commonly grown in the winter season after paddy.

During this period, daily maximum temperature vary between 25 and 38°C and that minimum temperature between 8 and 20°C. Chickpea is usually grown under residual soil moisture conditions in both lowland and upland areas. In lowland areas, it is grown as a relay or sequential crop after rice, while in upland areas it is grown mostly on fertile soil with a good water holding capacity after sesame, maize, greengram or fallow. Since chickpea is grown on residual soil moisture, it generally faces moisture stress during the grain filling and maturity stages. Long-term simulations indicated that application of 20 kg N and maintaining 33 plants/m^2 are optimum and economical for chickpea production on both clayey and sandy loam soils. Studies further indicate that providing two irrigations at 40 and 60 DAS coinciding with branching and pod development stages will enhance the yields.

Paddy

Paddy is the major crop cultivated in both summer and monsoon seasons in the PYPIP area. Summer paddy water requirements are quite high and more so when grown on sandy loam soils. In case of marshy lands summer paddy is the only profitable option. Simulation analysis indicate that summer paddy responds to application of N fertilizer up to 150 kg N and application of the same in four splits helps avoid N losses and improve it's use efficiency. Split application was found to be beneficial with monsoon paddy as well. Proper N management under flooded conditions is very important to improve N use efficiency and final yields. In addition use of appropriate variety is also important. Use of varieties having 150 days duration during monsoon period and 120 days duration during summer season were found to be optimal. For more rational and profitable use of water, it is advisable to shift to other alternate crops especially in uplands and on sandy soils, but concerted efforts are required to educate and convince the farmers.

Green gram

Green gram is cultivated both in pre-monsoon and monsoon seasons. Pre-monsoon season green gram is planted during April month. Simulation studies revealed that early planting during 1st fortnight of April will give better yields compared to delayed planting in the 2nd fortnight of April. Since sufficient rainfall is received during the months of May and June, the crop has not responded to irrigation. The crop has also not responded to fertilizer application. Hence, use of improved varieties is the most feasible option to improve yields.

Other crops

The project area is suitable for introduction of crops like corn and turmeric, but needs establishment of market linkages before promoting their production. Introduction of vegetables such as brinjal, okra, yardlong bean and chili are quite promising and field demonstrations of the same were carried out by WHH in project villages. Fruits crops such as papaya and mango were also taken-up in the upland areas for generating additional income to farmers. However, the markets for dry grains (cereals/pulses and oilseeds) were quite efficient and established while the same for perishables (vegetables/fruits) is in its nascent stage. So, strengthening of market linkages is the key before expansion of area under new crops.

5. Recommended water and nutrient management practices

Based on the results from simulation analysis and also based on the observations from various demonstrations, a set of water and nutrient management options were identified as best bet options to optimize their use and improve profitability. Below is the suggested water and nutrient management practices for the crops grown in the project area.

5.1 Paddy

Water management

Continuous flooding of water generally provides the best growth environment for paddy. Water requirement of flooded rice varies from one stage to the other and one season to the other as indicated in Table 5 and 6. After transplanting, water levels should be maintained around 3 cm which gradually increased to 5−10 cm with increasing plant height and maintained at the same level until the field is drained 7−10 days before harvest. Paddy is extremely sensitive to water shortage

Table 5: Stage wise water requirement of paddy crop

Stage	**Water requirement**	**Percentage % of total**
Nursery	40	3.2
Main field preparation	200	16.1
Planting to panicle initiation	460	36.9
Panicle initiation to flowering	420	33.7
Flowering to maturity	125	10.0
Total	**1245**	100

Table 6: Irrigation requirements of paddy under different soils in the project area

Soil type	Irrigation requirements (mm) excluding puddling water requirement	
	Monsoon	Summer
V3 (Vertisols)	518	1051
W5 (Planosols)	746	1275
G2 (Gleysols)	-	1031

Table 7: The time taken (days) to complete vegetative and reproductive phases by short, medium and long duration rice varieties.

Duration	Short duration	Medium duration	Long duration
Vegetative	60	75	90
Reproductive	60	60	60
Total duration	120	135	150

(below saturation) at the flowering stage and any water stress at this stage leads to increased spikelet sterility, thus fewer grains. Maintaining 5 cm water at all times from heading to end of flowering stage is the best option.

Nutrient management

In paddy different duration varieties are in cultivation such as short, medium and long duration. The short duration varieties take about 120 days to mature while the long duration varieties take about 150 days. Much of this variation is during the vegetative growth period (Table 7).

These stages need to be kept in mind when designing the fertilizer schedules. Fertilizer recommendations for paddy are as given below.

Location	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Myanmar	120	60	40

Recommended dose of P and K may be applied as basal in heavy soils. In case of light soils, K may be applied in two equal splits i.e., at basal and at panicle initiation stage. Nitrogen is to be applied in three splits (basal, active tillering and panicle Initiation stages). Use more splits for long duration varieties, for light textured soils and during summer. For long duration cultivars nitrogen need to be applied in four split doses at 15-20 days interval with application of final dose coinciding panicle initiation stage. Nitrogen should not be applied beyond this stage. Pay attention to the following tips for greater nutrient use efficiency.

- Incorporate nitrogen fertilizers into soil and apply water only after 36-48 hours
- Neem coated urea application will improve the N use efficiency
- Total P should be applied as basal only, should not be top dressed

- Appearance of rusty brown spots and discoloration of older leaves starting from 2-3 weeks after planting and uneven crop stand are the symptoms of zinc deficiency.
- Zinc deficiency in standing crop can be corrected by spraying 0.2% Zinc Sulphate solution (2g/lt of water) about 500 liters of spray solution is required to cover one hectare. Spraying should be repeated 2-4 times at an interval of 5-10 days.

5.2 Maize

Irrigation management

Maize is quick, vigorous and tall growing crop having broad leaves, therefore its water requirement is exceptionally high. A vigorous growing maize plant requires about 2-3 litres of water per day during the peak growing period. The crop cannot tolerate excess water or waterlogging conditions. Crop under water logged conditions become pale, grow poorly and the uniformity of the crop is lost. Waterlogging for three or more days damages the whole crop. So efficient drainage is of greater significance. Critical stages for irrigation in maize are seedling stage, knee-height stage, tasseling stage, silking stage and grain filling stage. Moisture stress during early stages leads to 3-5 days delay in tasseling and 5-8 days delay in silking, while stress at later stages results in drastic reduction in yield.

Irrigation schedule for monsoon season maize

- During monsoon season rainfall is sufficient to ensure adequate soil moisture during the entire crop growing period.
- For higher yields, apply 1 or 2 irrigations if dry spells of 10 or more days occur during the critical stages, especially during flowering and grain filling stages.
- Maize is known to be susceptible to water logging. Planting on ridge with provision of surface drainage will help overcome the waterlogging problem in uplands.

Irrigation schedule for winter season maize

- Rainfall during winter season is inadequate for cultivation of high-yielding maize hybrids.
- In light soils, it is desirable to schedule the irrigations at 70% soil-moisture availability throughout the period of crop growth and development.
- In heavy soils, irrigation at moisture level of 30% during vegetative stage and at 70% during the reproductive and grain-filling period is desirable.
- Four to six irrigations (~ 300 mm) are needed during the winter season.
- If six irrigations are given, give two irrigations up to flowering at an interval of 20-25 days, one (essential) at flowering, two after flowering and final one at early grain-filling stage.
- If five irrigations are given (~250 mm), avoid one irrigation at the vegetative stage
- If four irrigations are given, irrigation after the dough stage may be avoided.
- The irrigation schedule may, however be changed suitably depending on rains received

Nutrient management in maize

Fertilizer recommendations for Maize are as given below.

Location	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Myanmar	120	60	60

Entire P fertilizer should be applied as basal, while 50% of the recommended K fertilizer should be applied as basal and the remaining at tasseling stage. Nitrogen fertilizer should be applied in three equal splits at sowing, at knee height stage (35-40 DAS) and at tasseling stage.

5.3 Chickpea

Irrigation management

Chickpea is generally grown as a rainfed crop on residual moisture, but two irrigations, one each at branching and pod filling stages, are recommended for higher yield (80 to 100 mm). Higher number of irrigations may lead to excessive vegetative growth in heavy soils.

Nutrient management

The generally recommended doses for chickpea include 20–30 kg nitrogen (N) and 40–60 kg phosphorus (P_2O_5) ha^{-1}. If soils are low in potassium (K), application of 17 to 25 kg K ha^{-1} is recommended. There will be no response to application of K in soils with high levels of available K. Total quantities of N, P and K should be given as a basal dose. Foliar spray of 2% urea at flowering has been found beneficial in rainfed crops.

5.4 Green gram & black gram

Irrigation management

- Pre-monsoon green gram is generally grown under rainfed conditions and does not require irrigation unless faced with a prolonged dry spell.
- For winter and summer season crops, provide 5-6 irrigations. Irrigate at intervals of 7 to 10 days depending upon soil and climatic conditions.
- Moisture deficiency at the time of pod filling stage will reduce greengram yields
- Flowering and pod formation stages are critical periods for irrigation
- Avoid water stagnation at all stages by providing adequate drainage for disposal of excess water as the crop is sensitive to water logging.

Nutrient management

Generally recommended fertilizer doses for green/black gram include 20 kg nitrogen (N) and 50 kg phosphorus (P_2O_5) ha^{-1}.

Seed treatment with rhizobium (200 g rhizobium for 8 kg seed) and phosphobacteria culture (5 kg mixed with 500 kg FYM per hectare) is advisable.

5.5 Sunflower

Irrigation management

Provide irrigations at 8-10 days interval in light soils and 15-25 days in heavy soils. Critical stages for irrigation are bud initiation (35-40 DAS), flower opening (55-65 DAS) and seed filling (65-80 DAS). Moisture stress at these stages can lead to significant yield loss.

Nutrient management

Myanmar	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Rainfed	60	60	30
Irrigated	60	90	30

Application of 50% N +100% P and K as basal with remaining N applied in two equal splits, at 30 and 55 days after sowing is recommended. Boron is an essential micronutrient for sunflower which increases seed filling and yield. Spray borax 2g/l to capitulum (head) at star bud stage.

5.6 Groundnut *(winter cultivation)*

Irrigation management

On an average, groundnut crop requires about 290-350 mm of water depending up on the soil type. The most critical stages to avoid stress are flowering, peg penetration/pod formation and pod filling. Where irrigation facilities exist, it is advisable to irrigate at these stages for increase 30-35 % increase in pod yield.

Nutrient management

Myanmar	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Rainfed	20	40	20
Irrigated	30	60	45

For rainfed crop, apply entire nitrogen, phosphorus and potassium by placement in the furrow below the seed at sowing. For irrigated crop, nitrogen may be applied in two equal splits at sowing and 30 days after sowing. To get good yield, availability of Ca in the fruiting zone must exceed defined critical level during the time of pod development. Soil application of 250 kg/ha gypsum is sufficient to overcome the deficiency of Ca and S and increase the pod yield. Soil application of 10 kg Mg/ha as $MgSO_4$ corrects Mg deficiency.

5.7 Chilies

Irrigation management

Chili is grown both as rainfed and irrigated crop. For irrigated crop first irrigation is given immediately after the transplanting and subsequent irrigations are given depending on weather and soil conditions at 7-10 days interval during summer and rainy season and at 10 to 15 days interval during winter. The maintenance of uniform soil moisture is essential to prevent blossom and fruit drops. Frequent and heavy irrigations result in lanky vegetative growth and cause flower shedding. Flowering and fruit development are the most critical stages for water stress.

Nutrient management

Myanmar	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Rainfed	60	40	50
Commercial & Irrigated	210	60	60

Apply entire P fertilizer at the time of transplanting.
Apply nitrogen and potash fertilizers in five equal splits at transplanting and at 45, 70, 90 and 110 DAT.

5.8 Sesame (*monsoon and winter cultivation*)

Irrigation management

In sesame, there are three critical stages for irrigation. These are pre-flowering (22-25 DAS), flowering (35 to 45 DAS) and pod setting (55-65 DAS). Provide irrigations at these stages if crop experiences moisture stress. Maintain low moisture conditions at seed setting stage because seed maturity is effected leading to poor filling of capsules, hence stop irrigating 65-70 DAS.

Nutrient management

Myanmar	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
Rainfed	40	20	20
Irrigated	60	20	20

Apply entire P & K and 50% nitrogen fertilizers at the time of sowing. Remaining N should be applied 30 DAS

6. Conclusions

With an average annual rainfall of more than 900 mm, average monthly maximum temperatures varying between 27.7 and 38.5^{0}C and availability of irrigation water, the command area of PYPIP offer opportunities for year round cropping. Though monsoon season is the main cropping period, cropping is also done during winter and summer seasons. Paddy is the main crop grown during summer and monsoon seasons while chickpea and wheat are the preferred crops in winter season. Our studies have indicated good prospects for introducing commercial crops corn and turmeric, vegetable crops brinjal, okra, yardlong bean and chili and fruit crops papaya and mango in the project area, if required market opportunities are established.

Introduction of these crops makes farming more profitable and makes utilization of water more efficient. The study has also explored the opportunities to improve productivity of crops currently grown and identified a set of irrigation and nutrient management practices. These practices when promoted have the potential to improve the productivity up to 30% and meet the water demands of the entire command area.

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