# THE DEMAND FOR IRRIGATION WATER IN AN INTENSIVE IRRIGATION AREA

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**Linear programming procedures offer a useful means of estimating irrigation water demand functions at the farm level. If such estimates are to be aggregated to form regional demand schedules, care must be taken in the selection of representative farms if aggregation error is to be minimized. Both seasonal and intra-seasonal demand schedules are presented since both are important when irrigation demand estimates are being developed.**

## *Introduction*

The recent literature on water resource analysis, as represented by Bain *et al.* [1], Maass *et al.* [11] and Smith and Castle [16], has resulted in a considerable refinement of project appraisal over and above that resulting from cost-benefit analysis. These workers can, however, be criticized for their assumption that the demand for water in agriculture is perfectly elastic. Such a premise appears to be based on a supposedly fixed water requirement for crops, a concept employed by many and fostered by the work of Blaney and Criddle [2].

Such an assumption, however, is not supported by current thinking among biologists, and may unnecessarily restrict economic analysis. A reduction in the quantity of water applied, below the physically optimal level, will result not in crop failure, but rather in a reduction of final yield. That is, crop water response functions do exist and hence meaningful demand schedules for water can be derived based on these functions.

This means that irrigation water should and can be regarded in the same way as any other input to the agricultural production process. The recent work of Yaron [19], based on annual irrigation demand schedules, has emphasized this point. What is more, both Flinn and Musgrave [7] and Young and Martin [20] have argued conclusively that the time of application of irrigation water to a crop is an important determinant of its productivity. In consequence, not only the seasonal, but also the intra-seasonal demand schedules for irrigation water are important in the economic analysis of water as an input in agriculture.

The aims of this paper are thus:

(a) to justify the current use of linear programming procedures, rather than other techniques, for estimating farm and eventually regional demand schedules for irrigation water;

(b) to point out the necessity to select representative farm models in such a way as to minimize bias in the regional estimate; and

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(c) to derive, and discuss, the relationships between the seasonal and intra-seasonal demand schedules for irrigation water.

### *Derivation of Farm and Regional Demand Schedules*

Factor demand estimates at the farm level are commonly derived by one of two methods—regression analysis of time series data, or 'synthetic' demand estimates using linear programming.[1]

Regression analysis is most suited to determining demand relationships at a relatively high level of aggregation and requires adequate time series or cross-sectional data for all the relevant variables. Statistical problems aside,[2] regression analysis of historical data to predict future response is not without its difficulties. For example, those who are responsible for formulating agricultural policy or appraising alternative farm programs are often faced with the task of predicting the outcome of specific program proposals. If the new program provides a new set of institutional restraints for which there is no historical counterpart to use in estimating response, then regression models are likely to be inadequate as a predictive device.

Because of the limitations of regression models, the use of a synthetic approach, such as linear programming, is attractive. Such models represent, in effect, an attempt to simulate the actual decision process of the relevant managerial units. This approach is normative insofar as objective functions are explicitly stated.

In deriving demand estimates by linear programming procedures a series of related problems are solved in which the price of the factor of interest is varied from a minimum to a maximum level. As the price of the factor varies, different levels of input use become optimal and, in consequence, a series of price-quantity relationships is developed. The synthetic demand function derived by this procedure is of a stepped nature because of the linear nature of the production data, and the finite number of production alternatives and resource restrictions considered.[3] Thus demand 'curves' derived by using linear programming differ from the smooth curves of conventional theory.[4]

In most empirical situations it would be intolerably expensive and time-consuming to estimate the demand schedules for each firm in a region and then to derive the regional demand function by summing the individual firm functions. Therefore, some decision must be made about the number of producing units to be programmed. The usual simplifying procedure is to evaluate the optimal program for a small number of representative farms, each supposed to be characteristic of a larger group of farms in the region. Each representative farm demand curve is weighted by the number of farms in its stratum, and the weighted demand curves are then summed to derive the regional estimate.

[1] For examples of irrigation water demand schedules derived using regression models see Dawson [4] and Ruttan [13], and using linear programming models, Hedges and Moore [9] and Yaron [19].

[2] In this regard, see Duloy [5, pp. 21-44].

[3] For a discussion of the nature of stepped functions derived by linear programming procedures see Kottke [10].

[4] Such differences are, of course, minor when compared to the more fundamental differences in the partial equilibrium properties of linear programming versus conventionally derived demand curves.

### *Specifying the Representative Irrigation Farm Models*

In developing regional demand estimates using the above procedure, three sources of error may bias the demand schedule estimated for the region of interest. Stovall [17, p. 473] has specified these as:

(i) specification error;
(ii) sampling error; and
(iii) aggregation error.

Specification error arises because the programming model fails to accurately describe the conditions faced, the derived objectives, and the resulting decisions being made by the farm firm.

Sampling error arises when ". . . the distribution of the representative farm model's parameters over all firms in the population are not known, but are estimated using sampling techniques." [17, p. 474]. Sampling error thus arises when sample data are obtained, and when the population totals are estimated from the sample results. The problems of reducing and measuring sampling error are tackled by statistical procedures and sampling theory is sufficiently developed so that sampling rates can be set so as to hold sampling error to a desired level.

While specification error may be reduced by careful attention to the formulation of the representative farm model, and sampling error by statistical procedures, formal procedures for measuring, and minimizing aggregation error have not been developed. Aggregation error has been defined by Frick and Andrews [18, p. 696] as ". . . the difference between the area supply (demand) function as developed from the summation of linear programming solutions for each individual farm in the area and the summation from a small number of typical or benchmark farms."

Sheehy and McAlexander [15] and Miller [12] have reviewed the current situation with respect to attempts to combat aggregation error and have shown that the necessary conditions for selecting representative farms to minimize aggregation error within a given budget are still undefined in a general sense. Miller has demonstrated that, in the light of present knowledge, two criteria are useful to control aggregation error in an empirical situation. Miller [12, p. 145-6] recommends that:

(1) farms be grouped on the basis of what is the most limiting resource in the production process; and
(2) that farms with similar patterns of product response to price change be grouped together.

### *The Study Area and Model*

Resources, activities, and contraints pertinent to the study area, the Yanco Irrigation Area (YIA) were collected in a survey of 49 farms during 1964. Linear programming models were then developed to represent the major farm types in the study area. Parametric solutions were obtained for those resources limiting in the initial optimal plan for each model, as the scarce resources influenced the marginal value product and hence the demand for irrigation water.

The two resource constraints found to have a major impact on the demand for irrigation water (apart from the quantity of water delivered and its price) were the irrigable area and rice right of the farm. The cropping activities which had a major influence on the quantity of water demanded were the existence of high water use crops, specifically rice and sorghum, and to a lesser extent, irrigated wheat, in the optimal farm plan.

The maximum area of rice grown is at present controlled by an acreage allotment of 80, 60 or zero acres, based on water use for rice.[5] The areas of wheat and sorghum grown depend to a very large extent on the irrigable area of the farm and the rotational requirements of the rice crop. On this basis, it was found useful to stratify farms by irrigable area and rice acreage allotment.

All large area farms in the irrigation area were then stratified in relation to these two criteria. The basis of stratification and the number of farms falling into each stratum is illustrated in Figure 1. Linear programming models of each representative farm were then developed to reflect, as realistically as possible, the actual conditions faced by each of the five farm groups.

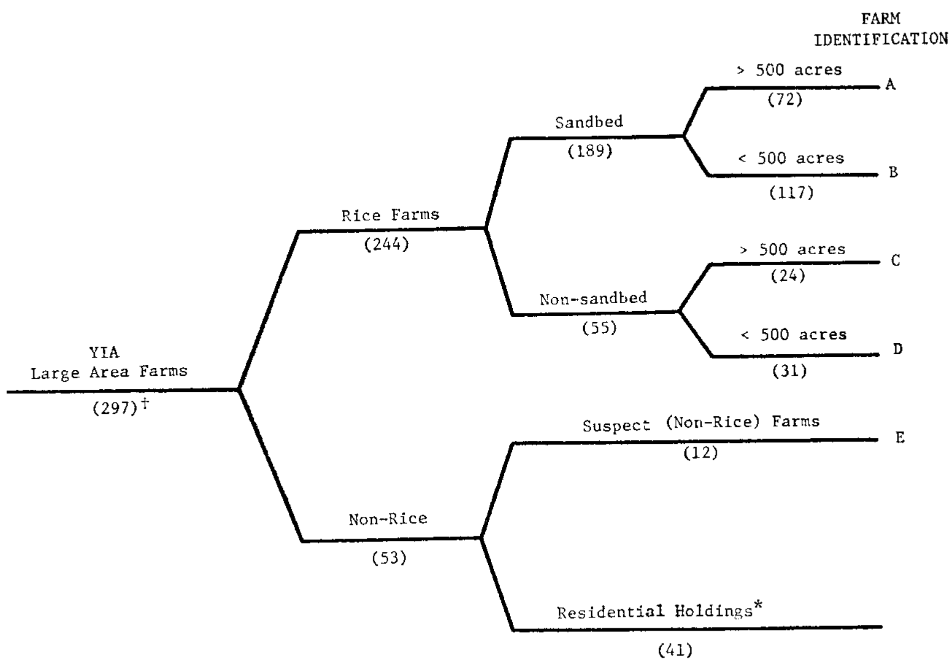



FIG. 1—Schematic representation of the basis for stratifying large area farms in the YIA into representative farm groups.

† The numbers in brackets are the number of YIA farms falling into each group.

* These holdings, although classified by the WCIC as large area farms, are better regarded as residential farms as they are not economically viable in themselves, or are specialty farms (e.g. pig or dairy farms).

The feasible cropping activities considered were rice (other than on the non-rice farms), wheat, barley, sorghum, oats, sudax, summer and winter pasture. In the case of each crop, allowance was made for a

[5] A sandbed underlies portion of the YIA. This causes higher deep percolation water losses on rice crops than those crops grown on the non-sandbed area.

range of rotation strategies and irrigation treatments. In particular, crop response to various levels of irrigation inputs at different stages of crop growth were explicitly incorporated within each linear programming model.[6] The forage activities were utilized by livestock activities, namely, fat lambs, spring or autumn drop; merino ewe flocks for wool or cross bred ewe production; wethers; and cattle (vealer and store fattening). Although a complete list of all crop and livestock activities pursued in the YIA (excluding horticultural production) would include more items, the ones considered account for over 96 per cent of the total gross value of production of large area farms in the study area [18].

## *The Farm Irrigation Water Demand Schedule*

### *The Seasonal Demand Schedule*

Using the variable price procedure of linear programming, demand schedules for irrigation water were generated for each of the five representative farm models considered. Figure 2 shows the stepped demand functions for three of the five farm models analysed,[7] and Table 1, the linear functions fitted to the five farm demand schedules.

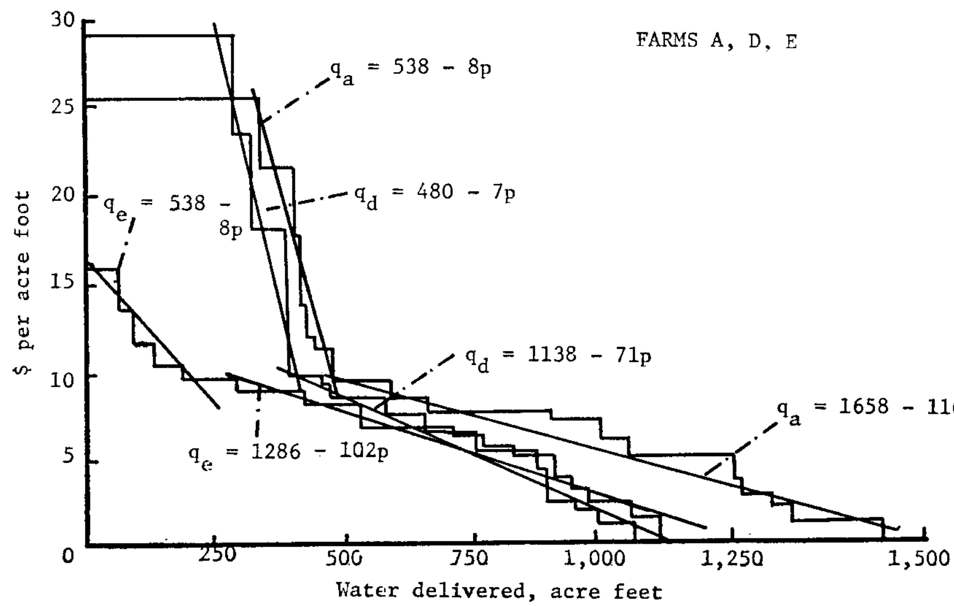



FIG. 2—The derived seasonal demand schedules for irrigation water for representative farm A, D and E.

Two points emerged from an examination of Figure 2. First, the demand for water at water prices below $10 per acre foot is far more

[6] The crop irrigation water response relationships were derived using simulation procedures. The basis of the plant-soil-atmosphere model has been outlined elsewhere [6].

[7] All five demand schedules are not shown because interpretation of individual schedules in the figure would be too confusing.

sensitive to price change than is the demand for water above this price. Second, at water prices below \$10 per acre foot the change in the quantity of water demanded per dollar increment in price tends to be more sensitive to the rice acreage restraint than to the irrigable area of the farm. These two features of the seasonal irrigation demand schedules can be appreciated by examining the relative magnitudes of the $\beta_1$ (i.e. slope) coefficients in Table 1.

TABLE 1

*Linear Functions Fitted to the Stepped Demand Schedules for the Five Representative Farms over the Two Price Ranges*[(a)]

| Farm | Estimated coefficients[(b)] $\beta_o$ | $\beta_1$ | $R^2$ |
|---|---|---|---|
| *I Water price range \$0 to \$9·5 per acre foot* | | | |
| A | 1,657·6 | −116·1 | ·96 |
| B | 1,204·1 | − 83·6 | ·98 |
| C | 1,618·2 | −112·6 | ·98 |
| D | 1,138·1 | − 71·3 | ·97 |
| E | 1,286·4 | −102·4 | ·96 |
| *II Water price range \$10 to \$25 per acre foot* | | | |
| A | 538·0 | − 7·7 | ·95 |
| B | 441·9 | − 6·0 | ·92 |
| C | 589·1 | − 8·8 | ·91 |
| D | 480·5 | − 7·4 | ·94 |
| E | 561·8 | − 34·1 | ·78 |

(a) $q = \beta_0 + \beta_1 p$.

(b) All coefficients significant at the one per cent level.

*The Intra-Seasonal Demand Schedules*

In Table 2 the pattern of demand for irrigation water, over a range of water prices during the irrigation season, August to April, is shown for Farm A. It can be seen that, for any given water price, the pattern of water use over the irrigation season is not uniform, and that the quantity of water taken in April is small. The table indicates that there are two peaks in irrigation water demand—a small one in spring and a larger one in later summer to early autumn. Such peaks do occur in practice and are recognised by the irrigation authority.

It is important to note that water obtained in any month in spring is a good substitute for water in any other month in spring, but not for summer or autumn applied water. Similar relationships apply for water delivered in summer and autumn, these being a consequence of the fact that the value of water applied to a crop at any given time is largely dependent on the physiological stage of development of the crop. The stage of development of a crop is controlled by the interaction between the biological characteristics of the crop and weather parameters (e.g. temperature and day length) as opposed to the irrigation regime to which the crop is subjected. Thus, there is little possibility of substituting water inputs between the spring, summer and autumn demand periods on the same crop, even if different prices were to rule in each time period. Therefore, just as irrigation season demand schedules for irrigation water can be derived, it is also meaningful to consider the characteristics and

TABLE 2

*The Quantity of Water Demanded in Each Month of the Irrigation Season for a Range of Water Prices, Farm A*

| Water[(a)] Price | Quantity taken (acre feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Spring | | | Summer | | | Autumn | | | |
| | Aug. | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | Total |
| 0·0 | 120 | 121 | 199 | 93 | 129 | 120 | 297 | 284 | 184 | 1,547 |
| 1·2 | 120 | 125 | 199 | 93 | 124 | 115 | 280 | 312 | 0 | 1,368 |
| 2·7 | 120 | 64 | 212 | 93 | 122 | 113 | 255 | 290 | 0 | 1,269 |
| 3·6 | 120 | 64 | 212 | 78 | 122 | 113 | 255 | 290 | 0 | 1,254 |
| 5·0 | 120 | 31 | 145 | 78 | 119 | 110 | 201 | 239 | 0 | 1,043 |
| 6·9 | 88 | 37 | 112 | 78 | 119 | 110 | 163 | 178 | 3 | 893 |
| 7·5 | 47 | 25 | 73 | 78 | 119 | 110 | 110 | 95 | 4 | 661 |
| 8·1 | 36 | 26 | 66 | 78 | 108 | 99 | 85 | 79 | 5 | 582 |
| 10·0 | 36 | 25 | 43 | 78 | 74 | 65 | 62 | 79 | 3 | 465 |
| 12·0 | 31 | 18 | 43 | 78 | 74 | 65 | 62 | 54 | 0 | 425 |

[(a)] $ per acre foot

implications of intra-seasonal demand schedules for irrigation water.

Figure 3 demonstrates the intra-seasonal demand schedules for irrigation water derived for the five representative farms in the Yanco Irrigation Area. These schedules are estimated as the quantity of water demanded in the three periods in response to changes in water price. Thus, the spring, summer and autumn demand schedules, if horizontally aggregated, sum to the irrigation season demand schedule for that farm reported in Table 1.

Inspection of the stepped demand schedules (and the linear functions fitted to these schedules) indicates that demand for water in autumn is more affected by changes in water price than is spring demand, while demand for water in summer appears to be rather insensitive to water price change.

As different quantities of water are purchased at the same water price in the three demand periods, demand elasticities serve as a useful summary measure to relate the quantities of water purchased to changes in water price. The arc elasticities for the intra-seasonal demand schedules for the five farm models are tabulated in Table 3. The table

TABLE 3

*Arc Elasticities of Demand for Irrigation Water in Spring, Summer and Autumn for the Five Representative Farms over a Water Price Range of $0 to $20 per acre foot*

| Period | Farm A | B | C | D | E |
|---|---|---|---|---|---|
| Spring | −0·82 | −0·86 | −0·78 | −0·83 | −0·75 |
| Summer | −0·19 | 0·00 | −0·24 | 0·00 | −0·48 |
| Autumn | −0·81 | −0·83 | −0·77 | −0·74 | −0·86 |

shows that the demand for irrigation water in spring and autumn is slightly inelastic (—0·8), but rather inelastic (—0·2) to completely inelastic in summer.

The relatively greater elasticities of demand for water in spring and autumn are a reflection of the substitution possibilities for water on winter pasture, wheat, sorghum, and sudax, and also by these crops being given fewer irrigations and being reduced in area as water price rises. If summer crops other than rice are grown, the demand for water in summer, within the water price range of $0 to $10 per acre foot, will be sensitive to price change, since sorghum and sudax both receive fewer irrigation treatments and are reduced in area. The effect of this is particularly apparent in the case of Farm E which grows no rice. If rice is the only summer crop grown, there will be an insignificant decrease in rice water use as water prices increase well above $10 per acre foot. In consequence, for Farms B and D, where rice was the sole summer growing irrigated crop, the demand for water in this period tends to be perfectly inelastic.

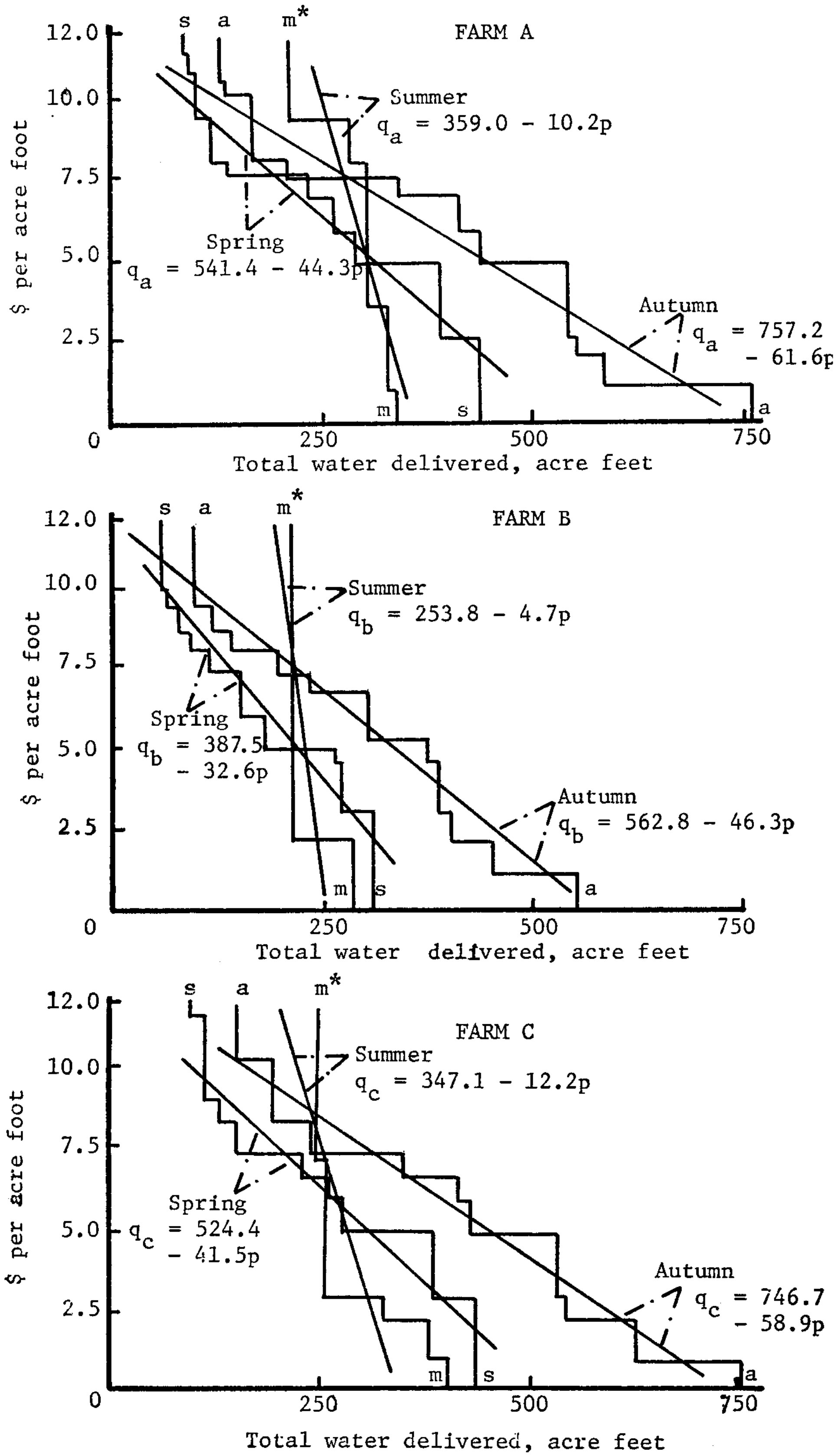
### *The Aggregate Regional Demand Schedule*

Classically the demand schedule for a given input in a competitive market is derived through horizontal summation of the demand schedules of the individual producers in the region being studied [14, p. 437-8]. Aggregation can be performed in this manner providing two conditions are met. First, the various producers in the region must confront the same factor prices, or alternatively, some other mechanism must provide for efficient interfirm resource allocation. In the study area (as in other irrigation areas in New South Wales) this is not the case. All farmers have an institutionally allocated water right not subject to market allocation, although there is competition for water in excess of the water right.[8] Therefore, following Yaron [19, p. 468], it was assumed in the present study that the allocation of the water right is given, and the concept of demand was restricted to the purchase of additional water.

Second, only the price of the input of interest is varied, all other prices are assumed to remain constant. Such an assumption implies that the demand for commodities produced in the region is perfectly elastic, and that the supply of all inputs, other than the one under scrutiny, is perfectly inelastic. In the present case, such an assumption appears reasonable. The major products of large area farms in the Yanco Irrigation Area are rice, wheat, barley, sorghum and fat lambs. The supply of these products (other than rice) from the study area are small in relation to Australian production and markets, so any fall in the YIA supply of these commodities as a response to a rise in water price can reasonably be expected to have an insignificant effect on their market prices. Also, within the water price range considered, the supply of rice will be insensitive to changing water price because of its extremely high net return per acre, and the imposition of acreage allotments on the farm models.

Given the above conditions, the regional demand schedule was derived as the aggregate of the weighted demand schedules for the representative

[8] Water supplied to a farmer in excess of the water right of the farm is known as 'additional water'.



FARM A
s a m*
Summer
$q_a = 359.0 - 10.2p$
Spring
$q_a = 541.4 - 44.3p$
Autumn
$q_a = 757.2 - 61.6p$
12.0
10.0
7.5
5.0
2.5
0
250
500
750
m s a
$ per acre foot
Total water delivered, acre feet
FARM B
s a m*
Summer
$q_b = 253.8 - 4.7p$
Spring
$q_b = 387.5 - 32.6p$
Autumn
$q_b = 562.8 - 46.3p$
12.0
10.0
7.5
5.0
2.5
0
250
500
750
m s a
$ per acre foot
Total water delivered, acre feet
FARM C
s a m*
Summer
$q_c = 347.1 - 12.2p$
Spring
$q_c = 524.4 - 41.5p$
Autumn
$q_c = 746.7 - 58.9p$
12.0
10.0
7.5
5.0
2.5
0
250
500
750
m s a
$ per acre foot
Total water delivered, acre feet

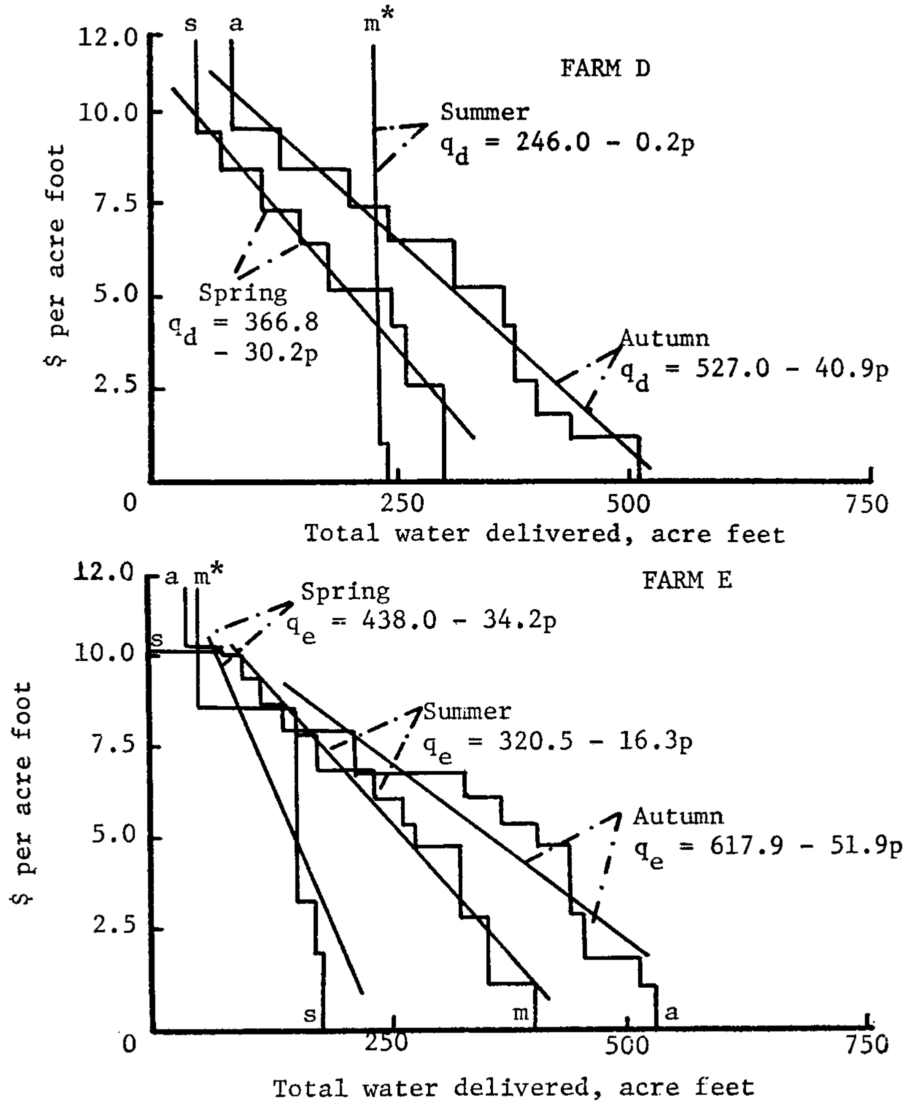



FIG. 3—The derived intra-seasonal demand schedules for the five representative farms in the YIA.

* s = spring; m = summer; a = autumn

farms defining the population. The aggregate demand schedule was specified as:

$$(1) \qquad D = \sum_{i=1}^{n} w_i f_i \text{ for all } p_w$$

where $D$ is the aggregate demand for the region;
$f_i$ is the number of farms in the $i$th stratum;
$w_i$ is the optimal water input to the $i$th representative farm when the price of water is $p_w$: and there are $n$ strata specified for the study area.

The result of such an aggregation was a single set of water quantity-price data in which each of the five representative farms exerts an influence proportional to the total quantity of water used by farms of that structure.

Figure 4 shows the normative aggregate demand schedule derived by this procedure for irrigation water in the Yanco Irrigation Area. The demand schedule presented in Figure 4 is divided into two portions—the left hand sector being the sum of the water rights, i.e. the predetermined supply, and the right hand sector representing additional water which may be allocated by the market, and which is thus regarded as the effective demand schedule for water by large area farms in the Yanco Irrigation Area.

The aggregate demand function generated by summing the weighted representative demand schedules, although showing greater uniformity and smaller changes along the steps than the five individual demand schedules, is essentially similar, subject to a water quantity scaling factor, to the individual demand curves presented in Figure 1. For example, there is an apparent change in slope of the demand schedule at a water price of $9·5 per acre foot, and the segment of the demand curve at prices below this is less inelastic than the segment representing the higher water price range. Therefore, two linear curves which have been superimposed on Figure 4 were fitted to the demand schedule.

### *Price Elasticity of the Seasonal Demand Schedule*

Table 4 lists the estimated price elasticities of demand for several water prices derived from the aggregate demand schedule. At current water prices (i.e. $2.50 per acre foot) the price elasticity of demand for purchased water was estimated at —0·25. That is, if current water prices rose by one per cent, it would be anticipated that there would be a fall in the quantity of water purchased of 0·25 per cent. At a water price of $6·3 per acre foot a one per cent rise in water price was estimated to cause a one per cent fall in the quantity taken. Therefore, at water prices less than $6·3 per acre foot, the demand for irrigation water is inelastic, at $6·3 per acre foot the demand has unit elasticity and above this water price demand is elastic.

## *The Aggregate Intra-Season Demand Schedules*

Aggregate intra-seasonal irrigation demand schedules can be derived for the spring, summer and autumn demand periods using a similar procedure to that used in developing the seasonal demand schedule. The aggregate demand schedules for spring, summer and autumn for the

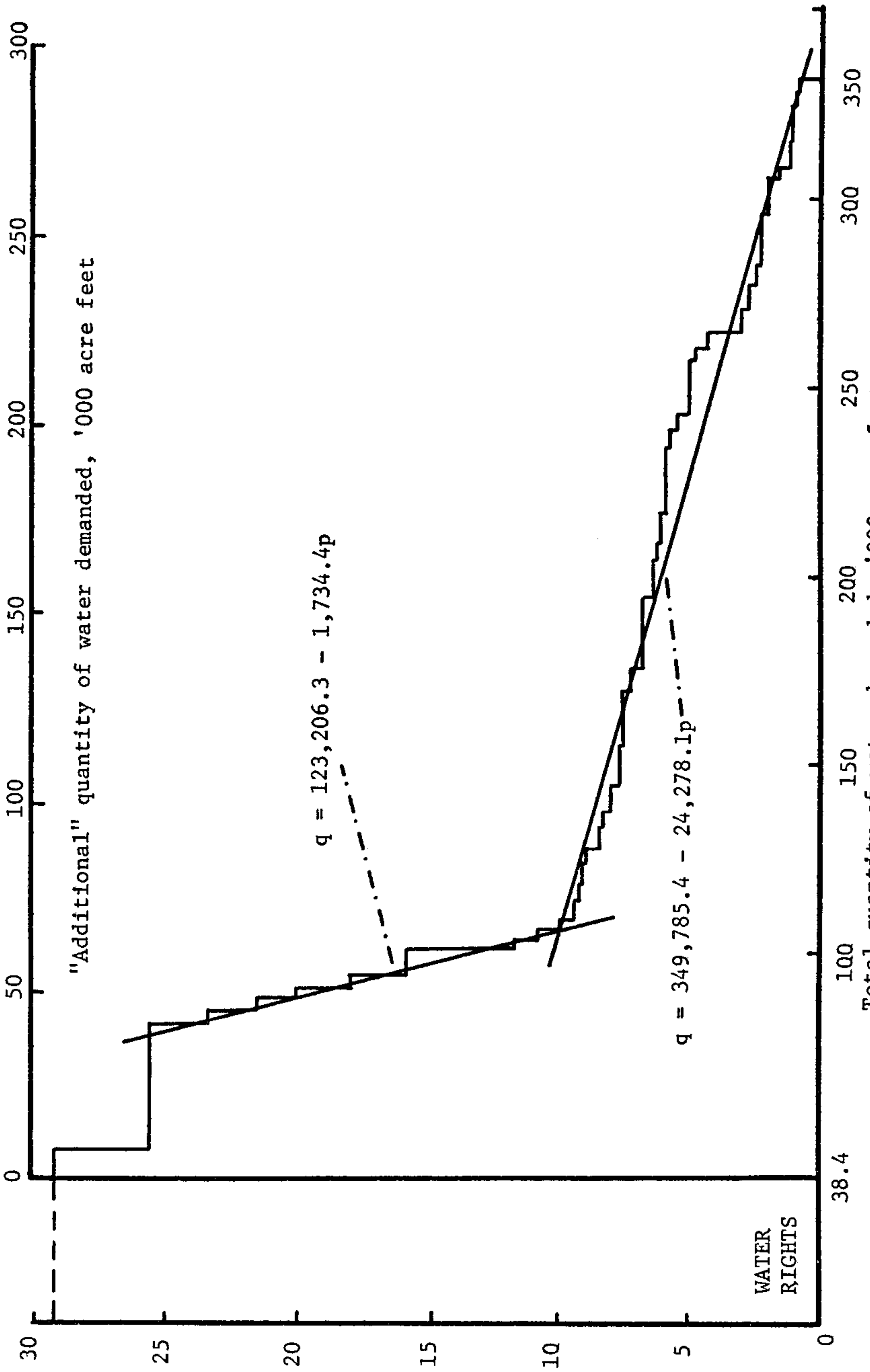



FIG. 4—The derived aggregate seasonal demand schedule for irrigation water by large area farms in the YIA

TABLE 4

*The Estimated Price Elasticity[a] of Demand for Purchased Water in the YIA*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Price[b] | 1·0 | 2·0 | 2·5 | 4·0 | 6·0 | 6·3 | 8·0 |
| Elasticity | —0·09 | —0·19 | —0·25 | —0·46 | —0·91 | —1·00 | —1·73 |

(a) $E = \frac{dQ}{dP} \cdot \frac{P}{Q}$

(b) $ per acre foot.

study area, over a water price range of $0 to $10 per acre foot are illustrated in Figure 5. The aggregate of these three schedules is, of course, the seasonal demand schedule for the study area shown in Figure 4.

Figure 5 illustrates that at low water prices considerably more water would be demanded in autumn than in spring or summer, but as water prices rise the decline in spring and autumn demand would be more rapid than in summer. The estimated point elasticities of demand for a range of water prices for the three periods are presented in Table 5. As anticipated, the aggregate demand for water in summer is extremely inelastic over the price range considered, while the demand for water in spring and autumn is elastic if the price of water exceeds $6·2 per acre foot.

## *Limitations and Implications of the Study*

### *Limitations*

The limitations of synthetic models, in this case linear programming models, for predicting farmer response to a changing environment are well known and will not be discussed here. The derived demand curves, at best, can only be regarded as short run estimates due to uncertainty about future prices, technologies and institutional constraints which may be imposed on the system. Even in the short run, farm managers' decisions may vary substantially from the actions predicted by the linear programming models of the farm firm. In particular, different subjective estimates of managers in relation to crop yields and prices, and different attitudes to risk may result in farmers' actual decisions differing, somewhat markedly, from those indicated as optimal.

The derived demand curves should not be extrapolated to other areas unless they duplicate the Yanco Irrigation Area in all significant respects. Particular attention should be focused on the level of institutional constraints; as the two major constraints—the irrigable area and rice right, are important determinants of the demand schedule for irrigation water. Even if farms in other areas face the same factor prices and constraints, the fact that the crop response functions were derived in relation to the weather and soil types of the study area, may make many of the coefficients in the linear programming models, for various enterprises and given irrigation regimes, specific to the study area.

### *Implications of the Study*

While recognizing the above limitations, the analysis gives useful results not readily obtained by the use of alternative procedures. For

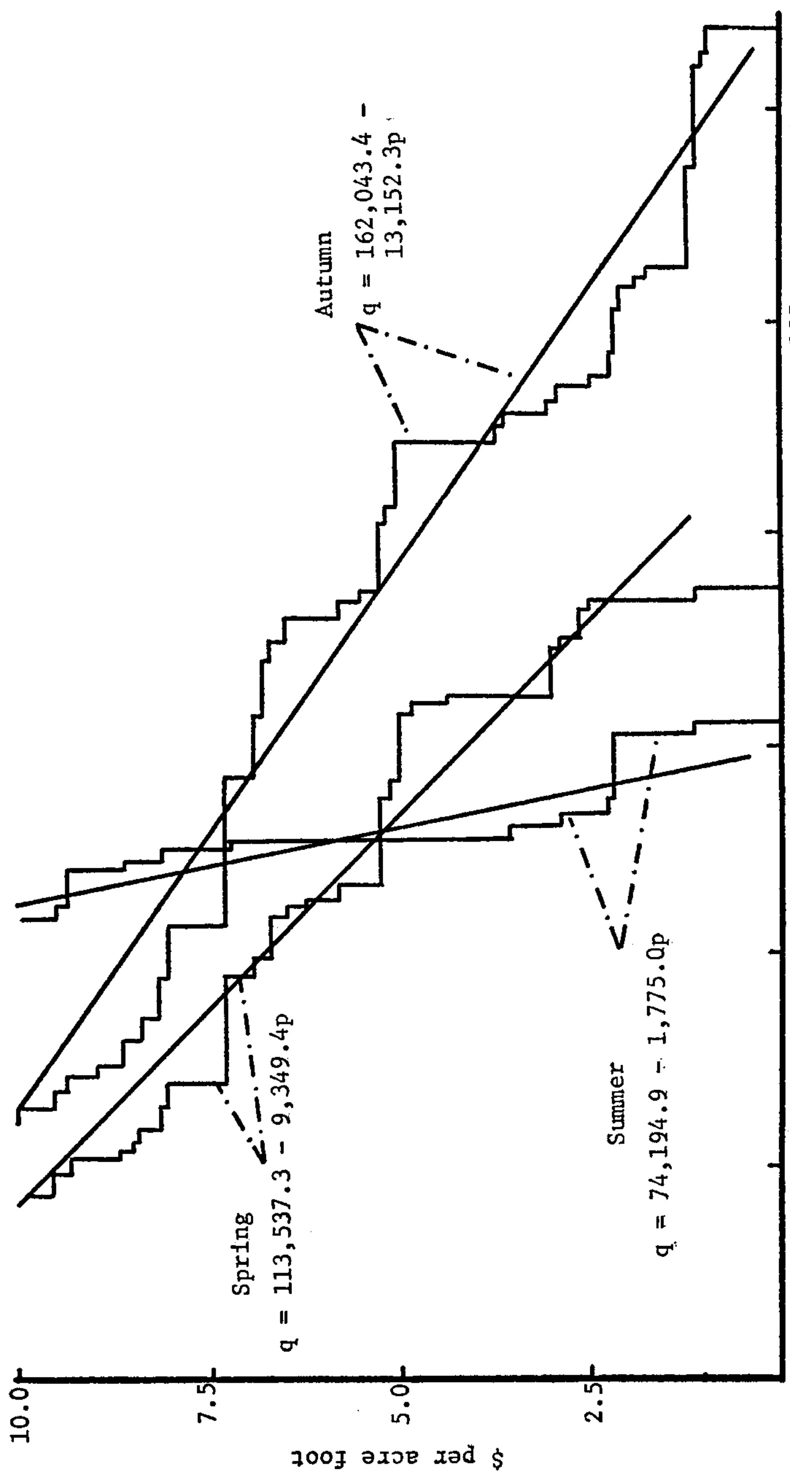



FIG. 5—The derived aggregate intra-seasonal demand schedules for irrigation water of large area farms in the YIA.

TABLE 5

*The Estimated Price Elasticity of Demand for Water in Spring, Summer and Autumn for Large Area Farms in the YIA*

| Water price(a) | Elasticity Spring | Elasticity Summer | Elasticity Autumn |
|---|---|---|---|
| 1·0 | −0·09 | −0·01 | −0·09 |
| 2·5 | −0·26 | −0·03 | −0·25 |
| 5·0 | −0·70 | −0·06 | −0·68 |
| 7·5 | −1·61 | −0·09 | −1·56 |

(a) $ per acre foot.

example, it was estimated that the seasonal demand for irrigation water at present prices is relatively inelastic in the study area. However, the demand for water in summer is extremely inelastic at present water prices when compared to the price elasticity of demand for water in spring and autumn. Hence, if the irrigation authority were to revise its water pricing policy, it could be anticipated that greater change in demand with respect to price changes would occur in spring and autumn than in summer.

At current water prices, in the absence of institutional constraints on water deliveries, it was estimated that the total demand for water by all 'large area' farmers in the irrigation area would be 289,084 acre feet, made up of 90,164; 69,757 and 129,163 acre feet being taken in spring, summer and autumn respectively. This total quantity is in excess of the quantity of water the authority allocates to the Area in any one season. In addition, the autumn demand would exceed the supply capacity of the distribution system in February and March [3]. At present the authority administratively limits water deliveries to meet the physical constraints of the distribution and storage system. Conceivably, the demand for water could also be reduced to the operational limits of the system by increasing water price.

Given knowledge of the cost function for storing and delivering water, the optimal water pricing and allocation policy for the irrigation area could be estimated. An example of such an analysis has been reported by Flinn [6]. Admittedly, it would be naive to think that resource allocation based solely on economic criteria, reflects society's goals. However, by incorporating both the supply and demand schedules for irrigation water within the current models of economic theory, economists are able to evaluate the social costs and returns of various administrative decisions on water allocation and pricing. The existence of such information could, hopefully, assist decision makers in formulating the best way to achieve various irrigation policy objectives while recognizing the economic implications of their decisions.

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