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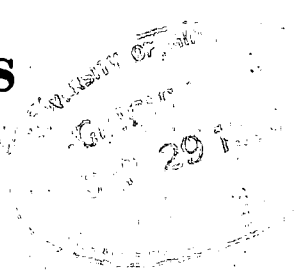
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## ECONOMIC AND SOCIAL PROBLEMS OF WATER SUPPLY AND CONTROL IN PORTUGAL

THE increasing of production, the raising of purchasing power, the creation of a greater demand for manpower and the improvement of the balance of payments are now the main targets of Portuguese economic policy. Portugal wishes to meet the growing needs for consumer goods resulting from constant demographic development, to improve the people's standard of living (about 40 per cent. of the population is rural) and to cut down imports where possible. A substantial increase in food production can be obtained only by intensifying agriculture, because the possibilities of utilization of new lands are already exhausted. Thus, it is mainly through transformation of dry-farming zones into irrigated ones that these aims can be achieved, and it is possible in the worst cases to increase production fourfold. This is the reason why hydraulic works have occupied a salient position in the Portuguese state planning of agricultural improvements. The large sums invested—over one billion escudos (35 million dollars)—are proof of the interest taken by the government in agricultural hydraulics. (100 escudos = £1. 5s. or \$3.50.)

The most difficult problem in Portugal consists of finding the quantities of water necessary for transforming dry-farming areas into irrigated ones. Rainfalls are irregular, with the consequence that the flow of surface streams is unpredictable, and subterranean waters scarce. In fact, a dry year gives only one-sixth of the rainfall of a wet year. Also, the number of rainy days per year can vary by 400 per cent. The driest months in Portugal are July and August. Rain falls chiefly between November and April. In the southern areas, where the rainfall is most scarce and irregular, there is often no rain for four or five consecutive months.

Owing to the rainfall distribution within the year, the surface streams or watercourses are alternatively completely dry for long periods and overflowing for very short periods. The annual stream-flow varies greatly—from one to ten in the rivers of the northern provinces, where rainfalls are more regular, and from one to forty in the southern rivers, which are also of more irregular course. Nearly

all the small rivers dry up during the summer; and, subterranean waters being very scarce, it is indispensable to retain the winter waters for summer irrigation.

In order to make the greatest possible use of the hydraulic resources of watercourses, it is therefore necessary to build reservoirs of great capacity, thus making possible the regular distribution of large volumes of water despite annual and seasonal variations in precipitation. It is no wonder that the construction of dams as large as technical and economic possibilities allow, should have become the rule.

The important rural hydraulic works in Portugal date mainly from 1938, thanks to the 'Plan of Hydro-Agricultural Development', which foresaw the exploitation of 106,000 hectares, corresponding to twenty conservation works distributed throughout the country. Some of these were meant not only to transform dry-farming areas into irrigated ones, but also to protect the land against floods and to improve its drainage.

Works benefiting about 14,231 hectares were completed by 1949 at a mean annual pace of 1,300 hectares. From 1949 to 1958 this pace grew to about 4,500 hectares per year. But this is not yet considered satisfactory, and it is necessary to quicken the pace still further.

These great works, indispensable for obtaining a substantial and planned increase of food production and the solving of economic and social problems, are managed by the state. But other works of lesser importance have been built and made effective by private initiative, often with the government's financial help. In the southern provinces of the country, for instance, thirty-two small independent projects have already been completed for the irrigation of 1,719 hectares. These works were financed under a special law, the 'Bill of Agricultural Improvements'.

The more important works or high dams have normally small hydro-electric stations, called 'dam-supports', whose turbines propelled by the irrigation waters produce electrical energy to be used in special pumping-stations needed for irrigation. The unused energy is sold to regional consumers. The principal characteristics of the great hydro-agricultural works already completed or nearly completed, and the respective costs up to 1955, are given in Table 1 on p. 394.

It can be seen from this table that 45,017 hectares have already benefited by great hydraulic works. This corresponds approximately

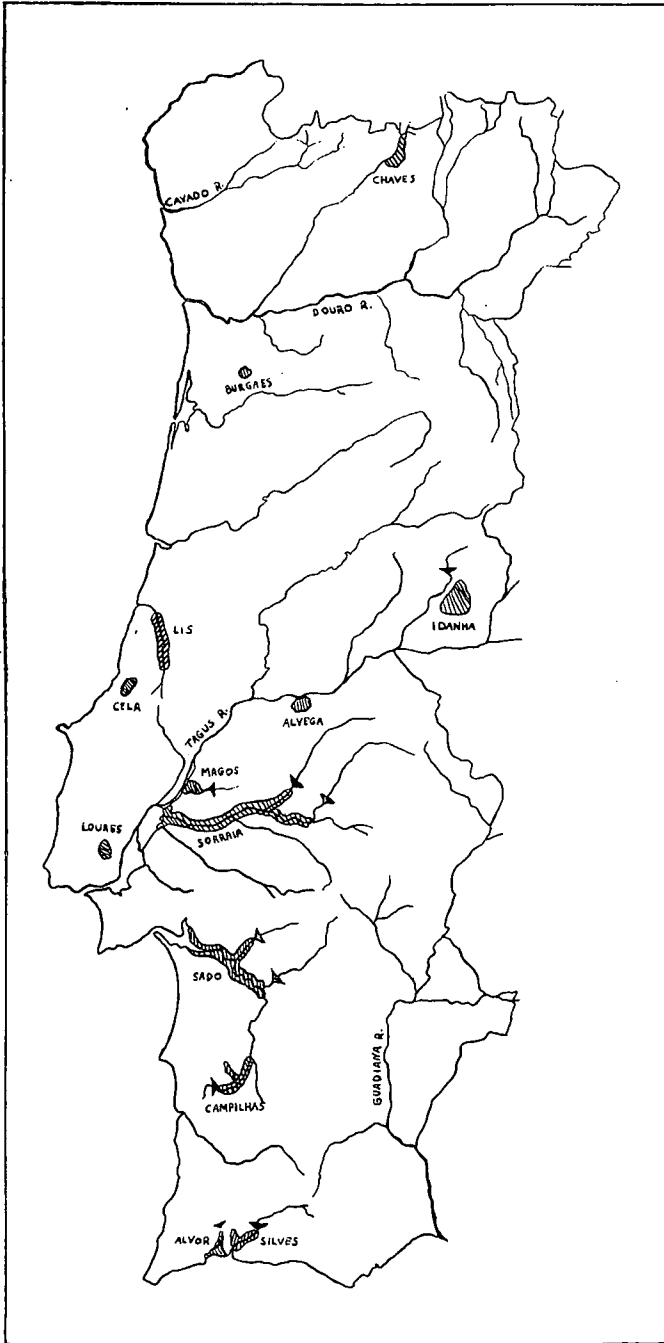


FIG. 1. Hydro-agricultural works in Portugal.

TABLE I. *Hydro-agricultural works in Portugal*

<i>Works and their purposes</i>		<i>Beneficiary zone hectares</i>	<i>Origin of the water</i>	<i>Storage capacity 10<sup>6</sup> m<sup>3</sup></i>	<i>Annual electrical energy capacity GWh</i>	<i>Development of irrigation network km.</i>	<i>Development of drainage network km.</i>	<i>Pumping stations</i>		<i>Costs per hectare (1,000 esc.)</i>
								<i>Height m.</i>	<i>Potential kW.</i>	
<i>Names</i>	<i>Objects</i>									
Paul de Magos	Irrigation Drainage Flood control	534	Reservoir	2.8	..	10.6	33.1	5.8	98	32.7
Paul de Cela	Irrigation Drainage Flood control	454	Diversion dam	..	..	6.7	25.2	2.5	33	20.9
Loures	Drainage Flood control	737	..	..	..	..	32.6	..	..	10.3
Burgães	Irrigation	168	Reservoir	0.4	..	12.3	..	..	..	28.8
Sado Valley	Irrigation	9,613	Reservoir Reservoir	63.0 94.0	2.0 5.0	167.4	..	..	..	36.1
Alvega	Irrigation	422	Pumping	..	..	26.7	..	..	..	12.6
Idanha	Irrigation	8,090	Reservoir	78.0	4.0	289.0	..	21.0 17.0	840 180	17.6
Chaves	Irrigation Drainage Flood control	1,049	Diversion dam	..	..	73.3	3.2	..	..	33.6
Silves	Irrigation	1,900	Reservoir	28.0	1.7	123.6	..	32.2	600	61.6
Campilhas	Irrigation	1,935	Reservoir	21.0	0.6	66.6	..	13.0 17.0	76 82	46.0
Sorraia Valley	Irrigation	16,155	Reservoir Reservoir	205.0 164.0	11.0 5.0	500.0	..	14.0	116	18.2
								27.0	190	
								9.0	70	
								18.0	160	
								11.5	120	
Lis Valley	Irrigation Drainage Flood control	2,140	Diversion dam	..	..	228.7	174.0	5.5 3.8	160 270	47.5
Alvor	Irrigation Drainage Flood control	1,820	Reservoir	35.0	1.0	111.0	61.2	4.2	70 70 70	28.4

to 42 per cent. of the area anticipated in the 1938 'Plan of Hydro-Agricultural Development'.

It is difficult nowadays to explain the criteria on which the decisions concerning the works projected in 1938 and the priorities adopted were based. Not only is it impossible to place ourselves in the 1938 atmosphere, but we must also realize that the plan was one of vast projection into the future, and was dependent upon circumstances, including the novelty of that kind of activity in Portugal. So we shall put off consideration of this problem until later, when we shall try to explain the reasons for choosing future projects. Let us now consider the cost of the works already completed.

The cost of the projects undertaken by the state varied, as may be seen from the table, from 10,300 to 61,600 escudos per hectare. The mean value on the 45,017 hectares affected corresponds to 27,160 escudos per hectare. It is also interesting to note that the highest costs—61,600 escudos, 47,500 escudos, and 46,000 escudos—arose on an area of only 6,000 hectares, i.e. 13 per cent. of the total area included in the works. The remaining works, serving 41,000 hectares, incurred an average cost of 22,300 escudos per hectare. In seeking an explanation for the high cost of certain works, one must admit the influence of economic difficulties during the post-war period. Also, in the case of the Lis Valley, it may be noted that large sums were spent in important drainage works, fluvial regulation and defence against floods, these sums being included in the global costs.

To give an idea of the cost of small projects undertaken on private initiative, we will consider forty-eight works built during the last eight years and authorized by the government. The total area related to these works is 1,830 hectares, with a minimum area of 15 hectares, an average of 38 hectares and a maximum of 220 hectares. The costs, according to the estimates for each project, reached an average value of 19,500 escudos per hectare. To analyse the limits of variation of costs it is necessary to distinguish three types: high dams combined with a water-distribution network; high dams only; and water-distribution networks alone. The cost of the first type varied from 10,500 to 39,500 escudos per hectare; the second type, from 5,300 to 33,000 escudos per hectare; the third type, from 1,000 to 12,700 escudos per hectare.

With regard to the stated cost of the small projects, it must be noted that the price of the land submerged was not included, that in twenty-three cases the figure did not even include the water-distribution

network, and that the cost of works for prevention against floods, drainage, hydro-electric pumping stations, roads leading to the high dams and re-establishment of interrupted communications was never included.<sup>1</sup> There is another reason for the high cost per hectare. Normally, owing to the small areas of the reservoirs, it is probable that they will not fill during dry years, so that it is often necessary to reduce the irrigated area. For these reasons no great significance can be attached to a comparison of the costs of these two different types of works. Each type has a different aim and a different way of realizing it. But both types of works are, of course, of great interest to our country and do not exclude each other. This has been proved by recent surveys made by the government concerning the irrigation plan of the great southern province of Alentejo. In fact, together with the great works already anticipated for irrigating 161,700 hectares, this scheme also included seventy-three small and medium works for an area of 11,235 hectares.

The mere indication of the cost of works, independently from the possible benefit resulting therefrom, has no significance. Let us then, knowing the cost of works already completed, try to estimate their consequences. One must, in the first place, insist upon the fact that, technically speaking, all the works fully correspond to their purposes. Of course, there may have been some or other inevitable deficiencies during the first years of utilization, but these have been rapidly corrected. The technical capacity of the services is established and we can make realistic plans for the completion of the works. Yet the pace attained is still found insufficient in relation to the present economic and social demands of the country. This view, which we consider of fundamental importance, calls for urgent revision so as to enable the rate of increase of irrigated areas to attain the ideal pace.

Let us consider firstly the increase in production, and secondly the social consequences. In a general way one may say that the works have led to a considerable increase in production, allowing in nearly every case the growing of two crops in the same year. It must be stressed that in places where irrigation was already practised the new works permitted a considerable improvement, even allowing for the fact that in some of them agriculture was already fairly intensive. Undoubtedly, even where farmers already used irrigation, the com-

<sup>1</sup> These expenses have been considered in the large projects undertaken by the government.



pletion of the works provided a much more reliable supply of the necessary volume of water.

But we must mention the existence of several areas where the increase in production still lags far behind the possibilities. In some cases, the fundamental cause seems to be lack of proper technical assistance to the farmers. The area of the Lis Valley works is a typical example. There the traditional crops—~~forage in the winter and corn in the summer~~—are still the main ones in the greater part of the newly improved zone. The expansion of wheat-culture in the winter, facilitated by the establishment of good drainage conditions, and the introduction of summer crops of ~~greater economic importance~~, have been very slow.

In other areas, the increase of production is due exclusively to the expansion of rice-culture. Not only does this bring technical disadvantages, but it greatly limits the possibility of attaining the social benefits which are one of our targets. Here, although there has been a considerable increase in the amount of salaries paid, the distribution of labour utilization throughout the year is still rather deficient. A very good example of this is found in the area of the Sado Valley works started in 1949. That area was exploited in its main parts through an extensive dry-farming system. The economic studies for the project planned an irrigated area with polyculture of cereals and forage crops, leaving for rice-culture only the areas which were most difficult to drain. Nine years after the completion of these works we are obliged to say that the planned results have not been achieved. Today practically the whole of the area is under rice-culture. This needs a great number of workers for short periods, but very few for the greater part of the year.

In other areas the full exploitation of all possibilities has been checked by the excessive length of time incurred between the completion of the works and the full adoption of irrigation. The Idanha works illustrated this very well. The agrarian structure of that region, where large-scale property ownership predominates, together with the physical difficulties of adopting irrigation owing to topography and nature of soil, have been responsible for a very slow evolution. Even today one can find considerable areas included in the new benefited zone as yet insufficiently improved, and it must be said that hardly one-half of the region has been fully developed for intensive irrigation. These difficulties result partly from lack of reform of the agrarian structure, but we must consider that the principal cause of

these various shortcomings is the lack of financial help which would enable the farmers to face the high expenses incurred in adapting the land to irrigation conditions. A proof of the increase in production which results from the conclusion of such works is given in the considerable increase in farm-rents in irrigated areas. These often reach five or six times their former value.

Let us now consider to what extent the farmers' standard of life has risen through the works, and whether or not a greater number of workers are employed. As our exposition must involve various problems, it will be easier to start with the works that have chiefly concerned areas of small-scale property ownership, such as Cela, Loures, Alvega, Chaves, Lis, Silves, and Burgães. Undeniably, the standard of life of small farmers in these areas has risen, but not yet sufficiently to bring them economic independence. The excessive smallness of rural properties is still the characteristic feature of the agrarian structure in these regions, because the works have not been followed by legal measures aimed at correcting the distribution pattern of land-ownership.

As an example, we present here some figures referring to the present agrarian structure of the area of the Lis Valley, which has benefited from irrigation facilities for two years. From Tables 2 and 3 it should be noted that 93.2 per cent. of the landowners possess areas below 2.5 hectares, corresponding to 58 per cent. of the irrigated area.

TABLE 2. *Distribution of land-areas per landowner in the Lis Valley zone*

Size of individual holdings (hectares)	Numbers of landowners		Corresponding areas (hectares)	
		Per cent.		Per cent.
Under 0.25 . . .	1,064	41.2	151.1	7.1
0.25-2.50 . . .	1,342	52.0	1,089.0	50.9
2.50-10.00 . . .	162	6.3	658.4	30.8
Over 10.00 . . .	14	0.5	240.8	11.2
Total . . . . .	2,582	100.00	2,139.3	100.00

TABLE 3. *Number of holdings per landowner in the Lis Valley zone*

	Single holdings		2 to 10 holdings		Over 10 holdings		Total
		Per cent.		Per cent.		Per cent.	
Number of land-owners . . .	1,062	41.2	1,361	52.7	159	6.1	2,582
Areas (hectares) . . .	314.2	14.7	1,225.9	57.3	599.2	28.0	2,139.3

More than half the proprietors, owning 85.3 per cent. of the area, have their land scattered in several holdings. In that region 28 per cent. of the land belongs to proprietors whose land is divided into more than ten holdings. No other comment is needed.

It is certain, however, that these works have brought great advantages in labour utilization, leading to a better use of paid labour.

We will now review the results obtained through hydraulic works in areas where large-scale property ownership prevails, such as Paul de Magos, Sado Valley, Campina da Idanha, Campilhas, and Sorraia. In these areas the agrarian structure is everywhere defective, as its evolution has been left to *laisser-faire*. It was desirable that property should be divided, as this was necessary for obtaining good economic and social results from the works. But this was not done. A few private transactions took place in the Idanha zone, but they were of limited social interest and mainly concerned medium and large landlords. An immediate consequence of the works was the appreciable increase in the proportion of land under lease and a considerable increase in rents. These things, of course, did not help the agrarian population to acquire land. If it is certain that the standard of life of the rural worker has risen, thanks to the greater possibilities of employment, it is also true that in the areas where rice-culture predominates, such as Magos, Sado, and Campilhas, the irregular distribution of work throughout the year has not allowed rural workers to find a permanent livelihood. During the short periods of sowing, planting, and reaping of rice, when demand for labour is greater, it becomes necessary to employ workers from other districts, and this intensifies a migratory movement with all the social inconveniences resulting therefrom.

In the case of the Idanha works, where distribution of labour throughout the year has improved, the social advantages are still modest owing to the slow pace of transformation of dry soil into irrigated land.

In the Sorraia Valley, where the works are not fully completed, it is premature to give an impression, especially as the zone to be irrigated is extremely long (about 200 kilometres) and includes regions of the most varied characteristics. However, we can already foresee that unless the nature of the governmental intervention is modified, the results will not be different from those achieved in the other areas.

Summing up, it can be said that, socially speaking, the results do not entirely correspond to our hopes. In fact, the settlement of small and medium farmers by means of spontaneous evolution was not

made possible; and, on the other hand, one cannot expect people to remain in areas where employment is uncertain for long periods of the year. This lesson, taught by experience, forces us to conclude that, in order to obtain the best use of hydraulic resources, it is necessary to complement technical action by state intervention aimed at attaining all the advantages which were mentioned as grounds for undertaking the works.

Another important aspect to be considered is the reimbursement of money spent upon the works by the state. Actually this has been done only in Magos and Alvega, although in other places works have already been completed for over ten years. The government has acknowledged that this situation presents serious inconveniences, as the burden thus borne by the state can lead to the conclusion that the hydraulic works have no financial justification. Also it is not fair to the farmers who have not benefited, and who comprise the great majority, that the state should spend such sums only for a small minority. Finally, if the farmers get used to having their water free, it will be difficult to make them accept the obligation of legal payment of taxes.

The landowner will certainly have to contribute to the maintenance of the works, the renewal of equipment and the reimbursement of the state for capital invested and from which he has profited. However, this payment must be compatible with the farmer's economic possibilities, which have been greatly modified by the new conditions. It is therefore of the greatest importance to determine the amount of income before and after hydraulic works, the resulting increase in profit, and the new value of irrigated land.

According to present legislation, the cost of works must be entirely repaid to the state by the beneficiaries. The payment must be made within fifty years, by means of annuities calculated on a basis of 4 per cent., 3 per cent., and 2 per cent., according to the productivity of the land. The payment of these annuities, called 'Tax of Irrigation and Benefit', is not claimed if it is demonstrated that the land value has not been sufficiently increased. If this is the case the amount of the tax may be reduced or payment postponed. The farmer is also obliged to pay another tax, of variable amount, expected to cover conservation and exploitation expenses and called 'Exploitation and Conservation Tax'. As we have already said, there has been some difficulty in collecting the taxes, although in most cases the land has increased in value.

We acknowledge that the transformation of dry-farming zones into irrigated areas, involving considerable modifications of agricultural methods, is a difficult and lengthy task. The period of time needed to introduce intensive exploitation varies greatly, as it depends on the conditions already prevailing in the area. Considering these facts, the reimbursement of the state by the proprietors has been adjourned, with all the inconveniences already noted.

It has been recognized that these public works always bring important sums to the state, even if one totally excludes the reimbursement by the landowners of the invested capital. It is well known that the increase in agricultural income in regions improved by irrigation leads to the development of commercial, banking, and industrial activities, and of transport and other services, with the result that more taxes are forthcoming from transport, banking, commercial, and industrial operations, &c. This is why it does not seem fair to demand from the proprietors the total payment of the cost of the works, once it can be said that they are a source of further income to the state. Taking this into consideration, and to prevent inconvenience resulting from delays in payment of taxes, the government is studying a new law concerning the hydro-agricultural works.

The general principles adopted by the state so as to bring forward the execution of hydro-agricultural works in Portugal may be summarized as follows. The state takes charge of the study and planning of the primary and complementary works designed for irrigation, drainage or other hydro-agricultural improvements, as well as the construction of all necessary works. The works, at first run directly by the state, are later allotted to specialized contractors under state control. Once completed, they do not remain for ever under state ownership but only during an experimental period, so as to avoid possible deficiencies. After a suitable time they are handed over to the beneficiaries, who take charge of the exploitation and maintenance of the works through local 'Associations for Irrigation of Land'.

Having reviewed the major aspects of the hydro-agricultural works in Portugal, let us now proceed to a few considerations of future projects. Although the current surveys have not yet given sufficient data for precise calculations, we may admit, to begin with, that there still exists an area of about 320,000 hectares to be irrigated in Portugal. The problem is to establish priorities for future works. The basic elements for determining priorities are: increase of production, higher standards of life for the agricultural population, increase in employment

and improvement in the balance of payments. In relation to the first of these aspects, it must be admitted that the increase in production will be greatest in areas that were formerly either uncultivated or extensively exploited. So it seems that the less hilly areas of dry-farming in the Alentejo (a vast province to the south of the Tagus river), where the value of agricultural production per hectare is the lowest, will fulfil the conditions for priority.

The possibilities of raising the standard of life of rural populations differ from north to south. In the north, where living conditions are deficient owing to over-population, the problem will not be solved inside the agricultural sector alone. It will be necessary to resort to industrialization, or to organize emigration to less populated areas of greater resources. On the other hand, in the south, where population is scarce and possibilities of industrialization are still remote, it is to be hoped that irrigation will lead to economic and social results of considerable importance.

The employment problem is more critical in the south, in spite of scarcity of population. Cereal crops predominate in that region, which is an extensive dry-farming area and demands great quantities of labour for short periods, dispensing with it almost entirely for the greater part of the year. The agrarian structure is defective, and estates are mainly very large. The disproportion between employers and wage-earners is great; labour is more or less guaranteed to wage-earners during the period between sowing-time and reaping-time; unemployment occurs from June to September. As it is precisely during that period that the irrigated crops need more manpower, their cultivation can contribute to a better distribution of labour throughout the year.

In relation to the improvement of the balance of payments, the most important works are those that allow the country to produce foods which we now have to import on a large scale, such as wheat and meat, or which we can most easily export, such as fruits. Alentejo is also the region that offers the most favourable conditions for such developments.

Besides these main features, it is also interesting to consider the costs of production and the possibilities offered for demographic progress and reform of the agrarian structure. Here again it is in Alentejo that the works may give results of the greatest significance. In fact, the value of land in that region is comparatively low, possibilities of increasing population are considerable, and the agrarian

structure urgently needs reform. It happens that Alentejo is also the province where basic studies of an agricultural and economic nature are most advanced. Therefore, the preparation of projects concerning this province is easier and more rapid.

Now that we have justified the priority to be given to the Alentejo for public irrigation works, we will mention the reasons for preferring big works to smaller ones. As a rule, small works benefit only a small number of proprietors, often only one. Therefore, these works always have a very reduced social scope compared with big works. Small works involve responsibilities that may be entrusted to one specialized technician, so they can be realized by private initiative, eventually with the state's financial aid. Large projects, on the contrary, bring great complexity from the technical as well as from the administrative point of view, and they demand important investments which, of course, are out of the reach of private enterprise. Also, they always concern a great number of landowners, and this involves state intervention. All these reasons justify the state's undertaking great hydro-agricultural works, leaving the small projects to private initiative. In Portugal these two types of works are complementary from various aspects. Their conjunction forms the water supply and control policy from which so much is expected for the betterment of the social conditions of our important agricultural population.

We have surveyed the hydro-agricultural works, and stated that their aim is the agricultural progress of the country through adaptation of land to irrigation, defence against floods, and draining when necessary. Electrical energy is produced only in the more important of these works, mainly for supplying the pumping-stations used for irrigation, the small quantities of remaining energy being sold to regional distributors.

However, there is in Portugal another aspect of the utilization of hydraulic resources. We have in mind hydro-electric works which are of great importance for the economic development of the country. In fact, as Portugal has neither petrol nor coal, hydro-electricity is its only natural source of energy. Unhappily, these resources are meagre (10,000 GWh per annum) and we foresee their complete utilization in the next twenty years.

Owing to local topographical conditions, it has not been possible to accumulate water from the two most important Portuguese rivers, the Douro and the Tagus, but in their tributaries high dams have been built for hydro-electric purposes. There, and on the hydrographic

basin of the river Cavado, situated in the north-west of the country, have been centred the Portuguese hydro-electric works. The government has recently ordered the study of a general plan for utilization of the basin of the Guadiana, an important river in the south. The implementation of the great hydro-electric works planned about twenty years ago was greatly delayed by the Second World War. But after 1944 the works were developed rapidly and in 1951 those which are the basis of the country's hydro-electric production began their service. The amount of energy now obtainable in the course of a normal year approaches 2,465 GWh. This represents approximately 25 per cent. of the total anticipated amount. The large hydro-electric works have been entrusted to special societies which associate the state with private capital and which act as concessionaires of public utility.



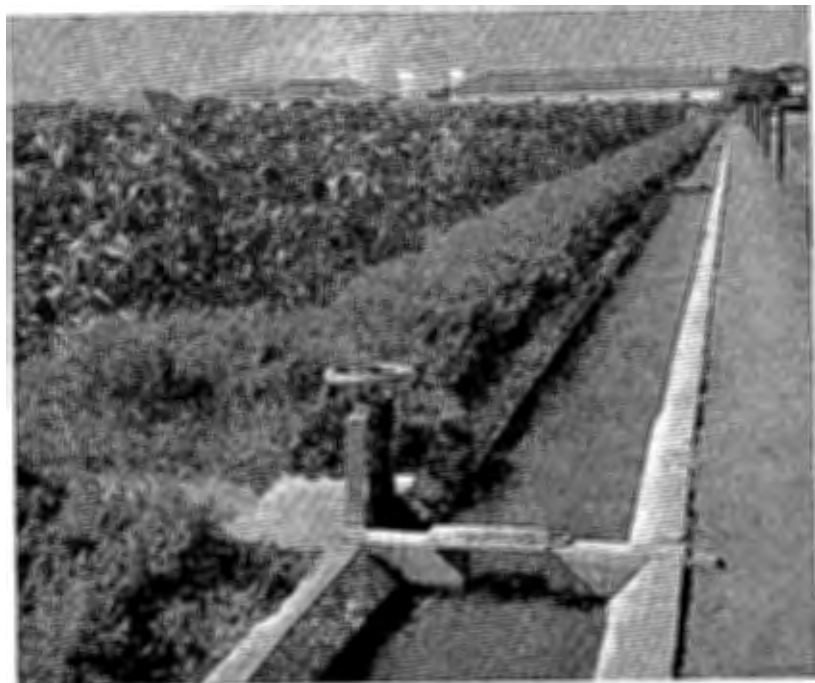


FIG. 2. Campilhas Agricultural Irrigation Experimental Station—A view of part of the irrigation network.

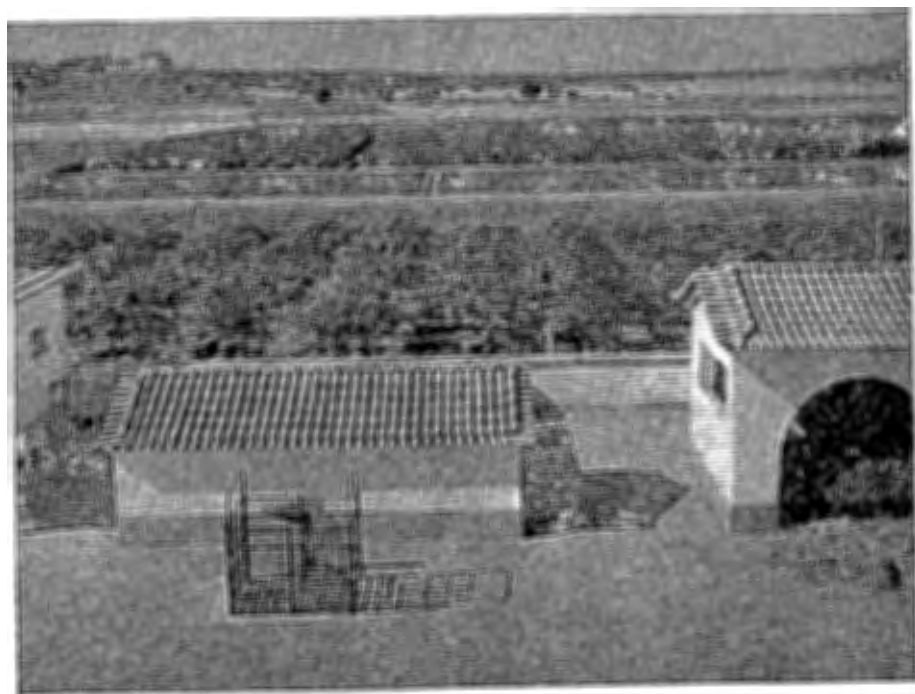


FIG. 3. Campilhas Agricultural Irrigation Experimental Station—A general view showing orchards, forage crops, and corn-growing experiments.