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TECHNICAL ASPECTS AND EXPERIMENTAL RESULTS OF SIP IRRIGATION

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ABSTRACT. After a brief introduction into the evolution of irrigation techniques, different sip irrigation methods developed in different countries, is discussed, with particular attention placed on the system developed by the Agricultural Hydraulics Institute of the University of Pisa.

This system was tested over a period of 20 years. The results of the working equipment and its influence on yield crops are herein related.

INTRODUCTION

The Sip Irrigation method carried out by Celestre and collaborators during the period in which the same Celestre was Director of the Agricultural Hydraulics Institute of the University of Pisa, represents the synthesis of solutions that can be selected to solve many irrigation problems. It is necessary to point out that the Sip irrigation method does not represent a particular means for the distribution of water to the irrigated plot, but a way for watering by different irrigation techniques, whether by the conventional or by new techniques.

The economical advantage that influences all human activities, suggests that for the future of irrigation there are two opposite and divergent solutions, in the ambit of which the individualization of the best technical economic results either in realization or in the operation of irrigation plants. The first solution is represented by the maximum continuity of watering during the time fixed by plants or equipment while the second solution is represented by the maximum irregularity of watering with varying movability of the equipments. The technical economical advantage of the two systems results, is evident when coinciding the two cases of intuitive optimization: the fixed, net reaching the minimum amount and the maximum efficiency with permanent water flow, while the movable, net's results are as economical and the flow is more rapid and has a larger watering capacity. At most, this last system reaches output with a single instantaneous watering. In practice the first solution could be approximated and also reached while the second could be only approximated for obvious reasons. Therefore, in relation to the ever growing cost of labour and the easiness of the mechanization and automation, two practical solutions for irrigation are advisable, both being maximally automatized, programable and mechanized:

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1) Continuous irrigation
   – minimum time possible tends towards continuity,
   – minimum watering with a specific discharge,
   – fixed irrigation equipment.
2) Non-continuing irrigation
   – the maximum time possible in relation to a soil type and crop,
   – maximum possible watering with rapid distribution,
   – highly movable equipment (with a tendency towards fixed systems.)

Obviously, we can not forget the great importance of the traditional systems that still represent the major form of irrigation in the world. Especially after the introduction of automatic and programmable systems that have bettered its use. It is certain that the varying irrigation systems will continue their coexistence, because the pedoclimatic and economic situations in which irrigation is practised are different as well as their varying needs and requirements which must be satisfied. The development of new techniques shows that, where specific needs are not required, the development of irrigation is destined towards one of the above solutions. A distinct division can be made between continuous irrigation and non-continuous irrigation based on soil moisture in regard to time. Meanwhile, the non-continuous irrigation methods, traditional systems for example, are characterized by various alterations in soil moisture and are practically uncontrollable, while the continuous distribution method is characterized by slight or gradual changes of the soil moisture and are easily controllable.

In terms of the soil moisture-time diagram, the first signs are the saw-toothed curve, corresponding to regular timing and „a domanda" for watering and having its course dominated by the natural drying of the soil. The second sign is characterized by a constant or slowly varying diagram, that can be controlled through a daily watering routine.

In the major number of cases studied from other sources, the results are that the constant or variable soil moisture gradually changes according to the physiologic and above all, to the soil moisture correlated to the daily needs. This permits the complete satisfaction of the physiological needs of the plants with favorable influence on their production.

The studies conducted by the Agricultural Hydraulics Institute of the University of Pisa, in comparing the results of permanent or almost permanent irrigation with traditional irrigation and then with the non-continuous system, (using tomatoes, carnations, wine grapes, ect) have given encouraging results especially if you consider the pedoclimatic conditions of the area where the research was completed. Based on these indications, we are sure that these systems allow for the maintainence of the soil moisture within stable limits or with slightly controllable variations. It should allow increased production from the point of view of quality and quantity, at least in the major part of the cases studied. The variations of the soil moisture content in space and time cause changes in the condition of the soil and vegetative state of the plant, which is in relation to the major or minor possibility of absorbing the principle nutritive elements and the eventual development of parasites. These considerations must be experimentally proven . Until now, we must consider the tendency in the use of the trickle irrigation system and abandon the true drip system in favour of daily micro time tables. We retain that frequent, but interrupted watering allows for a large variation in the soil moisture content during the day. In fact, the pF varies in space and time from a value of zero to a value of field capacity and higher, but nevertheless is easily adjustable with a quantity of water distributed. These oscillations activate the dynamic water air exchange in the soil. This is the positive maximum for the plants and soil /Grossi 1972/.

CLASSIFICATION OF DIUTURNAL IRRIGATION METHODS AND PRINCIPLE ASPECTS OF SIP IRRIGATION METHODS

From that which has already been illustrated and is valid in general, it follows that in the ambit of the two solutions indicated, in economic and technical terms, the best physiological output of the crops can be obtained easier with the use of irrigation methods that permit the controlled maintainance of the soil moisture content. These methods represent a new irrigation technique called „diuturnal irrigation" or „semi - permanent".
Celestre has classified this technique (in relation to the means of watering and methods of distribution) into three categories and in 10 classes. In this classification the trickle irrigation method and the sip irrigation method represent two categories of the new technique which is shown in the following:

Table 1.

DIUTURNAL IRRIGATION	A – Permeating Irrigation	I – Nebulized (Artificial mist over land)
		II – Uniform and reversible (Artificial acquifer)
	B – Trickle Irrigation	III – Shared (Total land surface watered)
		IV – Localized (Part of land surface watered)
	C – Sip Irrigation	V – Accumulated and spread (Hourly spreadings using accumulating tanks)
		VI – Accumulated and sprinkled (Hourly sprinklings using accumulating tanks)
		VII – With autoclave and sprinkling (Hourly sprinkling using autoclaves)
		VIII – Self propelling (Self propelling and dripping lines)
		IX – Timed and spread (Hourly spreadings using timing valves)
		X – Timed and sprinkled (Hourly sprinklings using timing valves)

The classification, in practice, assuming at least in regard to sip irrigation, evidently shows the principle aspects of sip irrigation and the possible variations in methods. The peculiar characteristic of sip irrigation is made up by its non-continuity of watering which follows at regular repeating intervals for the entire period of irrigation. The soil moisture is maintained practically constant in time with slight oscillation during the day which permits a sufficient aeration of soil without increasing the value of pF. The equipment is characterized by a small in diameter network with a tendency, in the case of peripherical accumulation, to an indispensable minimum, to guarantee a specific discharge, as in the case of the system proposed by our Institute which accumulates the volume of each sip in tanks installed directly in the areas irrigated. The distribution of water in an organized and continually cooperative way is carried out by „a domanda" as any diuturnal irrigation method.

The Sip irrigation method represents, in terms of the diuturnal technique, a method which can be used with any irrigation system provided that water distribution is repeated and frequent with more or less short intervals without watering. Referable to this method are for example: „pulsing" irrigation or „impulses" which are being developed with good results in many countries even if the final results may be different.

REVIEW OF „SIP" METHODS

The sip method originates principally through the evaluation of trickle irrigation and sprinkling irrigation in regards to different needs. In the first case it was directed towards the sip irrigation to eliminate the frequent clogging of the water distributing mechanism which is vulnerable because of the small holes. Sip irrigation leaves the path open to impure water without being filtered, or having other treatments. In the second case, the sip irrigation is a method for reducing the diameter of the network and placing the system in a steep area for which there is an inevitable large difference in water pressure. Much research has been done on this last solution by us and, above all, in the USSR where it has been studied with much interest / Lebedev 1969,Nosenko 1973, Shumakov et al. 1975/ This system, already in function with numerous prototypes on tea and vegetable plantations fits into class VII, the water distribution is made possible within a sprinkling autoclave. The water is pushed into smaller autoclaves, one for each nozzle, until total refilling, after which a hydromechanic temporizer sends a pressure signal through the network which activates the aperture device on the autoclaves causing sprinkling for a few seconds, after which there is another refilling time for a few minutes.
The particular interests in this system of irrigation are its microclimate aspects which, with the increase of the humidity in the air and the decrease in temperature probably compensate for the index of efficiency that is assumed to be quite low. The climatizing effect is considered to be so effective that the Soviet experimenters practiced the sip method with the traditional system commanded by an electric temporiser (class. X).

More numerous are the examples of the sip system evolved from evolutionary changes in the trickle method. Above all we remember the method practicedin France by the „Compagnie Nationale d'Amenegement Bas-Rone"/Decroix and Rutten 1960, Compagnie Nat.Amen.Bas-Rhone 1970, Decroix 1977/. The trickling lines, with a very simple metal emitter inserted in plastic tubes with small holes in the walls protected by a jet-breaker sleeve,are placed at the bottom of a furrow parallel to the crop's line and interrupted between one dripper and the next by a dividing wall. The system is subdivided into sections which are fed in rotating succession, with relatively high discharges with a volumetric valve.

The irrigation water at the pressure of 0.8–1.2 Atm. gives a discharge by each dripper, of around 60 l/h, and is distributed in the furrow with eventual water excesses.

In the Soviet Union and in particular at the „Union Research Institute of Mechanization and Techniques of Irrigation" (VNIIMIRT) of Kolomna, we found an interesting application for the sip system of hydromechanic temporiser already mentioned for the impulse system /Megale/.With a similar process that was already illustrated for the sprinkling irrigation, water is stored up, the same emitters are placed in parallel on the dripping line, which are equipped with a small plastic reservoit , about 100 cm^3, that acts as an autoclave. At every opening position, hit by a decreased pressure, the reservoir is emptied and each plant receives its small contents. Even keeping the discharges to a minimum utilising holes with diameters sufficiently large enough to reduce the danger of clogging, even without filtered water. The working pressure of this system varies between 1–1.5 Atm.

With the idea of eliminating the clogging of emitters the sip system „IRRISOR" has been conceived and produced by the Italian Society F.I.A.T./F.I.A.T Spa 1976/.In this case the emitters, reduced only to the discharge valve, are fitted in a series and are equally spaced. Each section of watering line between nozzles forms a type of autoclave which operates due to the elasticity of the hose and varying water pressure from 0 to the maximum piping operating pressure. The operating pressure can attain a maximum of 4 Atm. The dripping line, which forms a ring pipe, starts and finishes in correspondence with the pilot valve situated at the head of the distribution line. This valve, which is in function from the existing pressure between the start and finish of the trickling line, regulates the opening of the emitters, which empties in succession one after the other. The emitter's discharge, according to indications of the builder, varies with the pressure and number of emitters in the trickling line and reaches a maximum of 6 l/h for lines with 20 emitters and a working pressure of 4 Atm.

Lastly we have the equipment obtained by the Agricultural Hydraulics Institute of the University of Pisa, which has absolute priority due to the fact it was realized earlier, and is last recalled for its clearness of exposition.

SIP METHOD OF THE AGRICULTURAL HYDRAULICS INSTITUTE OF PISA

Starting in 1963-64 Celestre and his assistants performed the first studies and experiments to obtain a watering system offering the advantages of the trickle method and eliminating the most important defects/Celestre 1960,1964a,b,c/. This system, which in the previous classification can be found between those of class V „Distribution with the accumulation and spread", is based on a continuing flow in the irrigation network and an intermittent flow in a dripping line fed by small accumulating and temporizing tanks /fig. 1/. The watering network, organized for continuous discharge 24 hours a day, assumes a minimum diameter as in the more classic trickle system, while the emitters are subject to short discharge periods to permit a sufficiently large passage to reduce the danger of clogging. The accumulating tank is fed by the constant and continuous discharge „q" slowly filling in time „t" and rapidly emptied in time „T" with an exit discharge „q_u (τ)" variable. The function and dimensions of the tank are regulated by the equation of continuity:

$$\int q_u \, d\tau - qT = V_u \qquad 1$$

where V_u = qt is the utilizable volume of the accumulating tank.

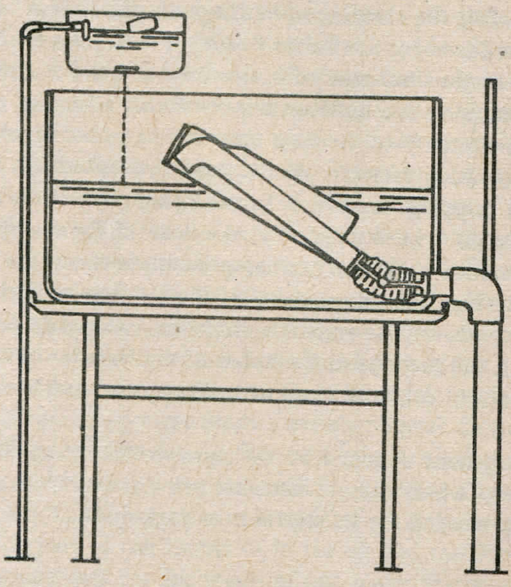

Figure 1. Automatic emptying device for accumulation tanks

Measurements of pressure and discharge effectuated on a standard system during recent or even in working /Megale 1980/ experiments,have confirmed that at first estimation the exit discharge can be considered constant /fig. 2/ and proportional to the number of watering lines. This observation allows us to write:

$$\frac{Q}{q} = 1 + \frac{t}{T} \qquad 2$$

where Q indicates exit discharge. Expressing the emptying time as a function of filling time and the time between two discharges, we can derive the utilizable volume.

$$V_u = qt = q\,\Theta\,\frac{Q-q}{Q} \qquad 3$$

In the case where the exit discharge is very large in respect to the input or where the filling time is very long in respect to the discharge the utilizable volume is practically equal to the report between the daily watering routine for the irrigated plot and the number of the daily sip needed.

$$V_u = q\,\Theta \qquad 4$$

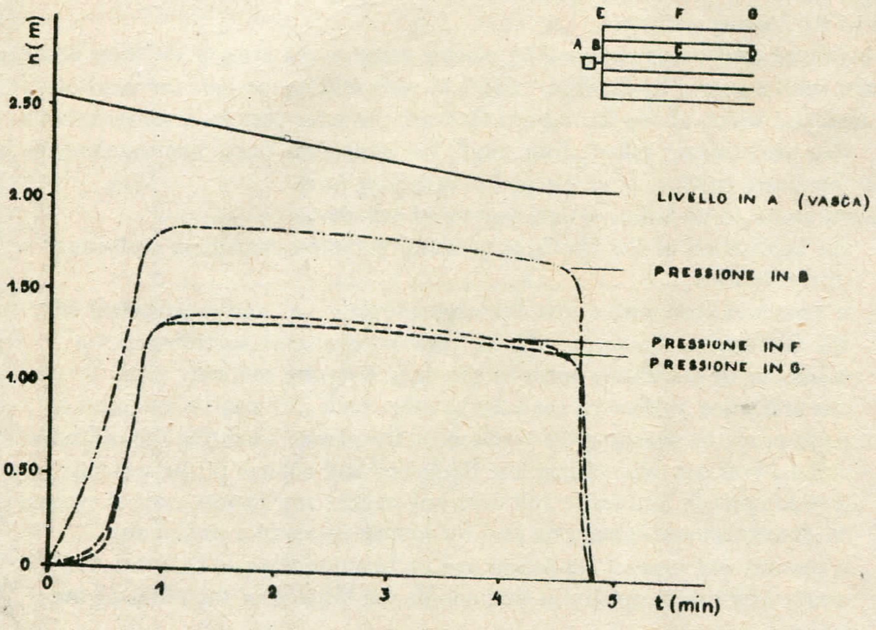

Figure 2. – Curves time–pressure

Flow regulator

The flow of alimentation „q" of each accumulation tank is perfectly regulated by means of a very simple device with a discharge opening in which a floating cock maintains a constant water level /fig. 1/. The device guarantees to the whole system uniformally perfect watering independent of pressure changes in the network, even if they are caused by normal head loss in long conducts, by uneven land or by changes caused by the opening or closing of different sections of the system.

Automatic emptying device for accumulation tanks

The automatic emptying devices for accumulation tanks can be of varying types and many are of the types conceived and experimented with in the Agricultural Hydraulics Institute of the University of Pisa. Of these, the one that was shown to be the simplest and most secure is the open armed siphon system with a weighted floating box /fig. 1/. The siphon is placed inside the floating mobile arm connected at the bottom of the tank to the distribution network with an elastic junction that allows the movement. As the water level increases, the floating arm rises upward rotating around its fixation point until it is blocked, stopping all other movement of the arm, allowing the water to fill the floating box through specific openings found on the superior part of the float. The sinking of the floating arm, weighted down by the water, primes the siphon to distribute water to the trickling lines, and, complets the emptying of the tank. The siphon dries the floating box and the mobile arm returns to its floating position.

An improved device was obtained by placing many mobil arms in the same accumulation tank with a simple mechanism, which at each refilling permits the pawl of different arms and which allows more portions from the same accumulating tank to be served. This mechanism, called „four ways" has undergone many improvements in the past few years arriving at an altogether satisfying level.

It seems useful to underline several aspects of this device:

1 – the application of the discharge regulator gurantees maximum uniformity of distribution;

2 – it functions even with a low discharge adductor „q" and independent of the distribution discharge „Q", „q" can be regulated according to the increasing or decreasing needs of the daily watering routine;

3 – the utilization volume of the accumulation tank „V" can be modified to these needs by changing the position of the pawls. Changing the utilizable volume you can also change the frequency and volume of the watering;

4 – it is completely automatic and does not require any remote control systems or energy sources reducing the need for human hands to a minimum;

5 – it permits any type of regulation and its functionning can be controlled by means of a simple apparatus that counts the number of the refills of the tank;

6 – it functions with a pressure of a few meters.

Emitters

Considering that the discharges emitted by the set up are sufficiently high and the working pressure very low, 0,1 – 0.3 bar, it is possible to use very simple emitters with free passages in the order of one mm. In particular, the trickler which is normally used is constructed with a plastic botton in A.B.S. with a 1.2 mm hole and a jet-breaker and covering.

It is possible now to mount an emitter on dripping lines with different sized holes to improve the uniformity of distribution and to make possible the use of the equipment even on slightly inclined lands. The results of the measurements taken from prototype emitters of varying diameters indicate that in the area of working pressure the relation to the pressure discharge can be expressed with the mathematical formula which is extremely simple and provides a satisfying approximation /fig. 3/ /Megale 1980/.For example: with the emitter normally used until now, the results of that relationship are:

$$q_{\phi\,1,2} = 13.492\, h^{0.512} \quad (\text{l/ora}) \qquad 5$$

valid for pressure, expressed in meters of water, from 1.2 to 2.2 in which the corresponding respective discharge is 14.8 and 20.2 l/hour.

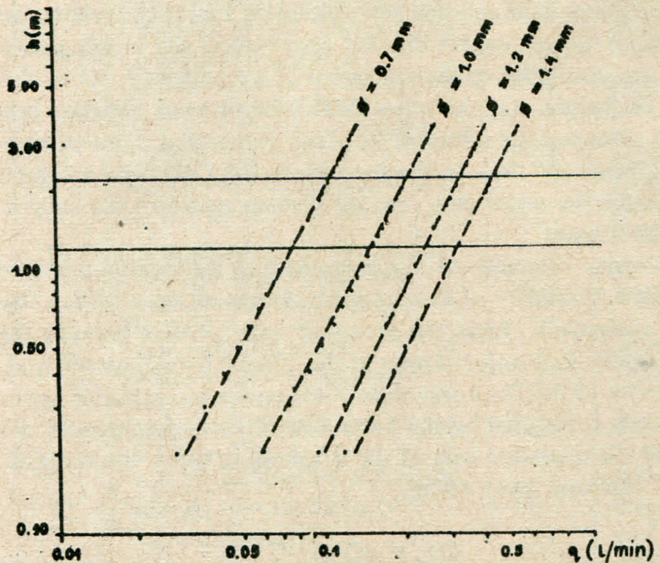

Figure 3. – Curves pressure-flow for drippers S_1

By knowing the characteristics of the emitters it is possible, with the aid of a calculator, to distribute the emitters of varying diameters in such a way as to obtain the maximum uniformity of distribution along the dripping line in relation to the length of the line and to the inclination of the land. For example: satisfactory experiments of this type have been developed at VITUKI in Budapest with varying types of emitters, among these a perforated botton similar to that used for the system of the Agricultural Hydraulics Institute of the University of Pisa /Perenyi 1977, Balogh and Klimo 1976/.

EXPERIMENTAL RESEARCH AND FIELD APPLICATION OF THE SIP METHOD

Experimental results of research on the micro-irrigation carried out by the Agricultural Hydraulics Institute of Pisa are reported in table 2; experimental fields are instead reported in table 3. The trials show that the working equipment were very satisfactory /tank, automatism, pipes, and emitters/. From the agronomical point of view it was observed that the yield, in general, has been higher quantitatively and qualitatively in the plots watered with the sip irrigation method. Such an advantage has been pointed out particularly for tomatoes in greenhouses.

OBSERVATIONS AND CONCLUSIONS

From what we have already seen we can deduce that between the two solutions predicted for the future of irrigation, continuous irrigation and discontinuous irrigation, the continuous solution represented by diuturnal systems, makes up the one from which we can expect the best agronomical and pedological results in relation to the possibility of the regulation of soil moisture and to the small distributed discharges. On the other hand discontinuous irrigation generally offers more advantageous solutions from the economical point of view for its low cost of equipment and use. In the field of localized diuturnal irrigation equipment we feel that, for the major part, the sip systems represent the natural evolution of the trickle systems.

With particular reference to the equipment of the Agricultural Hydraulics Institute of the University of Pisa, the advantages of sip irrigation start with the cost of the equipment. From the economic point of view between the two methods it results in a major savings in the cost of the equipment and its working/Celestre 1978/.The lower costs of the equipment,which in the examined case is around 17 %, is justified by the lower cost of the entire system, a simpler one, and by the minimum cost of the irrigation network according to the relationship /Celestre 1960, 1976/.

$$C/c = (Q/q)^{0.95} \qquad 6$$

valid for plastic tubes, in which „c" and „C" indicate the unit cost in the case of continuous discharge „q" and discontinuous discharge „Q". The working cost

Table 2 – Experimental tests of Sip and Trickle Method – Agricultural Hydraulics Institute – PISA

General					Trickle irrigation (or drip)				Compared irrigation			Crop results					
No	a) Research centre b) Location c) Researcher	Period year	Crop	Soil nature	(a) Method (b) Drippers or Devices	(a) Distance from the plant (b) Density	Water duty	Interval (days)	Method	Water duty	Interval (days)	Parameters in Comparison	Trickle or Sip test	Irrigation test	Dry test	Observations	Bibliographical reference
(1)	(2)	(3)	(4)	(6)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
1	(a) Ist.Idraulica Agraria - PISA (b) PISA (c) Papakonstantinou	1965	Pears	Sandy Loam	(a) Trickle (1) Sand tips (2) Hypodermocljsis (3) Capillaries	Variable	Upon Blaney formula	1		–	–	Equipment Control Vegetation effects				Favorable vegetation results	30
2	(a) See No 1 (b) PISA (c) Grossi-Ficini	1969	Tomatoes in green-house	Loam	(a) Trickle (b) 2 kinds (1) Inward pipe capillary (2) Capillary at tail tip	(a) 0.12 m	3 - 5 mm/dry	1	Furrow	3-5 mm/dry	4	Fruit yield	+ 30%			Major fruit size Frequent capillary cloggings	23
3	(a) See No 1 (b) LACONA-ELBA ISL. (c) Ficini-Grossi	From 1970 onward	Pears	Clay loam /Rich in coarse)	(a) Trickle (b) Inward pipe Capillaries	(a) 0.25 m	12 l/plant	1	Small basin flood	12 l/plant	5					Major vegetation strength Frequent capillary cloggings	16
4	(a) See No 1 (b) See No 3 (c) See No 3	From 1971 onward	Peaches	See No 3	(a) Sip (b) Button with jet-breaker	(a) 0.25 m	8-11 l/plant	1	See No 3	8-11 l/plant	4	Stalk diameter	+	–		Satisfactory dripper and automatism working	16
5.	(a) Ist.Idraulica Agr. Ist.Floric.Sanremo (b) Pescia (c) De Ranieri-Grossi	1969-70	Carnations	Loamy sandy	(a) Trickle (b) Button and inward pipe capillary		5-7 mm/day	1	Sprinkling		4-7 upon season	Flowers for plant Stalk length	8.5 +	7.1 –		Frequent capillary cloggings	31
5 bis		1970-71 onward			(a) Sip (b) Button with jet-breaker		5-7 mm/day	1	Sprinkling		4-7 upon season	idem 5 idem 5	11.38 +	11.27 –		Satisfactory working	31
6	(a) See No 1 (b) See No 1 (c) Grossi-Ficini	1970	Tomatoes in green-house	Loamy sandy	(a) Trickle (b) Button and inward pipe capillarly	(a) 0.25 m	3 mm/day	1	Furrow	30 % more	4	Fruit yield Fruit size	1030 ql/ha +	950 ql/ha –		Frequent capillary cloggings	24
6 bis		1971			(a) Sip (b) Button with jet-breaker	(a) 0.125 m	2-3 mm/day	1	Furrow	2-3 mm/day	4	See No 6 See No 6	688 ql/ha +	416 ql/ha –		General working satisfactory Few button cloggings	24
7	(a) See No 1 (b) See No 1 (c) Grossi	1972 onward	Pine trees	Sand	(a) Sip (b) See No 6 bis	(a(0.25 m	1.5 mm/day	1	Small basin flood	1.5 mm/day	10	Stalk diameter	++	+	–	General working satisfactory	18
8	(a) Ist.Idraulica Agraria e Ist. Orticoltura-PISA (b) Ist. Orticoltura S.Piero a Grado (c) Grossi, Tesi, Bonuccelli	1974 e 1975	Tomatoes in green-house Marmande 129-150 P Marrow Cucumber Pepper	Clay loam	(a) Sip (b) jet-breaker type S_1		3-4 mm/day	1				yield yield yield yield yield	870 ql/ha 1185 ql/ha 680 ql/ha 1540 ql/ha 440 ql/ha			Satisfactory working equipment	26
9	(a) Ist.Idraulica Agraria -PISA (b) Centro Sperim.Agraria Tombolo-PISA (c) Grossi-Ficini	1973 1974	Vineyards Vineyards	Sandy Sandy	(a) Sip (b) jet-breaker type S_1 (a) Sip (b) jet-breaker type S_1	(b)=(0.75) (b)=(0.75)	1.5 mm/day 1.5 mm/day	1 1	Small basin flood Small basin flood	1.5 mm/day 1.5 mm/day	15 15	yield grapes yield grapes	3.29 Kg/plant 5.30 Kg/plant		2.72 Kg/plant 4.89 Kg/plant	Satisfactory working equipment	25
10	(a) Ist.Idraulica Agraria-PISA (b) S.Piero a Grado-PISA (c) Ficini-Bertoiacci	1977-79	Bean	Sandy	(a) Sip (b) jet-breaker type S_1 Trickle Labirint		3 mm/day 3 mm/day	1 1	Furrow Furrow	3 mm/day 3 mm/day	6 6	yield yield	25.6 ql/ha 25.6 ql/ha	25.0 ql/ha furrow 25.0 ql/ha furrow	6.3 ql/ha 6.3 ql/ha	Satisfactory working equipment Satisfactory working equipment few emitter cloggings	15

Table 3. Field application of trickle and sip method – Agricultural Hydraulics – Institute – PISA

N°	LOCATIONE	year of instal.	irrigated crop	Method	Emitters Distance	Emitter type	Automatism	Observations
1	Ist.Ortofloricoltura Univ.Pisa	1976	Tomatoes S.Marmande in green-house	Trickle	0.50 m	Capillary	Manual regulation	Results satisfactory with regard to working eqipment and yield during four months after clogging with algae because the pipes are white
2	Ente Autonomo Flumendosa Campo Villasor (Cagliari)	1973	Citrus Orchard	Sip	2.00 m	Jet breaker S_1	one way	
3.	Ente di Sviluppo Della Piana Di Cela Campo Olivo (Caltanisetta)	1973	Vegetables	Sip	0.50 m	,,	,, ,,	
4.	Ente di Sviluppo Dell'Irrigazione in Puglia e Lucania-Bari Campo Fortore (FOGGIA)	1973	Vegetables	Sip	0.75 m	,,	,, ,,	
	Campo Tara (Taranto)	1973	Citrus Orchard	Sip	2.00 m	,,	,, ,,	Results in course of elaboration
	Campo Tara (Taranto)	1973	Vegetables	Sip	0.75 m	,,	,, ,,	
5.	Consorzio di Bonifica del Bacino Inferiore del Volturno Campo Volturno (CASERTA)	1973	Vegetables	Sip	0.75 m	,,	,, ,,	
6.	Somivac Corsica	1974	Peaches	Sip	1.00 m	,,	,, ,,	
7.	Ente Nazionale Cellulosa e Carta Campo di Bagno Roselle (GR)	1975	Popler wood	Sip	1.00 m	,,	four ways	Results satisfactory with regard to working equipment and yield
8.	Consorzio di Bonifica „Cellina Meduna"(PORDENONE) Azienda F.lli FABRIS FONTANA FREDDA	1975	vineyards	Sip	4-1-4 m	,,	four ways	Results satisfactory with regard to working equipment and yield
9.	C.T.G.R.E.F. Aix En Provence (FRANCIA)	1976	woded strips fire breaker					Supply tank with Automatism
10.	Laboratorio per lo Studio dei Problemi Agronomici Nell' Irrigazione del Mezzogiorno (Napoli)	1976	Vegetables	Sip	1.00 m	,,	one way	Experimental equipment
11.	Cooperative Miscurin Danszentmiklos (Ungheria)	1976	Apple Orchard	Sip	3.00 m	Capillary and jet breaker	four ways	Results satisfactory with regard to working equipment and yield
12.	Instituto Ortofloricoltura Univ. di Pisa – Campo S.PIERO A GRADO	1977	Vegetable in green-house	Sip	0.80 m	,,	,, ,,	Results satisfactory with regard to working equipment and yield
13.	Azienda Camelli Pietro Ponte a Greve (FI)	1977	Vegetables and Vegetables in green-house	Sip	0.70 m	,,	four ways	Results satisfactory with regard to working equimpent and yield
14.	Azienda Pacini Camillo Rigoli (PISA)	1979	Actinidia Chinensis	Sip	3,5x1x3.5m	,,	,, ,,	Results satisfactory with regard to working equipment and yield

is reduced, in the lower cost of pumping, filtration, and in the minimum surveillance required by the low frequency of the clogging of emitters.

The sip systems studied in PISA are all together automatic, and permit any regulation due to its usage in parallel which makes each irrigation section independent. The water emitted in short doses runs lightly on the surface releasing a predominantly horizontal distribution which increases the wet surface and betters the soil moisture diffusion /Ficini 1977/.It is evident that the use of this type of plant, as for the emitter type, is usable in normal conditions only in orchards for which the equipment cost is reduced or for flower and vegetable crops at high incomes for which the initial high investment cost is justified. The extensive crops are completely excluded from this field by the need of trickling lines which are so dense so as to be prohibitive. Even if it seemed to be possible to obtain good results with a large space between trickling lines /around 10 m/ /Cooperative Agricole 1974/ which would have opened new horizons for sip and trickle irrigation, recent research on corn at the Agricultural Hydraulics Institute of the University of Pisa, has reduced the hope of using these methods in opened fields /Grossi et al./.

All together we are convinced that the sip methods will have a good future and that the equipment of Pisa, for its low cost and technological and funcional reliability, already proven by ten years of active specific experimentation /Ficini and Grossi 1972/, can contribute to their positiveness.

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