

Analysis on the Economic Benefit and Soil & Water Conservation by Permeating Irrigation for Hilly Orchards

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Abstract: There are 271,000 hectares of orchards in the controlled small watershed in hilly areas throughout the Henan Province. In recent years, different forms of irrigation are developed. Experiments and investigations have been carried out in the apple orchards in the west part of Henan Province. It is convinced that permeating irrigation is an effective measure to prevent soil erosion in hilly orchards. It will improve not only the economic benefit of the small watershed control, but also that of the soil-water conservation.

To find out its exact functions, we carried out a three-year experimental observation and investigation trying to perfect the small watershed control, ensure its comprehensive benefits. Here's a detailed analysis of the economic benefit and water & soil conservation.

Flooding irrigation erodes, on the average, 10.2 m³ of soil per ha, that means erosion modulus 2,652 t/km² a year, if irrigated twice a year, while permeating irrigation will not bring about soil erosion. It will also save water up to 1,650—2,475 t/ha a year, increase water duration 5 more days after the irrigation and decrease soil erosion by 21m³. Hence, the benefit of water-soil conservation turns out to be remarkable.

This way of irrigation costs as much as RMB 6,000 yuan per ha, however, the economic benefit can be as high as RMB 4,830 yuan per ha. Meanwhile, it improves the fruit quality and saves labor. In a word, it is a practical and effective way of irrigation in hilly orchards.

Keywords: analysis on benefit, permeating irrigation, hilly orchards

1 Benefit of soil-water conservation

In the management of orchards, management of fruit trees is stressed, but management and protection of field bunds and slope is neglected. Deep hole-making, fertilizing and intertillage are stressed, but the maintenance of field bunds are neglected, even the soil-water conservation engineering are damaged. The protection facilities may not meet the designed standard after 3—5 years' operation. By flood irrigation, the trenches in the field were washed, the soft surface soil caused by intertillage was washed away, and field bunds were damaged. All this results in soil erosion. For this, investigations are made in west part of Henan Province. In the typical small watershed—Huoshayang Gully, example sections are selected and comparison tests are made between flood irrigation and permeating irrigation in the orchards. The index of retaining water in soil, saved water and reduced loss of soil erosion will be checked. When the tests are carried, observation sites with similar conditions are chosen, flood and permeating irrigations start at the same time.

1.1 Observation of flood irrigation and survey of soil loss

At the chosen observation site for flood irrigation, before the irrigation starts, soil moisture in the orchards has been checked; after irrigation, the soil moisture should be checked 3 times (5 days, 20 days and 35 days later). Surface soil loss (including surface washing lines and field bunds washed) should be measured 2—3 days after the irrigation. 6 observation tests are made in 1999, 2000 and 2001, refer to the

following Table 1:

Table 1 Records in flood irrigation test and observation site

Description		Time		99.04.12	99.07.16	00.04.20	00.11.06	01.04.11	01.09.10
		99.04.12	99.07.16	00.04.20	00.11.06	01.04.11	01.09.10		
Soil Moisture (%)	Before Irrig	8.1	7.9	8.0	8.4	8.1	8.2		
	5days after irrig	21.0	20.0	20.5	22.1	21.3	22.1		
	35days after irrig	8.0	7.7	7.9	8.7	8.0	8.0		
Water used in Irrig(t)		556.6	477.0	535.3	514.1	545.9	519.4		
Water used /ha(t/ha)		1,575	1,350	1,515	112	1,545	1,470		
Trenches washed		48	50	44	39	51	37		
Mini-trenches washed (t)		3.22	3.25	3.06	3.55	3.6	3.4		
Bunds washed (m ³)		0.8		0.4			0.23		
Deepened holes (m ³)			0.25						
Total washed amount (m ³)		4.02	3.5	3.46	3.55	3.6	3.67		
Average washed amount/ha • time(m ³ /ha)		11.37	9.9	9.795	10.05	10.185	10,275		

Note: Observation site: Hualing village. Irrigation area is 0.35ha

The average water amount used in flood irrigation per ha • time is 1,350—1,575 t; average soil moisture 3 days after the irrigation is 7.7%-8.7%; after irrigation soil washed away per ha • time is 9,075—11.4 m³; According to average soil moisture measured the time retaining water in soil is 35—40 days when draught continues.

1.2 Observation of permeating irrigation test

The growing period of fruit trees is from April to October. Average soil moisture shall be measured at any time. If the soil moisture is nearly the minimum soil moisture 8% (wilting coefficient) for apple tree's growth, the test is started.

According to the 6 permeating irrigation tests from 1999 to 2001, average water used per ha-time is 330 t, average soil moisture about 35 days after the irrigation is 9.3%-12%; the time retaining water in soil are 40-45 days. Refer to the following Table 2:

Table 2 Records in permeating irrigation test and observation site

Description		Time		99.04.12	99.07.16	00.04.20	00.11.06	01.04.11	01.09.10
		99.04.12	99.07.16	00.04.20	00.11.06	01.04.11	01.09.10		
Soil Moisture (%)	Before Irrig	8.8	9.3	8.5	9.1	8.3	8.0		
	5days after irrig	15.6	16.3	16.1	16.1	16.6	16.8		
	35days after irrig	11.0	12.0	10.9	11.8	9.3	10.3		
Water used in Irrig (t)		37.5	31.5	30	51.5	33	34.5		
Average Water used (t/ha)		375	315	300	315	330	345		

Note: Observation Site: In the apple orchard of soil and water conservation station. Irrigation area is 0.1ha

1.3 Result analysis of protection of water and soil in permeating irrigation

The average soil washed away per ha • time is 10.2 m³ in flood irrigation, approximately equal to 1 mm surface layer soil washed away. If 2 times of flood irrigation is taken the annual erosion module will

be 2,652 t/(km² • year), equal to medium erosion. The average water used per ha • time in flood irrigation is 1,485 t. If 2 or 3 times of flood irrigation are taken, the annual water used is 2,970—4,455 t.

The average water used per ha • time in permeating irrigation is 330 t. If 4—6 times of permeating irrigation are taken, the annual water used is 1,320—1,980 t. There is little soil erosion. 1,650—2,475 t per ha • year can be saved. The time retaining water in soil after irrigation will be 5 days added. Soil washed away will be reduced by 21 m³. Therefore, the effectiveness of soil-water conservation by permeating irrigation in hilly orchards is very obvious.

2 Economic benefit

2.1 Yield increase benefit

During the picking time of apple from 1999 to 2001, the apple yield and quality are investigated on site separately in the tested 0.35 ha orchard by flood irrigation and the tested 0.1 ha orchard by permeating irrigation. It is clear that 5,500 kg per ha • year and 15% of big size apple ($\Phi > 70$ mm) are increased in the orchard by permeating irrigation. The apple size is shown in the following Table 3.

Table 3 Apple size

Apple Size	1999		2000		2001		Average	
	Permeating Irrigation	Flood Irrig.	Perm. Irrig.	Flood Irrig.	Perm. Irrig.	Flood Irrig.	Perm. Irrig.	Flood Irrig.
$\Phi > 75$ mm (%)	31	26	32	28	36	21	33	25
$\Phi 70$ —75mm (%)	44	38	40	36	42	31	42	35
$\Phi < 70$ mm (%)	25	36	28	36	22	48	25	40

2.2 Analysis of input and output for permeating irrigation engineering

2.2.1 Investment and annual operation cost

For the tests, only the investment and annual cost more than that for flood irrigation are calculated.

Investment: It is calculated according to designed engineering on the observation site.

Operation Cost: The operation cost added in permeating irrigation is mainly maintenance charge and repair charge. The maintenance charge is 5% of the investment. The repair charge takes place when the mini pipe holes are blocked. The pipe should be dug out, cleaned and the sand bags should be changed. 67.5 man-days per ha and 5,130 sand bags are needed. The annual operation cost totals 565.5 yuan per ha.

2.2.2 Benefit added by permeating irrigation

If the permeating irrigation is adopted, on average, 5,500 kg fruits are increased per ha-year, 50 man-days per ha • year are reduced and 1,650—2,475 t of water is saved. If the average price is RMB 0.4 yuan per kg; the price of one man-day RMB 20 yuan; water RMB 1 yuan/t, then average benefit of RMB 4,840.5 yuan per ha can be raised.

2.2.3 Tax payment from benefit increase

According to the local conditions, tax of RMB 0.11 yuan per kg for special products such as apple should be levied. The output per ha by permeating irrigation is 27,990 kg/ha. The output per ha is 5,500 kg more than that by flood irrigation. So the tax payment of the added benefit is RMB 604.5 yuan.

Based on the above analysis, the net benefit per ha • year by permeating irrigation is RMB 4,840.5 yuan. The engineering investment per ha is RMB 6,012 yuan; annual operation cost is RMB 565.5 yuan and the tax payment is RMB 604.5 yuan. The repayment period of total investment is 1.6 years according

to static calculation. Also in the orchards by permeating irrigation, the quality of apple is greatly improved, irrigation water and man-days can be saved. So the economic benefit is very obvious.

In short, if permeating irrigation is used in hilly orchards, not only the economic benefit is better, but also the effect of soil-water conservation is greater. Therefore, permeating irrigation in hilly orchards is a good, practical and effective irrigation measure. Permeating irrigation is suggested to be spread in hilly orchards.