On-farm Irrigation Method at the Laoag Vintar River Irrigation System

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Abstract

Basin flooding is the usual method of irrigating mulched garlic during the dry season under the Laoag Vintar River Irrigation System. Field observations showed that the flow rate under basin flooding ranged from 10-33 liter per second (lps), with a weighted average of 21 lps. Duration of irrigation ranged from 10-26 hr/ha, with a weighted average of 14 hr/ha. Irrigation interval ranged from two to three weeks. Advance and recession profiles showed distinct *high* and *low* spots in the basin plots. Yield response curve showed a threshold value of 300 mm of water applied. Application efficiencies ranged from 57-73%, with a weighted average of *65%.* Regression analysis of application efficiency and stream size showed an optimum critical flow rate of 25 lps to attain a potential efficiency of **76%.**

Introduction

Every irrigation method has advantages and disadvantages. An irrigation method is best when it is suited to local conditions. An irrigation method should be flexible in order to apply varying depths of water to meet the needs of different crops or of the same crop at different stages of growth.

Irrigation methods vary depending on the availability of water, soil type, climate and cultural practices employed hy farmers. They also vary depending on location, due to differences in local conditions such as crops grown, topography and water quality (Johl, **1970).**

Improved management of water at the farm level conserves water, labor and soil and also increases crop yield. Evaluating an irrigation method is a must to determine its effectiveness (Merriam and Keller, 1979). Results of the evaluation will also provide management with the needed information whether to modify a method or not.

Objectives

The study aimed to develop an irrigation method suited for garlic. Specifically it aimed to: (1) document and evaluate existing on-farm irrigation practices for garlic during the dry season; and (2) recommend improvement/modification of the existing irrigation method.

Site, Duration and Limitation

The study was conducted at the Laoag-Vintar River Irrigation System (LVRIS), one of the eight irrigation systems under the Ilocos Norte Irrigation Systems (INIS) located in the province of Ilocos Norte. LVRIS is a gravity-type irrigation system serving 2377 hectares (Figure 1). Irrigation practices for garlic were observed during the 1987/88 dry season at farm plots owned by selected farmer-cooperators that were located along the areas served by laterals B (Vintar town), F (Barangay Dibua) and H (Barangay San Mateo), and by sub-laterals F1c (Barangay Sta Maria) and F1d (Barangay Navotas).

Methodology

Five sites, planted mostly to garlic, were selected. Sample paddy fields representative of each site were considered as the units of observation. To estimate stream size, duration and interval between irrigation, advance and recession of irriga-

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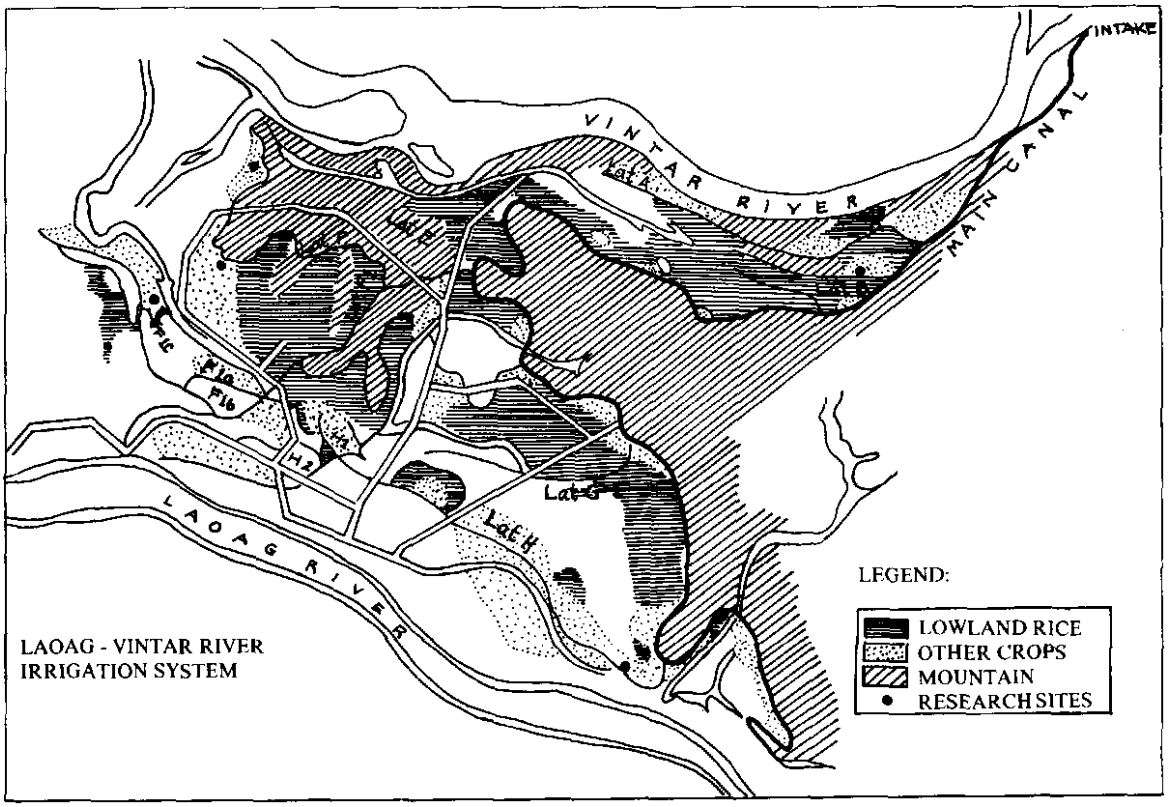


Figure 1. Map of the Laoag-Vintar River Irrigaton System (LVRIS), Ilocos None, Philippines showing cropped areas and research sites during the 1987-88 dry season.

tion water, and application efficiency, data were collected from the selected farm plots using participant observation technique and standard irrigation evaluation procedure. Farmers' management and cultural practices were also monitored.

Stream Size Measurement

To measure the stream size conveyed to the farm plots, 5-cm by 60° trapezoidal, 30-cm cutthroat and 7.5-cm Parshall flumes were installed at the inlet of the head ditch of each selected farm plot. Duration and interval between irrigation, as well as irrigated area were also determined.

Application Efficiency

Application efficiency was measured in the traditionally-farmed garlic farms as an index of an irrigation method's efficiency.

Amount of water applied to each field was measured from the flumes installed at the inlet of the head ditch. To determine water stored in and depleted from the root zone, soil samples were collected from the effective root zone up to 45 cm deep at 15-cm interval. Samples were taken two to three days after irrigation with soil moisture content assumed at field capacity and one day before the next irrigation with the difference as the amount depleted. Soil moisture content. was determined by oven drying. Bulk densities at various depths in each farm plot were also determined using core sampler.

Advance and Recession of Irrigation Water

Grid stakes at equal intervals were laid within selected farm plots. The advance of the water stream across the basin was observed by recording the time when water reached any stake. The receding water front at several stakes after the inlet supply of irrigation water has been shut off was also noted.

Rainfall, Evaporation, Crop Yield and Management Practices

Class A pan and standard non-recording rain gauge were installed to measure rainfall and evaporation, respectively. From a 2×2 meter area taken

at random from each farm plot, crop cuts were collected one day before harvest. Harvested garlic were cleaned, weighed and sun-dried for about three weeks. Crop cut yields were expressed in t/ha. Planting, tillage operation, fertilizer application, occurrence of pest and diseases and other cultural practices were also observed.

Results and Discussion

Laoag Vintar River Irrigation System *(LVRIS)*

LVRIS belongs to rainfall Type I; with two pronounced seasons, i.e. dry from November to April, and wet during the rest of the year. During the dry season, diversified crops subsisted on irrigation due to zero rainfall (Figure 2). Average weekly evaporation during the dry season was 32 mm/day. Because of fragmented and small landholdings (less than 0.5 hectare), most farmers planted and irrigated diversified crops such as garlic, tomato, mungbean (planted after garlic), watermelon and other vegetables during the dry season. Results of the on-farm level survey showed that 95% (60 sample farmers) of the respondents preferred to plant rice, if there was sufficient water supply during the dry season (Table 1). This implies that availability of water for irrigating rice is an important factor to consider in irrigated diversified cropping. However, only 52% of the farmers were satisfied with the dry season water deliveries. Almost all farmers interviewed wanted to improve their existing irrigation practices.

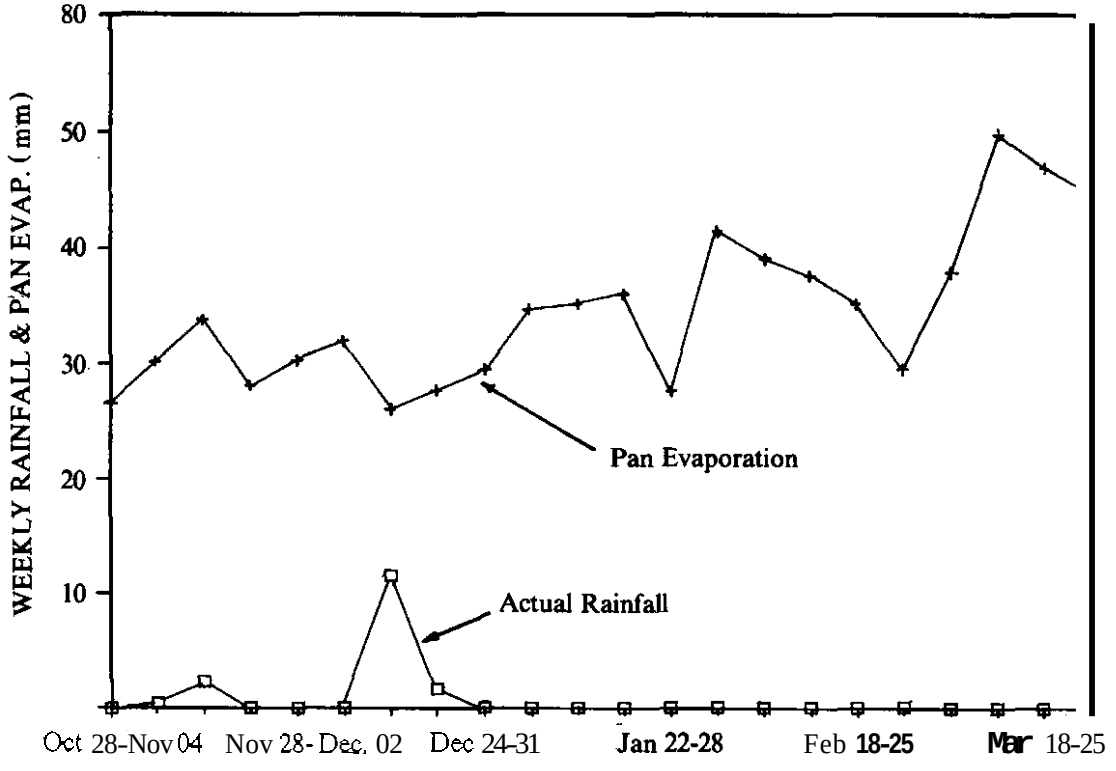


Figure 2. Weekly rainfall and pan evaporation at Laoag-Vintar River Irrigation System, Ilocos Norte, Philippines, 1987-88 dry season.

Table 1. Proportion of fanners relating some irrigation management perception with dry season water supply by location. LVRIS, 1987/88 dry season.

	Sections							
	Head (n=20)		Middle (n=20)		Tail (n=20)		Total (n=60)	
	No.	%	No.	%	No.	%	No.	%
Willing to plant rice if sufficient water is available	17	85	20	100	20	100	57	95
Satisfied with the dry season water supply	16	80	8	40	7	35	31	52
Willing to improve irrigation practices	20	100	20	100	20	100	60	100

Cultural Management Practices for Garlic

Garlic is the most profitable dry Season crop planted after rice in northern Luzon. In 1988, price of garlic increased from 725 to ₱180/kg. Under LVRIS, land preparation did not always entail tillage operation. In tilled farms, most farmers used carabao drawn implements for plowing and harrowing operations. Others hired a tractor to harrow the field for two to three passing at ₱0.12/m^2. Field plots in San Mateo were harrowed twice. In untilled farms where the previous crop was rice, straw and weeds were cut close to the ground. The field was drained to field capacity and covered with rice straw before planting the seeds. Rice straw about 5 cm thick were spread over the farm plots as mulch.

Most farmers used pointed bamboo sticks to dibble the soil and to plant the garlic seed cloves. The seed cloves were then inserted vertically into the soil to about 2-3 cm deep. Planting distance ranged from 20×20 cm to 25×25 cm. Occurrence of root rot and leaf spot at vegetative stage and tangle top at bulbing until maturity were observed. Occurrence of these diseases was attributed to soil moisture and humid environment during the day. It was observed that growth of broad-leafed weeds was minimal on mulched garlic, however, mulching was not effective in controlling grasses and sedges. Manual weeding was done by using family and/or hired labor. Most farmers applied urea and complete fertilizers either by broadcast or dibbling methods. Fungicide was also applied.

Existing On-Farm Irrigation Management Practices for Garlic

Method and Scheduling of Irrigation. Under LVRIS, basin flooding was the usual method of irrigating mulched garlic (Ilocos White variety) during the dry season. Irrigation water was conveyed from the supplementary and/or internal farm ditches to the side of the basin. The basin was flooded and water was allowed to infiltrate the soil. Most of the moisture was retained in the basin.

Garlic is usually irrigated three to four times, depending on the availability of water and rainfall (Table 2). A heavy pre-planting irrigation was usually done to soften the tillage pan to ease planting. Pre-planting irrigation was done three to four days before planting when the rice straw mulch was laid on the soil surface. Irrigation was also applied at pre-bulbing and bulbing stages to facilitate the removal of weeds and fertilizer application. Light irrigation at maturity was applied to soften the soil to ease harvesting operation and to facilitate land preparation for the next crop, usually mungbean. Depth of irrigation water applied ranged from 8 to 11 cm, with a weighted average of 10 cm. Most basins bad enclosed dikes to prevent runoff. Some dikes, however were farmed, built up and were easy to break. This means that non-rectangular basins matching soil boundaries are feasible (Memam and Keller, 1979).

Table 2. Irrigation scheduling and depth of water applied during the various growth stages of garlic, LVRIS, 1987/88 dry season.

Order of Irrigation	Growth Stage	Days After Planting (days)	Depth of Water Applied (cm)
First	(Pre-planting)*		10
Second	Pre-bulbing	30- 40	10
Third	Bulbing	50- 80	11
Fourth	Maturity	90-120	8
Weighted Ave			10

*Pre-planting irrigation is done three to four days before planting when rice straw mulch are spread over the fields.

Flow Rate, Duration and Interval Between Irrigation

Field observations revealed that the flow rate used for garlic irrigation ranged from 10-33 lps, with an average of 21 lps (Table 3). Field observation also showed that erosion at these flow rates was minimal. Rice straw mulch served as buffer against erosion, especially for high flow rates. Field plot sizes ranged from 0.07-0.2 hectare. Duration of irrigation application ranged from 0.7-2.2 hour. Irrigation intervals were from two to three weeks depending on the availability of water and rainfall.

It was observed that some farmers applied water considering the flow rates but not the rooting depth and advances of uniform stream in their fields. Farmers had little knowledge about the two basic criteria questions in irrigation - "when to irrigate?" and "how much water to apply?? Limited water supply and unequal rotational distribution during dry season coupled with low density of farm ditches to convey irrigation water to the farthest point of the turnout resulted in farms located at the tail section receiving inadequate irrigation water.

Yield of Garlic. Estimate from crop-cut samples showed varying mean yield (Table 3). Farms in Vintar obtained the highest yield at 2.28 t/ha, followed by farms in San Mateo, 2.21 t/ha. Lesser yields were observed in farms located at the tail section because of the occurrence of root rot and tangle top, and sediment-transport when the fields were flooded during the August 1987 typhoon.

Based on the yield response curve, threshold value of water applied was 300 mm (Figure 3). Availability of water was not associated with higher yields. Results are consistent with the nature

Table 3. Mean yield, water use, flow rate and duration of irrigation for garlic, LVRIS, 1987/88 dry season.

Site	Mean Yield (t/ha)	Water Applied (mm)	Flow Rate (lps)	Duration (hr/ha)
Vintar	2.28	576	33	12
San Mateo	2.21	298	14	17
Dibua	1.72	405	17	11
Navotas	1.62	246	22	10
Sta. Maria	1.75	299	10	26
Weighted Ave	1.93	406	21	14

of the crop since garlic requires less water and is very sensitive to wet conditions.

Advance and Recession ***Profiles.*** Advance and recession profiles indicate abnormal change from uniform normal condition of the irrigation method.

Advance and recession isotime profiles show distinct high and low spots in some fields (Figure **4).** These spots cause differences in water infiltration resulting to non-uniform distribution and low application efficiency. To minimize these problems, levelling is recommended for basin method; or a possibility of border or small corrugations to speed up irrigation, can also improve the current irrigation practice. However, these alternatives require additional cost, labor, and- have some adverse effects on farm sue; although in some countries like Taiwan and Thailand border irrigation in garlic has been found effective.

Application Efficiency. Application efficiency is a measure of uniformity but it does not indicate the adequacy of irrigation. Stream size, depth of water over the soil surface, and infiltration rate influence application efficiency (Hansen et al.. **1979).** Application efficiency estimates were generally low and extremely variable (Table **4).**

An efficiency of **73%** was observed in farms in Navotas and San Mateo. Mean application efficiency of the system was ***65%.*** The relatively higher efficiency observed compared with other sites was due to lesser amount of water applied. High efficiency also shows that water allocation and distribution depend on the farm's location within the system.

Computed application efficiencies of basin-flooding irrigation for garlic indicated that all cases had an efficiency of less than **90%** and the highest frequency was in the range of 80-90% (Table ***5).***

Figure ***5*** shows the relationship of application efficiency with stream size. The second degree curve shows that the optimum streamflow rate was 24 lps. Using this flow rate, the estimated optimum application efficiency of **76%** was within the desirable range of about 60-85% for basin irrigation method (Merriam and Keller, **1979).**

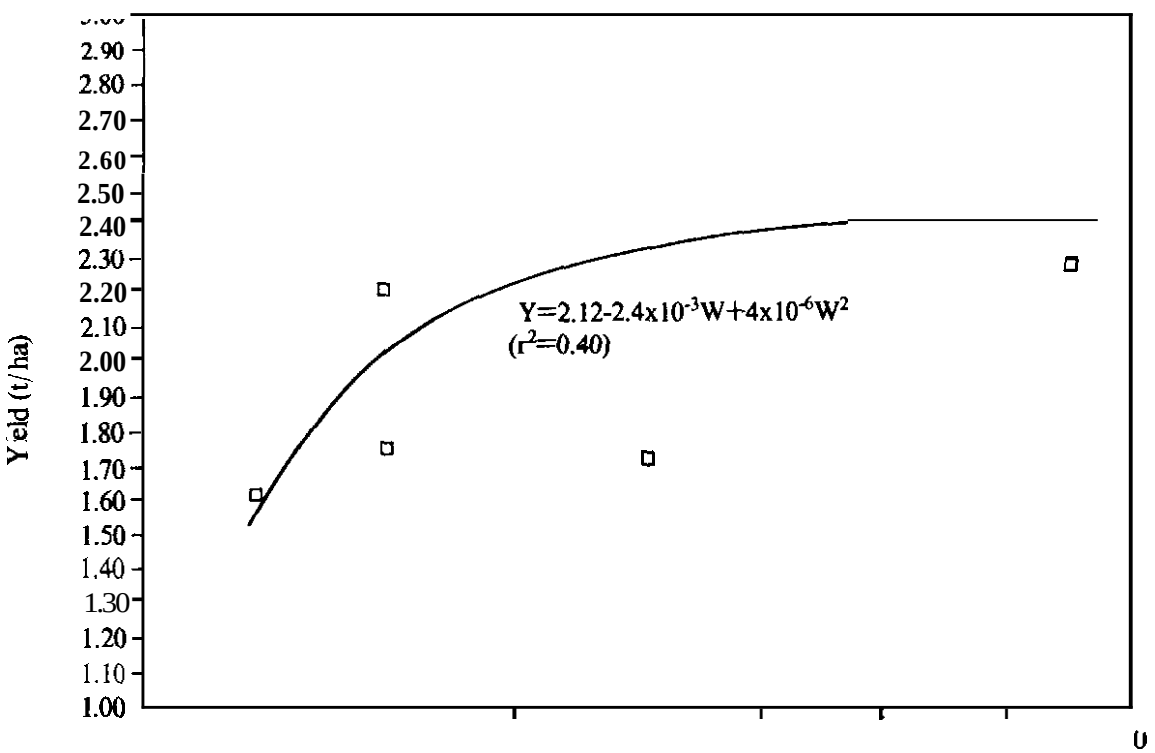
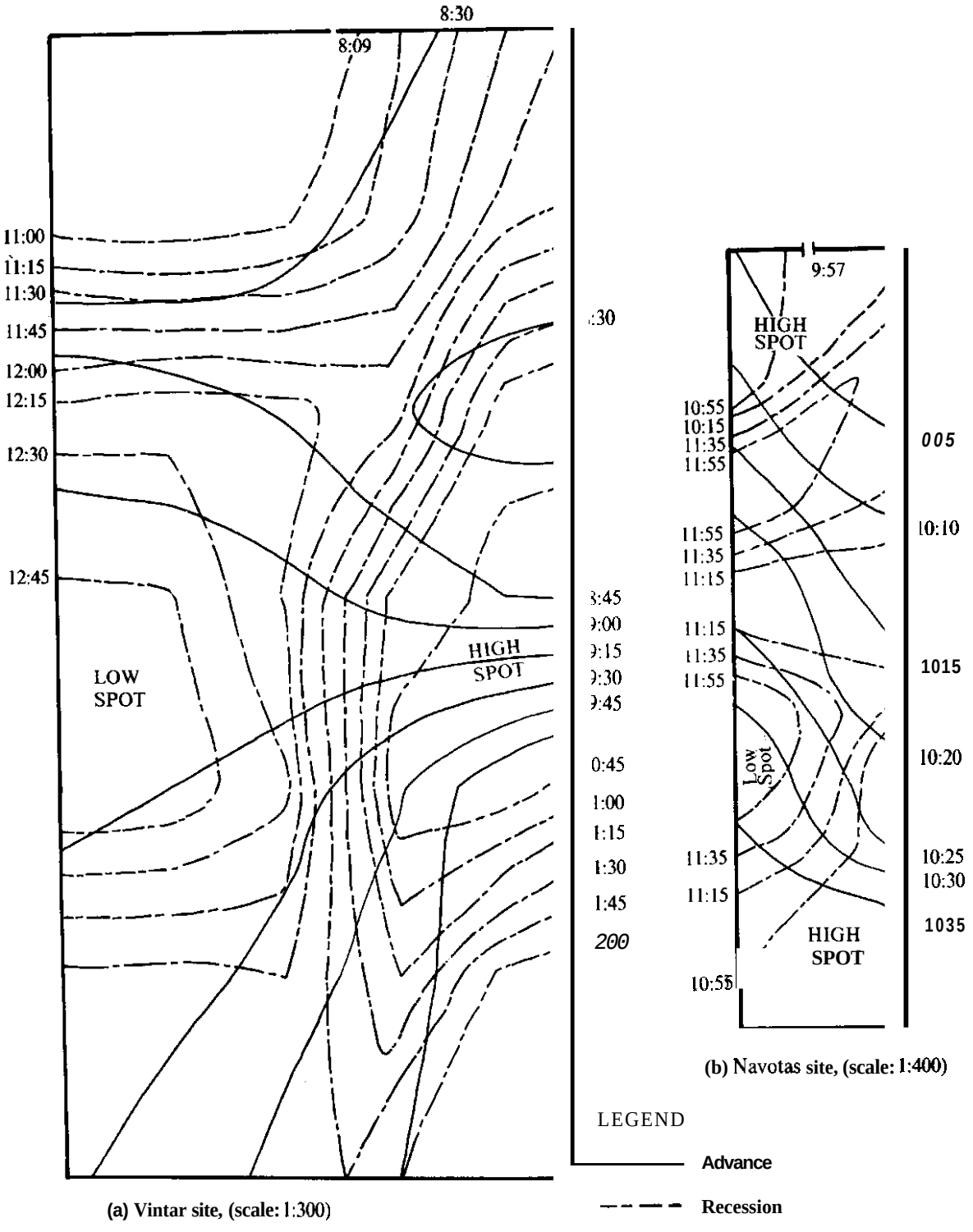


Figure 3. Yield response of garlic to the total water applied at farmers' field, Laoag-Vintar River Irrigation System, Ilocos Norte, Philippines, 1987-88 dry season.



(a) Vintar site, (scale: 1:300)

(b) Navotas site, (scale: 1:400)

Figure 4. Isotime profiles of **flowing** stream of basin-flooding irrigation on mulched garlic at farmers' field, **LVRIS,** Ilocos Norte, 1987-88 dry season.

Table 4. Soil type, total water applied, stored and application efficiency of basin irrigation of garlic, LVRIS, 1987/88 dry season.

Site	Soil Type	Total Supplied (mm)	Total Stored (mm)	Application Efficiency (%)
Vintar	Clay loam	576	399	69
San Mateo	Loam	298	217	73
Dibua	Loam	405	242	59
Navotas	Sandy loam	246	217	73
Sta. Maria	Sandy loam	299	170	57
Average		406	270	65

Table 5. Variation of application efficiency of basin irrigation of garlic, LVRIS.

Application Efficiency Interval	No. of Observation	% of Total Observation	Accumulated (%)
0 - 10			
10 - 20			
20 - 30	1	5	5
30 - 40	2	11	16
40 - 50	1	5	21
50 - 60	2	11	32
60 - 70	4	21	53
70 - 80	4	21	74
80 - 90	5	26	100
90 - 100			
Total	19		

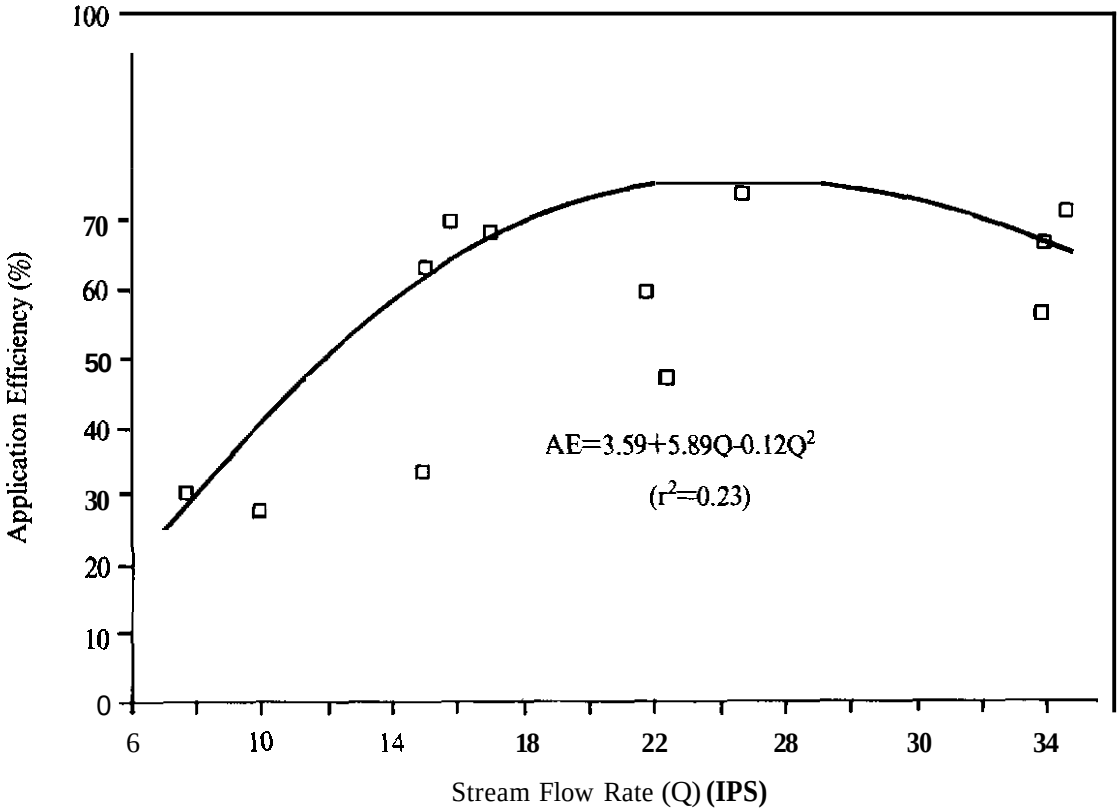


Figure 5. Relationship between application efficiency and stream size on basin-flooding of garlic at farmers' field, Laoag-Vintar River Irrigation System, Ilocos Norte, Philippines, **1987-88** dry season.

Conclusion and Recommendation

Farmers have been traditionally planting garlic **as** a diversified crop during the dry season. Basin-flooding was the method used to irrigate garlic.

Basin-flooding irrigation method can be efficient only when the basin **is** carefully graded and leveled, intake rate of the soil **is** uniform and the correct depth of water is applied in due time considering the time of ponding of irrigation water.

The existing irrigation method can be modified using either a "contour-like" basin without removing the cross slope, or by constructing down slopes like border-strips.

Thorough evaluation of the irrigation method at farmers' field is recommended to develop an innovative irrigation technique that will maximize land, water, soil and labor use.

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