ECONOMIC COMPARISON OF SURFACE AND SUBSURFACE DRIP IRRIGATION METHODS AND IRRIGATION INTERVAL ON COTTON YIELD

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ABSTRACT

This study was conducted to compare economically, two irrigation methods, surface and subsurface drip irrigation systems with different irrigation intervals, on cotton yield. Necessary data obtained from a research project conducted in Kashmar Agricultural Research Station in Khorasan Razavi province. During 2006-2008, design treatments were included irrigation interval (2, 4 & 6 day) and drip irrigation methods (surface and subsurface drip irrigation). Partial budgeting method was used for economic comparison.

Results indicated that all treatments have gross marginal benefit bigger than one, and net marginal benefit is positive too. So, in order to select economic irrigation method, rate of return index was used. Finally, after comparing both treatments, subsurface irrigation method with 4 days interval with %122 rate of return, obtained as the better irrigation method.

1. Introduction

According to the International Institute index for water management , Iran's water situation is Critical, and to preserve current situation ,our country should be able to increase up to 112 % to water resource until the end of 2025. with regard to the existing facilities, this seems impossible.

With regard to this fact that in the last five years ,almost, 90 percent of agricultural production has been irrigated crops, so it is neccessare to revision in water resources management for increase or keep current production. In this regard, One of the existing strategies is, using modern methods of irrigation.

Research indicate that using of micro irrigation systems not only decrease water consumption between 30 to 60 percent but also increeas crop yield between 20 to 70 percent.

At the present , situation of underground water resources in Khorasan province is critical, and in the majority of the plain of province ,underground water level falls every year, its result are, a decrease in wells and aqueducts out put and , an increase in energy costs of water extraction. So water extraction from 70 plain of 78 of province plain is forbidden and using of modern irrigation methods is in priority.

Dougherty and et al (2009) established , a seven-year study from 1998 on a Decatur silt loam to evaluate cotton yield and performance of drip irrigation tape products under conventional fertilizer application and fertigation compared to dryland cotton. Irrigated systems consistently yielded more than the dryland system over the course of the study;the latter had a strong positive return only when early-season rainfall was

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above the 30-yr norm. Fertigation offered no clear advantage over surface fertilization because the 7-yr average return of $ 207 ha-1 was close to the return of $ 212 ha-1 for comparable surface fertilized SDI. Irrigation increased 7-yr net returns, exceeding dryland systems by $ 400 ha-1.
Brodsky and et al (2000) conducted a study to optimize irrigation management techniques for low energy precision application (LEPA) irrigation and subsurface drip irrigation (SDI), and compare resulting cotton lint yields and profitability of these irrigation approaches. Economic analysis of Texas High Plains cotton production showed that LEPA resulted in higher net returns to management and risk than SDI as irrigation capacity increased above the 0.1 in/d level. However, SDI treatments resulted in net returns of over $80/ac and may be an acceptable alternative where LEPA installation costs are greater than $333/ac, physical constraints prevent the use of LEPA, or SOl installation costs are lower than $800/ac.
Styles and et al (1997) investigated effect of three methods of irrigation include subsurface drip irrigation (SDI), correct furrow and standard furrow on cotton yield in salinity soil. Cotton yield in SDI method was reported 16% more than the other methds, and Net income in three methods obtained respectively, 1623,1249 and 1457 $ in hectares
Romero and et al (2005) A cost–benefit analysis performed for a mature, commercial almond plantation in Southeastern Spain to determine the profitability of several regulated deficit irrigation (RDI) strategies under subsurface drip irrigation conditions (SDI), compared to an irrigation regime covering 100% crop evapotranspiration (ETc). The plantation was subjected to three drip irrigation treatments for 4 years. T1 (control, surface drip irrigation)- irrigated at 100% ETc throughout the growth cycle, T2 (RDI treatment under SDI)- an irrigation strategy that provided 100% ETc except during the kernel-filling period, when only 20% ETc was provided and T3 (RDI treatment under SDI)—an irrigation strategy that provided 100% ETc except during the kernel-filling period (20% ETc) and post-harvest (50% ETc). A 45% water saving was achieved with strategy SDI T3, while almond production was reduced by only 17%, increasing water use efficiency compared to the control irrigation regime. SDI T3 had fixed overhead costs 9% higher than T1, however, the operating costs were 21% lower for SDI T3 compared to T1. This reduction in costs was basically due to the 45% saving in the cost of water and the corresponding saving in electricity.The break-even point was lower in SDI T3; each kilogram of almonds cost 0.03€ less to produce than in the control conditions. Related to this, the maximum price of water for obtaining profit 0 was 0.21€ m_3 for SDI T3 compared to 0.18€ m_3 for T1, indicating that higher water costs can be borne in SDI T3 (up to 0.03€ m_3 more expensive). Finally the profit/total costs ratio (used as an expression of the overall profitability of the orchard) indicated a greater profitability for the treatment SDI T3 compared to T1 (10.46 and 9.27%, respectively). The RDI strategy SDI T2 did not show economic indices or water use efficiency as much as those of SDI T3. From these results we conclude that RDI applied during kernel-filling and post-harvest under SDI conditions, and specifically the irrigation strategy SDI T3, may be considered economically appropriate in semiarid conditions in order to save water and improve water use efficiency.

2. Material and methods

In order to compare treatments economically ,Partial budgeting method was used .In this method, changes in benefits obtained from treathments compared to changes in its costs.So, first ,costs and income of each treatment are computed .then, net benefits of each treatment is computed by total production value minus costs that isn’t common between treatments (so net benefit isn’t equal to net income). In third step, total treatments are sorted by cost item ascending as a table, and finally,for compare trearments two by two, below relations are computed.

$$\text{Marginal gross benefits of B treatment relative to A treatment} = \frac{\text{Marginal gross benefits of B treatment-Marginal gross benefits of A treatment}}{\text{Costs of B treatment –Costs of A treatment}}$$

A and B are treatments that must be compared.

Marginal net benefits of B treatment relative to A treatment =
Marginal net benefits of B treatment- **Marginal net benefits of A treatment**

Marginal cost of B treatment relative to A treatment= **cost of B treatment**- **cost of A treatment**

$$\text{Marginal rate of return of B treatment relative to A treatment} = \frac{\text{Marginal net benefits}}{\text{Marginal cost}} \times 100$$

In this study, Pipe installation and harvest cost are not common. so, these are only costs that have been computed. costs and benefit are computed as current price of 2008

After treatments were sorted and above relation were computed, treatment that its Marginal gross benefits are less than 1 are omitted and again treatment comparing is repetted.

Remained treatment have Marginal gross benefits bigger than 1. In the last step, treatment which is end of table and have an acceptable marginal rate of return is selected as economic treatment.

3. Results and discussion

The results were shown in table 1 to 3.

Unit of prices of input and output is 10 rials and base on current price of 2008 year.

Cost difference of Pipe installation, is include laboure for furrow and fill it. Cost of cotton Harvesting, computed base on average cost of cotton harvesting by cotton planters per KG in Khorasan province.

For computing "Cost difference of harvesting", harvest cost of treatment that have the lowest harvest cost, was reduced from harvest cost.

Gross benefit per ha was computed base on average price of cotton that cotton planters sold their products.

Net benefit of each treatment was computed from gross benefit mius total cost difference.

Result indicated that all treatments have marginal gross benefit bigger than one , and marginal net benefit is positive too. so , all treatment remain in comparsion and aren't delet. In this situation ,In order to select economic irrigatin method ,rate of return index is used. finally , after compare treatments two by two, Subsurface irrigation method with 4 days interval with %122 rate of return(table 3) , obtained as the best irrigation method (consider that maximum of rate of return is not base of dicision. because treatments are compared two by two) .

Table1. Initial calculation of treatments
Source: Research calculation

Year	Treatments		yield	Cost difference of Pipe installation	Harvest cost	Cost difference of harvesting	Total cost difference	Gross benefit per ha	Net benefit
	Interval	Method							
First	Two days	Surrface	1715.8		156512	31208	31208	1078468	1047260
First	Two days	SDI	2624.7	72000	239413	114109	186109	1649709	1463600
First	Four days	Surrface	1611.5		146998	21694	21694	1012908	991214
First	Four days	SDI	2903.8	72000	264877	139573	211573	1825174	1613601
First	Six days	Surrface	1373.7		125304	0	0	863423	863423
First	Six days	SDI	2557.7	72000	233307	108004	180004	1607639	1427635
Second	Two days	Surrface	4499.6		410434	0	0	2828158	2828158
Second	Two days	SDI	5123.1	72000	467309	56874	128874	3220059	3091185
Second	Four days	Surrface	4658.5		424931	14497	14497	2928052	2913555
Second	Four days	SDI	5725.7	72000	522281	111846	183846	3598853	3415006
Second	Six days	Surrface	4587.3		418436	8002	8002	2883296	2875294
Second	Six days	SDI	4937.1	72000	450344	39910	111910	3103162	2991253
Average	Two days	Surrface	3107.7		283473	11603	11603	1953313	1941710
Average	Two days	SDI	3873.9	72000	353361	81491	153491	2434884	2281393
Average	Four days	Surrface	3135.0		285964	14094	14094	1970480	1956385
Average	Four days	SDI	4314.8	72000	393579	121709	193709	2712014	2518305
Average	Six days	Surrface	2980.5		271870	0	0	1873360	1873360
Average	Six days	SDI	3747.4	72000	341826	69956	141956	2355401	2213445

Table 2 . Final results of treatments comparisons after sorting by increase of cost in the first and second year

Year	Treatments		Yield	Cost difference of Pipe installation	Harvest cost	Cost difference of harvesting	Total cost difference	Gross benefit per ha	Net benefit	Marginal gross benefit	Marginal net benefit	Rate of return
	Interval	Method										
First	Six days	Surrface	1373.7		125304	0	0	863423	863423	-	-	
First	Four days	Surrface	1611.5		146998	21694	21694	1012908	991214	7	127791	589
First	Two days	Surrface	1715.8		156512	31208	31208	1078468	1047260	7	56046	180
First	Six days	SDI	2557.7	72000	233307	108004	180004	1607639	1427635	4	380376	211
First	Two days	SDI	2624.7	72000	239413	114109	186109	1649709	1463600	7	35965	19
First	Four days	SDI	2903.8	72000	264877	139573	211573	1825174	1613601	7	150001	71
Second	Two days	Surrface	4499.6		410434	0	0	2828158	2828158	-	-	-
Second	Six days	Surrface	4587.3		418436	8002	8002	2883296	2875294	7	47136	589
Second	Four days	Surrface	4658.5		424931	14497	14497	2928052	2913555	7	38260	264
Second	Six days	SDI	4937.1	72000	450344	39910	111910	3103162	2991253	2	77698	69
Second	Two days	SDI	5123.1	72000	467309	56874	128874	3220059	3091185	7	99932	78
Second	Four days	SDI	5725.7	72000	522281	111846	183846	3598853	3415006	7	323821	176

Source: Research calculation

Table 3. Final results for comparisons of average of treatments after sorting by cost as ascending

Treatments		Yield	Cost difference of Pipe installation	Harvest cost	Cost difference of harvesting	Total cost difference	Gross benefit per ha	Net benefit	Marginal gross benefit	Marginal net benefit	Rate of return
Interval	Method										
Six days	Surrface	2980.5		271870	0	0	1873360	1873360	-	-	
Two days	Surrface	3107.7		283473	11603	11603	1953313	1941710	7	68350	589
Four days	Surrface	3135.0		285964	14094	14094	1970480	1956385	7	14675	104
Six days	SDI	3747.4	72000	341826	69956	141956	2355401	2213445	3	257060	181
Two days	SDI	3873.9	72000	353361	81491	153491	2434884	2281393	7	67948	44
Four days	SDI	4314.8	72000	393579	121709	193709	2712014	2518305	7	236911	122

Source: Research calculation

Conclusion

1-Using of subsurface drip irrigation (SDI) method versus surface method have additional costs but is economical.
2-Subsurface irrigation method with 4 days interval with %122 rate of return , obtained economically as the best irrigation method .

4. References

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