Agricultural Water Demand along the Lower Colorado River Mainstem:

Developing and Testing a Three-Model Approach for Econometric Analysis

by

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STATEMENT BY AUTHOR

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ABSTRACT

In order to make adjustments that let water be used at the highest value, agricultural water must be freed up to urban and municipal uses. A significant portion of the agricultural water savings can be accomplished through shifting cropping patterns from water intensive to water conserving crops. An important question is what are the appropriate policies or legal tools to do this. This study demonstrates that modest price or quantity restraint adjustments elicit strong responses in cropping patterns for agriculture along the Lower Colorado River.

CHAPTER 1

INTRODUCTION

Figure 1.1 – The Lower Colorado River

Figure from USBR Lower Colorado River Accounting System Report, 2007

1.1 Purpose and Implications of the Study

Eighty percent of all Colorado River flow is used to irrigate nearly 4 million acres of agricultural lands in the southwestern United States (USBR, 2011a). The agricultural sectors of both California and Arizona – the states diverting the first and second largest amounts of Colorado River water – consume more freshwater than all other sectors combined. In Arizona, agriculture accounts for about 71% of water demand (ADWR, 2010) and in California this amount is 77% (CDWR, 2005). The substantial amounts of Colorado River water irrigating farmlands in these two states underscores the importance that agriculture plays in the water balance of the river. A thorough understanding of agricultural practices along the Lower Colorado is therefore imperative to planning for a future of warmer temperatures and less precipitation (USBR, 2011a).

In the past, conflicts over water in the West were largely avoided by expanding the pie through the development of new water supplies underwritten by federal funds. Yet it is now "…not much of an exaggeration to say that the water frontier is being inexorably closed in much of the West, and the implications for Western institutions like irrigation districts are likely to be significant" (Leshy, 1982). As noted by Glenn (1979)"…the sheer bulk of agricultural water use [in the West] makes that sector the most obvious place to look for conserving water as a substitute for developing new supplies." The Sonoran Institute (2007) details three principal ways the agricultural sector can reduce its water consumption: by investing in irrigation efficiency, by reallocating farmland to less water intensive crops, and by retiring agricultural land. In this study we focus on cropping decisions and the role of different water constraints, pricing schemes, and allocation schemes in influencing these decisions.

Agricultural water demand is a sequential process influenced both by acreage decisions and irrigation decisions. Acreage decisions involve the choice of which crops to grow and how many acres to plant. Irrigation decisions include both the amount and timing of water applied to each crop. First, farmers make cropping decisions based on expected agricultural input and output prices, the physical characteristics of their land (e.g. soil and slope), crop rotation considerations, and expected water deliveries. Farmers then must make irrigation decisions throughout the growing season to accommodate the cropping decisions they made. Prior to planting, growers have a relatively high degree of flexibility in formulating their annual water demand. Once crops are planted, however, the ability to respond to changes becomes limited by cropping choices. Actual monthly water diversions depend on acreage decisions made in addition to actual weather and water supply conditions (as opposed to predicted conditions).

Agricultural cropping decisions play a major role in determining demand for irrigation water. For example, in the Southwest, producing alfalfa demands about three times as much water per acre annually as vegetable and melon crops (see chapter 4.13) and most farms in the Southwest grow a wide variety of crops that vary in water demands. To understand farmers' cropping decisions – and thereby a major component of Colorado River water demand – we develop and estimate econometric models to determine the factors driving these decisions.

Multioutput production equations can vary widely between states and agricultural districts[1]. Proper econometric analysis of cropping decisions requires knowledge of whether the quantity of an input (namely water) is fixed or variable over the production period at the farm level (Moore & Dinar, 1995). Agricultural districts along the Lower Colorado River constitute a heterogeneous mix of water apportionment and water pricing systems. The diversity of systems renders econometric analysis at the regional level limited and unenlightening in explaining crop-level land allocations as a function of water related variables. The first step in econometric analysis is therefore the assignment of agricultural districts into like groups (the term "water regime" is used henceforth) based on the water constraints faced by each district's farmers. These constraints depend on institutional policies at the federal, state, and district levels.

Chapter 2 reviews past literature concerning the topics we cover in this thesis and comments on the unique contributions this work brings to the field. Chapter 3 develops the concept and criteria for water regime assignments. Chapter 4 details the compilation, construction, and summary statistics of the variables used in the econometric regressions. Chapter 5 develops several model specification tests of competing models of agricultural water use to determine the suitability of these assignments. In Chapter 5, we also address econometric issues common to panel data and propose specifications to address these issues. Chapter 6 reports the empirical results, including the model specification test results and

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[1] For the purpose of this study, the term "agricultural district" is used to describe any entity that has an entitlement to divert water from the Lower Colorado River for agricultural means, including irrigation districts, irrigation and drainage districts, Indian reservations, and private landowners.

econometric estimates of crop-level land allocation equations for each water regime. Finally, Chapter 7 discusses the implications of the empirical results in the context of the study, summarizes our work, and draws conclusions.

This research makes three general contributions. First, it develops the methods and criteria for assigning agricultural districts to specific water regimes for more informative land allocation estimation. Secondly, it develops a method for incorporating land constraints into the land allocation models that avoids an acute multicollinearity issue with the water quantity variable. Lastly, it assesses the role of cropping decisions in agricultural water demand along the Lower Colorado River – and therefore the majority of total water demand in the region – and how agricultural water demand might adapt to modified water quantity or price constraints due to water conservation policies.

1.2 Background

1.2.1 Bureau of Reclamation and the "Law of the River"

The Bureau of Reclamation (USBR) is a federal agency with the mission to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public (USBR, 2009). According to the USBR official website, the agency is the United States' largest wholesale water supplier, operating 348 reservoirs with a total storage capacity of 245 MAF[2] and provides a fifth of Western farmers

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[2] MAF refers to Million Acre-Feet of water, while AF refers to Acre-Feet of water. One AF of water is the amount of water required to cover an acre of land with one foot of water, or about 325,853 U.S. gallons. This unit of volume

with irrigation water. This irrigation water supplies 10 million farmland acres that produce 60% of the nation's vegetables and 25% of its fresh fruits and nuts. Since its inception in 1902, USBR has constructed more than 600 dams and reservoirs in the 17 Western states (USBR, 2011b).

Colorado River water diversions in the Lower Basin states of Nevada, Arizona and California are subject to laws, judicial rulings and decrees, contracts, interstate compacts, operating criteria and an international treaty collectively known as the "Law of the River" (USBR, 2010). The cornerstone of this collection of legal documents is the *Colorado River Compact of 1922*. Negotiated by the seven Colorado River Basin states and the federal government in 1922, it defined the relationship between upper and lower basins and endorsed the suggestion of Secretary of Commerce Herbert Hoover that each basin receive 7.5 MAF of river water annually. The apportionment of the Lower Basin's 7.5 MAF was established with the *Boulder Canyon Project Act of 1928*. The state of California was allocated 4.4 MAF, the state of Arizona 2.8 MAF and the state of Nevada 0.3 MAF. Further, the Act authorized and directed the Secretary of the Interior to function as the sole contracting authority for Colorado River water use in the lower basin and requires any user of Colorado River water in the Lower Basin to have a water delivery contract with the USBR. This requirement was confirmed by the U.S. Supreme Court in its 1964 ruling on *Arizona v. California* and subsequently in its *Consolidated Decree* in 2006 (Arizona v. California et al., 1964) (Consolidated Decree, 2006).

Article V of the *Decree of the Supreme Court of the United States in Arizona v. California* requires the Secretary of the Interior to provide detailed and accurate records of diversions,

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is commonly used in the United States in reference to large-scale water resources and we use the acronyms MAF and AF for the duration of this paper.

return flows, and consumptive use of water diverted from the mainstream of the Colorado River below Lee's Ferry, the point differentiating the Upper and Lower Colorado River Basins. The reports have tabulated measured diversions, measured returns and consumptive use of each user taking water from the Lower Colorado River since 1964. These Water Accounting Reports were used to compile the data to develop the *diversions* and *consumptive use* variables used in this study.

In 1984, USBR partnered with the U.S. Geological Survey, the lower basin states and the Bureau of Indian Affairs to develop a method for estimating consumptive use by diverters of Lower Colorado River water. This collaboration resulted in the development of the Lower Colorado River Accounting System (LCRAS) in the late 1980s. Beginning in 1995, LCRAS has generated and released annual reports detailing agricultural, riparian and domestic diversions and consumption of Colorado River water (USBR, 2001). Each report includes tables displaying the number of cultivated acres within each agricultural district disseminated by crop variety. This information was used to develop the *total agricultural acres* and *crop-group* variables used in this study.

1.2.2 Role of Entitlement Priorities for Lower Colorado River Water

The primary division of Colorado River water in the lower basin is amongst the states; 4.4 MAF to California annually, 2.8 MAF to Arizona annually, and 0.3 MAF to Nevada. Beyond the state level division of water, agricultural districts are then entitled to their respective diversions. The 1979 *Supplemental Decree* to the Supreme Court's decision in *Arizona v. California* addressed the present perfected rights (PPR) that were established with the *Boulder Canyon Project Act* and clarified that these PPR's take precedence over any subsequent uses of

Colorado River water. PPR’s are recognized for historical diverters of Colorado River water and are numbered according to the established date of first diversion and beneficial use. All of the Californian agricultural districts included in this study have a PPR and all Arizonan districts with a priority of one or two have a PPR. Palo Verde Irrigation District has the oldest established diversion and beneficial use of river water and therefore has the first PPR for California. The first three PPR’s in Arizona are all Indian Reservations. The “priority” column in Table 1.1 follows the entitlement hierarchy as listed by the respective states.

Table 1.1 – Colorado River water use entitlements for districts of interest

ARIZONA

District[a]	Priority	Entitlement type: Diversion	Entitlement type: Consumptive use
Colorado River IR	1	662,402	
Fort Mohave IR	1	103,535	
Yuma Valley ID	1	254,200	
	3	unquantified water rights certificates[c]	
North Cocopah IR	1	7,681	
	1	1,140	
	4	2,026	
Cibola Valley IDD[b]	4	9,366	
	5	1,500	
	6	2,000	
Sturges Gila Monster Ranch	1	780	
	3	6,285	
	4	1,435	
	5	656	
	6	unspecified	
Mohave Valley IDD	4	35,060	
North Gila Valley ID	1	24,500	
	3	24,500	41,203
Unit "B" IDD	1	6,800	
	3	unquantified water rights certificates[c]	
Yuma ID	3		67,278
Yuma Mesa IDD	3		141,519
Wellton Mohawk IDD	3		270,000

CALIFORNIA

District[a]	Priority	Entitlement type: Diversion	Entitlement type: Cons. use
Palo Verde ID	1		219,780
	3b	For mesa[d]	
	6b	For mesa[d]	
Fort Yuma IR, Indian Unit	2	water rights certificates[e]	
Fort Yuma IR, Bard Unit	2	water rights certificates[e]	
Imperial ID	3a		2,600,000
	6a	300,000	
Fort Mohave IR	1	16,720	

[a] IR denotes Indian Reservation, ID denotes Irrigation District, IDD denotes Irrigation & Drainage District

[b] In December 2004, CVIDD reduced its entitlement from 24,120 AF of 4th priority, 3,000 AF of 5th priority and 4,000 AF of 6th priority to its current (2011) total entitlement of 12,866 AF through water rights transfers to the Hopi Tribe, the Mohave County Water Authority, Cibola Resources, and Arizona Recreational Facilities, Inc.

[c] Certificates granting right to quantity which may be applied beneficially in accordance with "good usage" for irrigation of the land described

[d] Amounts for beneficial use on 16,000 acres of mesa lands

[e] Certificates granting right to beneficial use for a gross area not to exceed 25,000 acres for FYIRBU,CA and FYIRIU,CA combined

1.2.3 Diversions and Consumptive Use Clarified

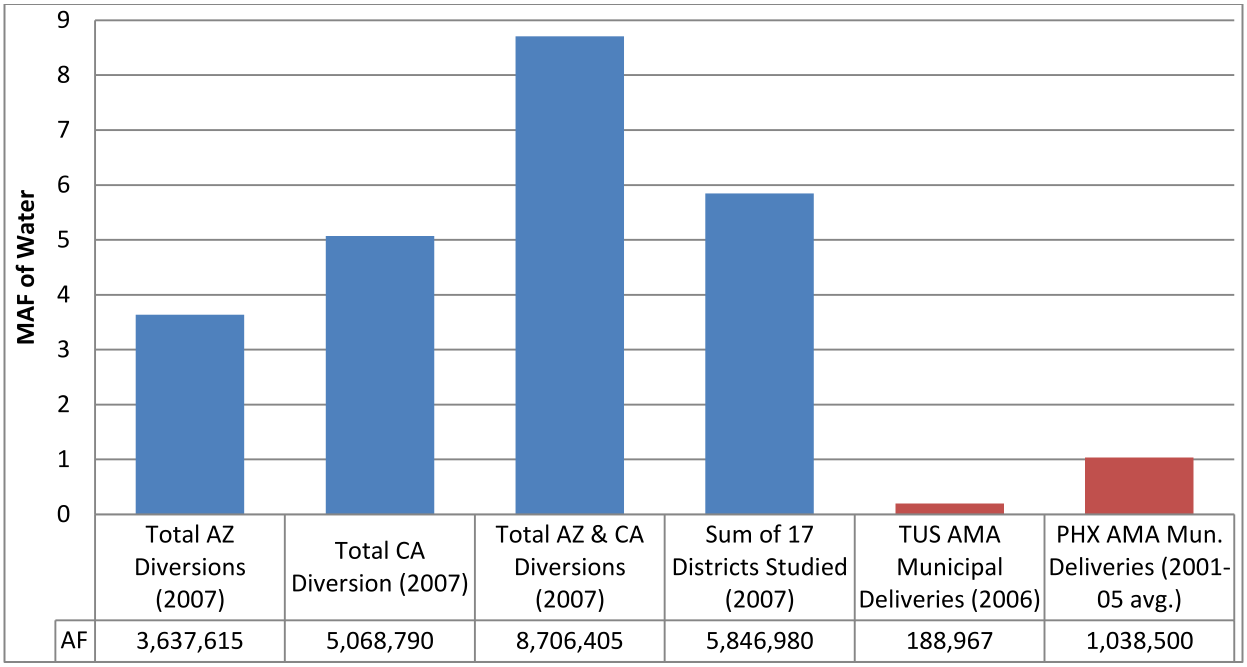
Delivery contracts for Colorado River water either describe the water right in terms of an annual diversion right or in terms of an annual consumptive use right. To clarify, in its Water Accounting Reports the USBR defines a diversion as "… an action that removes water from the mainstream or causes increased evaporation losses through an expansion of the surface area of

Figure 1.2 – Agricultural diversions from Colorado River in perspective

the mainstream. The diversion may be (i) surface water that is moved through a turnout structure or drawn from a pump in the river, or (ii) water drawn from the mainstream by pumping groundwater.” (USBR, 2005). Consumptive use, however “… is the difference between the amount of water diverted and the amount of water that returns to the mainstream from that diversion after the water has been put to beneficial use.” (USBR, 2005). For agricultural purposes, “returns” is primarily runoff and seepage from farm fields. Nine of the agricultural districts of interest have a Colorado River water entitlement in terms of diversions while the remaining eight have an entitlement in terms of consumptive use, including three of the four largest districts by total diversions (see Table 1.1).

1.2.4 Diversions in perspective

The 17 agricultural districts included in this study account for more than 70% of total water diversions from the Lower Colorado River Mainstem. Figure 1.2 displays the sum of Colorado River diversions for the 17 agricultural districts of interest for the year 2007 compared to total Arizona Colorado River diversions in 2007, total California Colorado River diversions in 2007, the sum of Arizona and California diversions in 2007, and Tucson and Phoenix municipal deliveries for 2006 and average for 2001 – 2005, respectively. This figure helps to demonstrate agriculture’s unrivaled impact on total Colorado River water demand.



	Total AZ Diversions (2007)	Total CA Diversion (2007)	Total AZ & CA Diversions (2007)	Sum of 17 Districts Studied (2007)	TUS AMA Municipal Deliveries (2006)	PHX AMA Mun. Deliveries (2001-05 avg.)
AF	3,637,615	5,068,790	8,706,405	5,846,980	188,967	1,038,500

1.2.5 The Role of Water Price in Agricultural Water Use

At the farm level, land allocation to crops might be determined partially or wholly by the price farmers pay for the water. As different crops require different amounts of water to complete their growing cycle, in districts where water prices are higher one might expect to see the farmers allocating more land to crops that are less water intensive, ceteris paribus.

The USBR constructed all of the major water projects on the Lower Colorado River and is responsible for macro-level water management of the river's waters. In general, Colorado River water entitlements are tied to the land. Historically, typical entitlements allowed the contracted diverters to divert as much water as could be put to beneficial use on their land. In recent decades, as over allocation of the river has become more apparent, these diversion amounts have been quantified and limited for larger and lower priority districts. A typical contemporary diversion contract with the USBR allocates a quantified amount of water to the agricultural district at no cost per unit of water. Individual farmers then contract with the district for irrigation water. Through exhaustive telephone and email correspondences with agricultural district water operations managers, contemporary water pricing information at the farm-level for each of the districts was compiled.

CHAPTER 2
LITERATURE REVIEW

2.1 Key Studies

A number of studies precede this thesis in estimating the role of water in cropping decisions. Three papers by Michael R. Moore and colleagues proved to be the most helpful in developing our theoretical and empirical models. Moore and Negri (1992) evaluates water strictly as a fixed input in crop land allocation and crop supply equations for all Bureau of Reclamation water projects across the American West. Their model was estimated on a regional basis and the findings for the Lower Colorado River region are useful for comparison with our own results. The study concludes that the water quantity constraint is a strong determinant of production decisions across all Bureau of Reclamation (USBR) production regions, but that cropping patterns and supply responses are largely inelastic to the constraint.

Moore and Dinar (1995) develop several model specification tests of two competing models of input use: variable-input model and fixed-input model. The tests are applied independently to two inputs, surface water and land, using data on production in the western San Joaquin Valley of California. Their application of non-nested *F*-tests for water and land input model comparison is a useful decision tool and lays the groundwork for the first stage of analysis in this study. They maintain that although water is commonly modeled as a variable input, it may be more accurately thought of as an input whose aggregate amount is fixed, but allocable across different crops. Their model selection tests suggest producers in the western San Joaquin Valley of California employ water as a fixed, but allocable input and that the implications of including the incorrect water input extend to the misspecification of profit functions. An important issue they confront is the severe multicollinearity between water quantity and total acreage, as both are important factors in cropping decisions but fluctuate positively through time with one another across the panel. Their solution was to include land as a variable input (price-determined) rather than a fixed input, despite their model comparison tests suggesting the fixed-land model was preferred, at the expense of some accuracy in the coefficient estimates.

Negri and Moore (2009) models water as a fixed but stochastic variable in the Pacific Northwest. The underlying assumption is that water quantity, not water price, constrains producers on USBR water projects in the Northwest, but that irrigation water supplies are stochastic on an annual basis depending on weather conditions. This study also corrects for an endogeneity issue that is not addressed in the other literature we reviewed; the issue being that using actual water deliveries instead of expected water deliveries in the land allocation equations generates a measurement error in the variable, as farmers must make cropping decisions at the beginning of the growing season based on expected water deliveries. The authors address this endogeneity issue with an instrumental variables approach. The study finds that farmers' land allocations are more responsive to expected water supply than to uncorrected, endogenous, actual water supply, and that overall the responses of land allocations with respect to water are relatively elastic in the Pacific Northwest.

An important and insightful study concerning the water constraints and economic efficiency of USBR water projects by Kanazawa (1993) lays out a framework for determining whether farmers are bound by a water quantity ceiling or constrained by water price. The study uses farm-level data from the Westlands Water District in central California. The Hausman and non-nested tests that Kanazawa employs suggest that farmers in Westlands are, in fact, bound by the USBR entitlement ceiling, consistent with the findings of Moore and Dinar (1995).

To gain some insight regarding the mission, history, sovereignty, and legal standing of irrigation districts in the American West we turned Leshy (1982). Leshy explains the purpose for the creation of irrigation districts in the West and describes their changing role as the agricultural sector has stagnated and municipal water demand has boomed in recent decades. He emphasizes that irrigation districts are special governmental entities outside the framework of local municipal or county governments, straddling a thin line between “public” and “private” entities. Importantly for the purposes of this study, we learn that irrigation districts can compel the inclusion of unwilling landholders within their bounds. This forced inclusion denies the farmers the opportunity to abscond to a bordering district with lower water prices or more lenient water diversion limitations.

There is a dearth of literature concerning water price in USBR-served agricultural districts, either at the district level or at the farm level. One important exception is Michelsen, Taylor, Huffaker, and McGuckin (1999) use unpublished survey results and new district-level information to examine the rate structures and incentives of district water pricing for districts served by USBR water projects. The findings reveal that the majority of districts use fixed charges independent of the quantity of water delivered and that most rate structures recently implemented are designed so that the first-tier quantity allocation satisfies most farm-level crop water needs. Further, they find that district management objectives may be satisfied by these rate structures, but price incentives for water conservation are diminished or nonexistent. This study was useful as a tool for the development of a water price variable and for comparison to our own water price data.

Econometric analysis of time-series cross-section data is particularly sensitive to model misspecification due to the multidimensional nature of the sample data. The article by Beck and Katz (1995), "What to do (and not to do) with Time-Series Cross-Section Data," examines some issues in the estimation of such models and calls into question the conclusions of many published studies that employed a generalized least-squares approach. They provide an alternative ordinary least squares estimator with panel-corrected standard errors that, based on Monte Carlo analysis, performs well in the presence of contemporaneous correlation and first-order autocorrelation.   We find their analysis applicable and their proposed estimator appropriate for our own dataset.

2.2 Divergence from the Literature and Unique Contributions

As noted by Moore and Dinar (1995), traditional agricultural production models include land and water as variable inputs. Their model selection tests were based on farm-level data analyzing water use within one irrigation district and their finding indicated that the farmers within this district were in fact constrained by water quantity. Statistical analysis of the individual agricultural districts included in our study revealed that the Lower Colorado River clearly has a heterogeneous mix of agricultural water users and the single model approach was not adequate for explaining cropping decisions for all districts in the region. We therefore develop three distinct water regimes based on the water constraints faced by the districts' farmers and test the performance of the competing water constraints within these regimes to determine the suitability of regime assignments.

Following the methods of Negri and Moore (2009), we correct our water quantity variable for endogeneity by avoiding the use of current year water deliveries. Rather than use a set of instrumental variables, however, we simply use diversions lagged one year. Negri and Moore use lagged diversions and a number of climate and other physical variables to account for stochastic river flows, but we find this to be unnecessary for our dataset. Our research does not address the issue of stochastic river flows due to the institutional policies dictating water use on the Lower Colorado River. All of the agricultural districts included in our study have a water entitlement for at least a portion of their water that is higher priority than major municipal uses. For example, in the event of a major water shortage on the Colorado River, the Central Arizona Project[3] is required to forgo its entire 1.5 MAF entitlement before any of Arizona's major agricultural districts would see a decrease in water. The situation is similar in California as the entitlement priorities of Metropolitan Water District[4] and San Diego County Water Authority are below all of the entitlement priorities of the California agricultural districts. Due to this virtual guarantee of agricultural water deliveries, lagged diversions is an excellent indicator of current diversions, while not contemporaneously correlated with the error term.

Past research estimating farm-level cropland allocation functions uses acreage dedicated to each crop as the dependent variable in a set of land allocation equations (see

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[3] The Central Arizona Project is a 336 mile diversion canal in Arizona that delivers about 1.5 MAF of Colorado River water from Lake Havasu to Pima, Pinal, and Maricopa counties (CAP, 2011).

[4] Metropolitan Water District provides Colorado River water to approximately 19 million people over about 5,200 square miles in Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura counties (MWD, 2010).

Huffman 1988; Kanazawa 1993; Moore and Negri 1992; Moore and Dinar 1995; Negri and Moore 2009). Using actual crop acreage as the dependent variable yields coefficient estimates that are applicable for the average for all those districts studied, resulting in unclear interpretation when district size varies greatly, as do our districts of interest (see Table 4.1). We address this issue by dividing each crop's acreage by total arable acres, effectively making the units of our dependent variables *proportion of arable land dedicated to crop* n. We also adjust our water quantity variable by dividing it by total arable acres, effectively making the units of our water quantity variable *diversions per arable acre*, for intuitive coefficient interpretation. Using diversions per arable acre as the water quantity variable serves the dual purpose of eliminating the problem of severe multicollinearity between the water quantity and total land constraints without dropping either important variable from the equations.

CHAPTER 3

COMPETING MODELS OF AGRICULTURAL PRODUCTION

3.1 Competing Models of Agricultural Water Demand

An important consideration when constructing regressions to analyze farm-level cropping decisions is whether water should be modeled as a fixed or variable input. Understanding whether water prices or institutionally based water constraints guide farmers' diversion decisions is essential for correct specification of the crop-group land allocation equations. As noted by Rausser and Zusman (1991), when water is a quantity-rationed (fixed) input, "Water prices…constitute pure distribution instruments devoid of an allocation effect." The econometric implications of the distinction between fixed water and variable water are elaborated by Moore and Dinar (1995):

> Heuristically, a variable input model differs from a fixed input model in a simple way: when an input is variable, its price will be among the variables explaining producer decisions; when an input is fixed, its farm-level quantity will replace its price among the independent variables.

Competing models should, therefore, differ by their exclusive inclusion of either water price or water quantity as an independent variable.

Water price constraints do not exist at the district level along the Lower Colorado River. Agricultural districts are entitled to divert an allotment of water based on historical institutional policies at no charge, so in effect, all districts are technically water-quantity constrained, but a district will not experience this constraint if their entitlement substantially exceeds district demand. Farmers contract with their respective district to divert water that is constrained by price, quantity, both, or neither through district-level policies. If the aggregate of farmers in a district experience a water price constraint in making land allocation decisions, then we consider that district to be water price constrained.

If comprehensive data on profit or cost were available, comparing competing models would be a straightforward exercise; hypothesis tests would compare the performance of a water-price versus water-quantity versus no-water-variable model in explaining profit variation after estimating multicrop profit functions for each regime (Moore & Dinar, 1995). Hypotheses would also compare the performance of crop-group own and cross output prices in predicting farmer profits. Data on profit or cost, however, are not available, so an alternative method for comparing competing water input models must be developed. We begin by reviewing the role of water in agricultural multioutput profit functions. We then propose our criteria for water regime assignments and outline the tests to be employed to determine the suitability of these assignments.

3.2 Agricultural Water Demand

A simplified two-crop economic model for agricultural production when water quantity is not constrained is as follows:

$$\Pi = P_1 Q_1(A_1, W_1) + P_2 Q_2(A_2, W_2) - A_1(r_1 + p_w) - A_2(r_2 + p_w) \qquad (1)$$

$$s.t.\ A_1 + A_2 \leq \bar{A}$$

where:

Π = multioutput profit

P_n = Output price of crop n

Q_n = Output quantity of crop n

A_n = Acreage allocated to crop n

W_n = Water allocated to crop n

r_n = Production costs for crop n

p_w = Price of water

$\bar{A}$ = Total farmland available to producer

This simple multioutput agricultural production model falls short of articulating the complexity of agricultural profit maximization along the Lower Colorado River. The first complicating factor is the presence of institutional water constraints, or a water “ceiling”, which serves to limit the amount of water to which agricultural districts are entitled. Colorado River water appropriations can be envisioned as hierarchal. At the highest tier within the United States, the Upper Basin and the Lower Basin are appropriated designated quantities of river water. States within each basin are then designated a quantified amount of the basin appropriation. Respective state-level water authorities then oversee the allocation of this water to lower hierarchal entities, such as agricultural districts, municipalities, and wildlife refuges. Water is allocated to these entities based on a seniority system that, in general, entitles those districts that made original claims on river water to more water at a higher priority. Each district is limited to the amount of Colorado River water they can use through either diversion or consumptive use contracts. Regardless of the amount or the type of contract, essentially each district has a water ceiling that cannot be legally exceeded. This ceiling is passed on to individual farmers through water pricing, land assessment fees, and monitoring.

Figure 3.1 – Simple agricultural water demand model

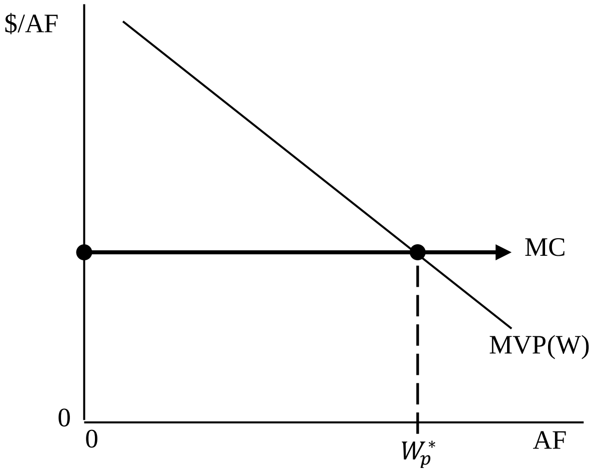

Figure 3.2 – Agricultural water demand model with an institutional water ceiling

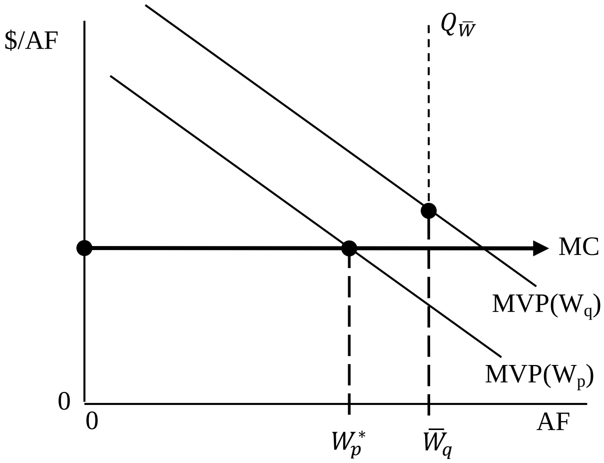

Figure 3.1 graphically displays the quantity of water a farmer will choose (W_p^*) due to the price constraint imposed by the constant marginal cost (MC) when there is no institutional water constraint, where MVP(W) is the marginal value product of water to the farmer. In Figure 3.2, W_p^* displays the quantity of water a farmer will choose if the institutional water ceiling ($Q_{\bar{W}}$) is not binding, while $\bar{W}_q$ is the quantity of water a farmer will choose if the institutional water ceiling is binding. MVP(W_p) is therefore the marginal value product of water to the farmer under a water price constraint while MVP(W_q) is the marginal value product of water the farmer under a water quantity constraint.

Further complication is introduced to the model due to the lack of an easily quantifiable water price. Agricultural districts are not charged for water diverted from the river. Farmers within district boundaries, however, are charged at rates designed to cover district operation and maintenance costs. These charges vary considerably by district. The charges are substantial for those districts that manage complex water conveyance systems, such as extensive canals and pumping stations, while farmers in districts within the river's floodplain only pay the electricity costs for pumping river water from the ground. p_w therefore varies considerably from district to district and is rarely, as equation (1) implies, a constant cost per unit of water ($/AF).

3.3 Developing Water Regimes

Water regimes are constructed in which water pricing and quantity constraints follow similar institutional rules. Through data analysis, literature review, and personal communication with agricultural district managers, we have assigned each of the 17 districts of interest to one of three water regimes. Districts falling within Regime 1 are those where farmers receive all of their needed water at no marginal cost and are not bound by a water ceiling. An institutional water ceiling exists for these districts, and by proxy for the districts' farmers, but the data suggests that the water ceiling is high enough that for all 12 years of our study the districts do not approach it, and are therefore effectively unconstrained by an institutional water ceiling. Within Regime 1 we observe districts employing three distinct water pricing structures that we will designate 1a, 1b and 1c. 1a districts charge farmers no price for water but farmers pay the price of pumping the water from the floodplain. In 1b districts, farmers pay an assessment fee – a flat charge per acre of land put into production that year – which allows farmers to divert as much water as can be put to "beneficial use" on that acre[5]. Lastly, 1c districts charge farmers an assessment fee permitting the diversion of a defined

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[5] Beneficial use is defined by the Bureau of Reclamation as the quantity which may be applied beneficially in accordance with good usage in the irrigation of the land described.

number of AF per acre at no marginal cost, but impose a marginal cost for each additional AF of water diverted beyond this defined number of AF per acre. To be included in the Regime 1, the aggregate of farms within such districts cannot approach the onset of the marginal cost (see Figure 3.3). Districts in this Regime 1 are effectively unconstrained regarding water price and water quantity.

Regime 2 is comprised of districts that employ one of two pricing structures. The first is those districts that charge farmers a constant marginal cost for all AF of water diverted but do not approach the institutional water ceiling. The second is those districts with a pricing structure identical to 1c above – charging farmers an assessment fee permitting the diversion of a defined number of AF per acre at no marginal cost but imposing a marginal cost for each additional AF of water diverted beyond this defined number of AF per acre – but includes only those districts that are approaching or are beyond the onset of the marginal cost while not approaching the institutional water ceiling (see Figure 3.3). This behavior is interpreted as the imposition of a marginal cost having a constraining effect on farmers’ decision making. Districts in Regime 2 are effectively unconstrained regarding water quantity but experience a water price constraint.

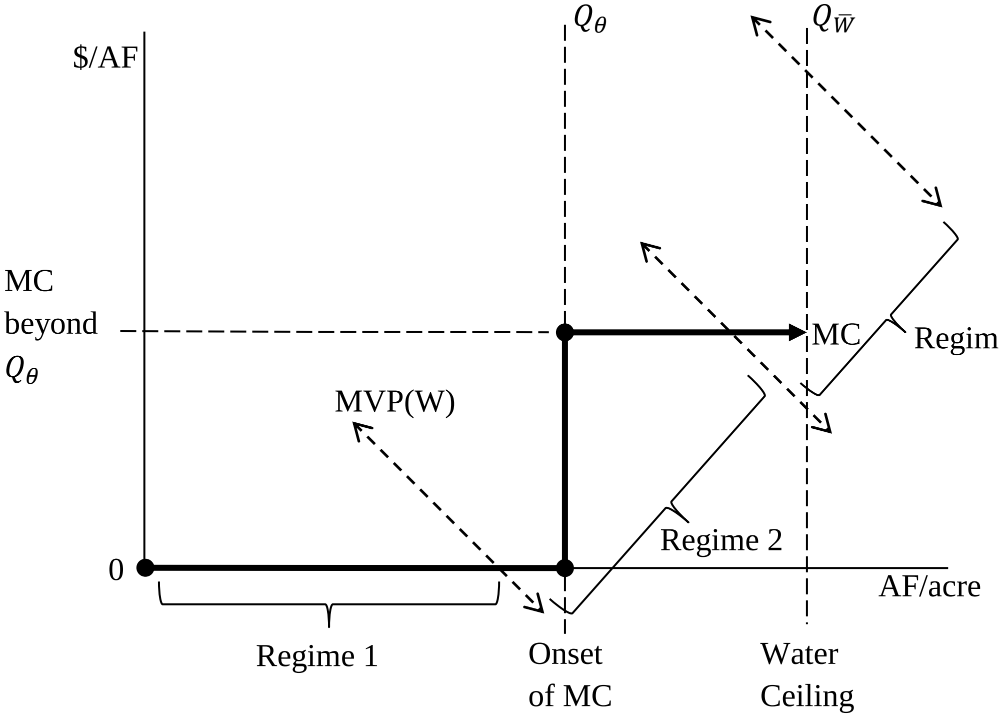
Regime 3 includes districts that approach or exceed the institutional water ceiling regardless of pricing structure. We assume that there is little or no effective price constraint as these districts consistently approach or exceed the amount of water legally diverted during the 12 years of study (see Figure 3.3). Regime 3 districts are effectively unconstrained regarding water price but experience a water quantity constraint.

For description of the empirical criteria used in determining regime assignments please see chapter 4.14.

Water entitlements, whether in terms of diversions or consumptive use, are prescribed as a total AF water amount for the district. An exception is those districts that are entitled to an amount of water for "beneficial use" on a quantified number of agricultural acres. For comparison purposes we convert district entitlements into a farm-level water ceiling ($Q_{\overline{W}}$) measured in the units AF per acre. This is done by dividing the entitlement by the average number of irrigated acres in production over the 12 year study period. Figure 3.3 displays the three water regimes in one graphic.

Figure 3.4 – Figure 3.6 are graphical examples of the three water regimes described above using agricultural districts from this study, where W_D is average district diversion for the

Figure 3.3 – Agricultural district water regimes



study period and Q_θ is the onset of a marginal cost. The shaded area in Figure 3.5 represents the Regime 2 qualifying range for W_D, encompassing "approaching" a marginal cost (the left extent of the shading) to experiencing a marginal cost while not experiencing a quantity constraint (the far right extent of the shading). Such a range is necessary due to the stochastic nature of annual diversions. Farmers order diversions on a monthly basis throughout the growing season with the onset of a marginal cost in mind, but will end up diverting just under or just over the point where a marginal cost is imposed. Assessment fees and marginal costs have risen over time due to inflation, compensation for district improvements, etc., but institutional water ceilings and the point of the onset of a marginal cost have remained consistent for the timeframe of this study (1996 – 2007).

Figure 3.4 – Water Regime 1 example
e.g. Fort Mohave Indian Reservation, AZ
($0 for all AF of water pumped as of 2010)

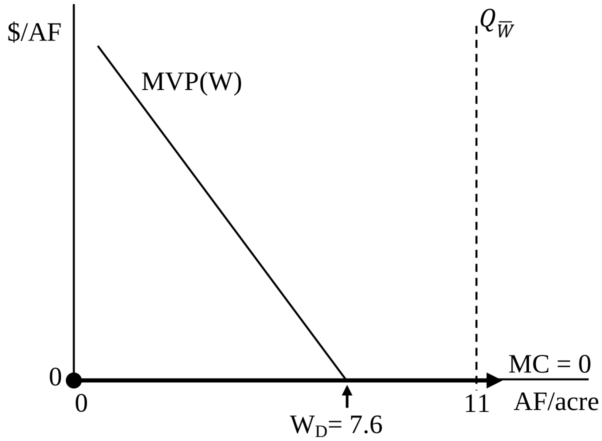


Figure 3.5 – Water Regime 2 example
e.g. Yuma Valley Irrigation District, AZ
($86 for 1st 5 AF/acre then MC as of 2010)

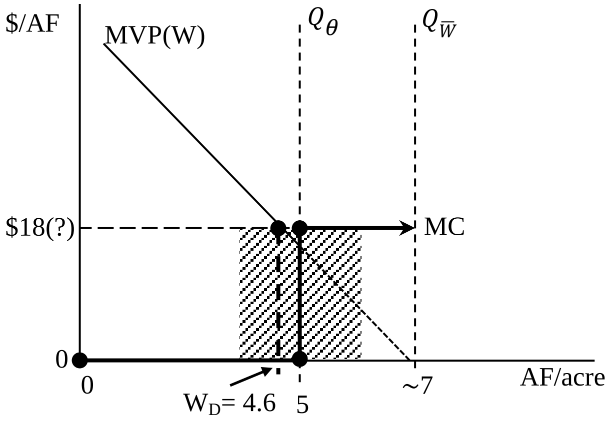
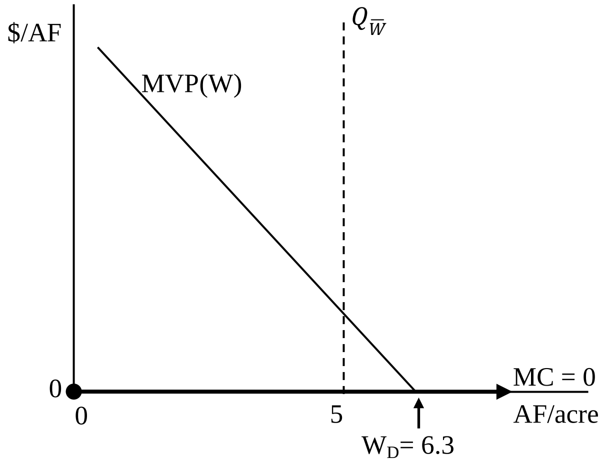


Figure 3.6 – Water Regime 3 example
e.g. Fort Mohave Indian Reservation, CA
($0 for all AF of water pumped as of 2010)



Assigning the agricultural districts of interest to three water regimes allows us to elaborate on the simple agricultural water demand model. We now identify three distinct multioutput profit equations, one corresponding to each water regime. For simplification we develop the equations using two crops. As we do not possess farm-level data, these equations represent district-level cropping decisions, which is the aggregate effect of all farm-level cropping decisions within a district. Water quantity constraints are experienced at the district level in terms of total AF, so the water quantity variables in these equations are measured in units of AF (rather than units AF per acre as in Figure 3.3 –Figure 3.6).

Regime 1: Nonbinding water ceiling, no water price constraint

$$\Pi = P_1Q_1(A_1, W_1) + P_2Q_2(A_2, W_2) - r_1A_1 - r_2A_2 - \theta(A_1 + A_2) \qquad (2)$$

Regime 2: Nonbinding water ceiling, price constraint

$$\Pi = P_1Q_1(A_1, W_1) + P_2Q_2(A_2, zA_T - W_1) - A_1(r_1 + \theta) - A_2(r_2 + \theta) - \omega(W_1 + W_2 - zA_T) \tag{3}$$

$$s.t.\ W_1 + W_2 \leq zA_T$$

Regime 3: Binding water ceiling, no price constraint

$$\Pi = P_1Q_1(A_1, W_1) + P_2Q_2(A_2, \overline{W} - W_1) - A_1(r_1 + \theta) - A_2(r_2 + \theta) - \omega\big(\overline{W} - z(A_1 + A_2)\big) \tag{4}$$

$$s.t.\ W_1 + W_2 \leq \overline{W}$$

where:

P_n = Output price of crop n

r_n = Input production costs for crop n

W_n = Water allocated to crop n (AF)

ω = MC per AF of water beyond first block

θ = Assessment fee (per irrigated acre) for first block of water

Q_n = Output quantity of crop n

A_n = Acreage allocated to crop n

$\overline{W}$ = Institutional water quantity constraint (AF)

z = AF/acre at zero marginal cost

$A_T = \sum_{n=1,2} A_n$

The multioutput profit function for Regime 1 includes one water pricing variable, θ, which is the assessment fee for the first block of water per acre. θ will assume a value of zero for those districts such as Fort Mohave Indian Reservation, AZ (see Figure 3.5) that impose no assessment fee and never charge a marginal cost for water. Only districts not approaching the onset of a marginal cost and unbound by a water ceiling are assigned to Regime 1, so the variables ω, $\overline{W}$, and z are irrelevant and therefore not included in equation (2).

The multioutput profit function for Regime 3 contains $\overline{W}$, which represents the institutional water ceiling imposed on the district. This water quantity constraint is expressed as the condition: $W_1 + W_2 \leq \overline{W}$. This condition indicates that the amount of water allotted to any crop-group can only be as much as the difference between the water ceiling and the amount of water allotted to the remaining crop-groups.

The data suggests that for Regime 2 the constraint of an imposed marginal cost is analogous to a water quantity ceiling. The aggregate of farmers in Regime 2 districts use an amount of water just under the threshold for the onset of a marginal cost. The variable z is the amount of water in AF per acre that farmers can use at no marginal cost. Research indicates that individual acres are not assessed for the amount of water applied; rather, the total water amount a farmer diverts in a given year is divided by the amount of land the farmer puts into production for the same year. This allows us to have use a single variable z in the profit function instead of crop exclusive variables z_1 and z_2. We express the price constraint experienced by farmers in Regime 2 as the condition: $W_1 + W_2 \leq zA_T$. The amount of water in AF per acre that farmers can use at no marginal cost multiplied by the total acres put into production at the district level yields the AF of water the aggregate of farmers experience at no marginal cost. This condition indicates that the amount of water allotted to any crop-group can only be as much as the difference between zA_T and the amount of water allotted to the remaining crop-groups in order to avoid paying a marginal cost for water.

Figure 3.7– Figure 3.9 display graphically the effect of water regime on cropping choice. In Figure 3.7 we see that the optimal water allocation to crop 1 (W_1^*) is wholly disassociated from the optimal water allocation to crop 2 (W_2^*). This demonstrates that when both water quantity and water price are unconstrained a farmer need not consider the amount of water allocated to crop 1 when making decisions about water allocation to crop 2. In Figure 3.8 and Figure 3.9 we observe that water allocations for the two crops are not independent. Farmers

maximize revenues in Regimes 2 and 3 by choosing the water allocations to each crop where the marginal value product for each is equal. If farmers in Regime 2 received a lower marginal cost for water (ω) then water allocations to each crop would be adjusted to maximize total revenue, meaning slightly more water to crop 1 than to crop 2 such that $\mathrm{MVP}_1 = \mathrm{MVP}_2 = \omega$. Farmers in Regime 3 maximize production revenues in the face of a binding water ceiling by adjusting water allocation to crop 1 and 2 such that $\mathrm{MVP}_1 = \mathrm{MVP}_2$ and $W_1^* + W_2^* = \overline{W}$.

Figure 3.7 – Regime 1 water balance Two crop water allocation model

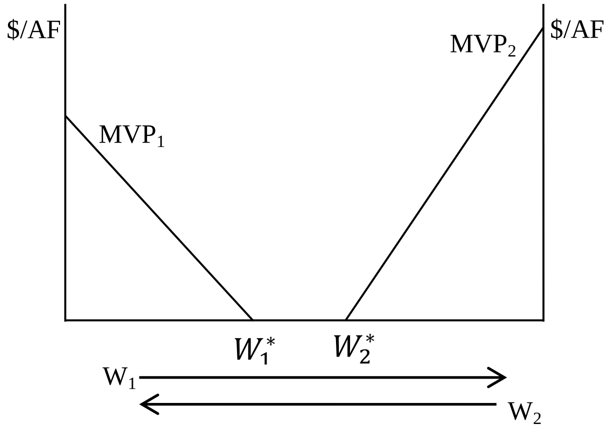


Figure 3.8 – Regime 2 water balance Two crop water allocation model

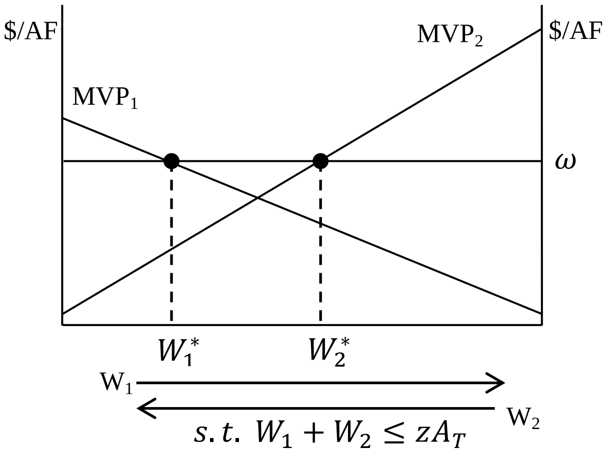
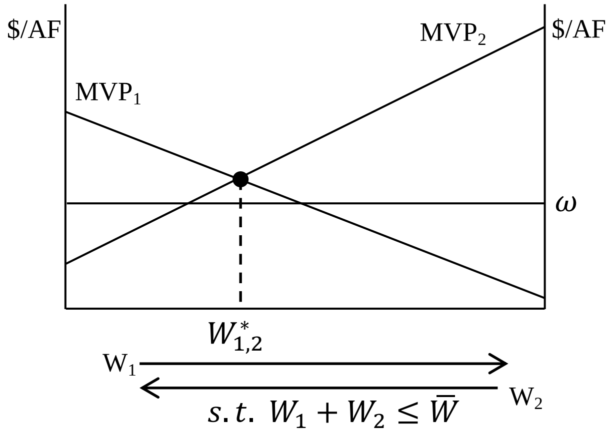


Figure 3.9 – Regime 3 water balance Two crop water allocation model



3.4 Implications of Water Regime Assignment

Thus far we have not discussed the role of land constraints in crop-level land allocation decisions. Establishing water regime assignments did not require an analysis of land constraints, but assessing the implications of regime assignment to cropping decisions does require such analysis, particularly if water constraints are not binding. We discuss the role of land constraints in this section.

Deriving the first-order conditions of equation (2) for Regime 1 we get:

$$\frac{\partial \Pi}{\partial A_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial A_1} - (r_1 + \theta) = 0 \tag{5}$$

$$\frac{\partial \Pi}{\partial A_2} = P_2 \frac{\partial Q_2(A_2, W_2)}{\partial A_2} - (r_2 + \theta) = 0 \tag{6}$$

$$\frac{\partial \Pi}{\partial W_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial W_1} = 0 \tag{7}$$

$$\frac{\partial \Pi}{\partial W_2} = P_2 \frac{\partial Q_2(A_2, W_2)}{\partial W_2} = 0 \tag{8}$$

$$\therefore W_1 = W_1(P_1, A_1) \tag{9}$$

$$\therefore A_1 = A_1(P_1, r_1,) \tag{10}$$

Result (10) indicates that neither water quantity nor water price constrain production in Regime 1. When arable land is not a constraint, cropland allocation to crop 1 is a function of own crop output price and own crop input costs. If arable land is a constraint at the farm level, we would expect a crop’s own-price as well as cross-prices (prices for crops other than crop 1) to be significant factors in determining crop-level land allocations. It is reasonable to assume that arable land is a constraint at the farm level in Regime 1 as farmers face no water quantity or water price constraints that might deter their planting all arable acres. We therefore hypothesize that the cross-price coefficients will be significant in land allocation regressions for Regime 1. Further, we hypothesize that any water variable will not contribute additional explanatory power in land allocation regressions for Regime 1.

Deriving the first-order conditions of equation (3) for Regime 2 we get:

$$\frac{\partial \Pi}{\partial A_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial A_1} + P_2 \frac{\partial Q_2(A_2, zA_T - W_1)}{\partial (zA_T - W_1)z} - r_1 - \theta + \omega z = 0 \tag{11}$$

$$\frac{\partial \Pi}{\partial A_2} = P_2 \frac{\partial Q_2(A_2, zA_T - W_1)}{\partial A_2} - r_2 - \theta + \omega z = 0 \tag{12}$$

$$\frac{\partial \Pi}{\partial W_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial W_1} - P_2 \frac{\partial Q_2(A_2, zA_T - W_1)}{\partial (zA_T - W_1)} - \omega = 0 \tag{13}$$

$$\therefore W_1 = W_1(P_1, A_1, P_2, A_2, z, \omega) \tag{14}$$

$$\therefore A_1 = A_1(P_1, r_1, P_2, z, \omega) \tag{15}$$

Result (15) indicates that when water price is a constraint to production, cropland allocation to crop 1 is a function of own output price, output cross-prices, own input costs, amount of water received at no marginal cost, and the marginal cost paid for water once z is exhausted. Regime 2 consists of districts that are approaching or are just beyond the water use threshold where a marginal cost is imposed for extra water. Approaching this threshold, farmers must make cropping decisions that maximize gross revenues while minimizing the amount of marginal cost water they purchase. We therefore expect that cross-price coefficients will be significant in the land allocation equations for Regime 2 regardless of any land constraints that may be present. We also expect the coefficient on z (AF of water included in first block) to be significant in crop-level land allocation regressions. We expect that the marginal cost of water beyond the first block (ω) will also be significant for Regime 2 cropping regressions, but we do not have this data for all years of the study so we cannot test this effect.

Deriving the first-order conditions of equation (4) for Regime 3 we get:

$$\frac{\partial \Pi}{\partial A_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial A_1} - r_1 - \theta + \omega z = 0 \tag{16}$$

$$\frac{\partial \Pi}{\partial A_2} = P_2 \frac{\partial Q_2(A_2, \bar{W} - W_1)}{\partial A_2} - r_2 - \theta + \omega z = 0 \tag{17}$$

$$\frac{\partial \Pi}{\partial W_1} = P_1 \frac{\partial Q_1(A_1, W_1)}{\partial W_1} - P_2 \frac{\partial Q_2(A_2, \bar{W} - W_1)}{\partial(\bar{W} - W_1)} = 0 \tag{18}$$

$$\therefore W_1 = W_1(P_1, A_1, P_2, A_2) \tag{19}$$

$$\therefore A_1 = A_1(\bar{W}, P_1, r_1 P_2) \tag{20}$$

Result (20) indicates that when water quantity is a constraint to production, land allocated to crop 1 is a function of the water quantity constraint, own-crop output price, own-crop input costs, and output cross prices. Regime 3 includes those districts that approach or exceed the institutional water ceiling. Approaching the water ceiling, farmers must make cropping decisions that maximize gross revenues while remaining at or below their water entitlement. We therefore expect that cross-price coefficients will be significant in the land allocation regressions for Regime 3. It is clear that if farmers are approaching or exceeding the institutional water ceiling then water price is effectively not constraining to production. We therefore expect coefficients on water price variables to be insignificant to the land allocation regressions. Conversely, we expect water quantity coefficients to be significant in land allocation regressions for Regime 3.

CHAPTER 4

DATA AND DESCRIPTIVE STATISTICS

4.1 Data Sources

Data to carry out the econometric analysis was obtained from multiple sources. Data on irrigated acreage and cropping patterns were obtained from the Bureau of Reclamation's Lower Colorado River Accounting System (LCRAS). Data on monthly water diversions and reservoir levels was obtained from USBR Water Accounting Reports. Data on agricultural output and input prices was obtained from USDA's National Agricultural Statistical Service. Streamflow data for various points on the Upper and Lower Colorado River was obtained from National Weather Service's Colorado River Basin Forecast Center and USGS's National Water Information System. Streamflow data for various points on the Alamo and New Rivers was obtained from the USGS's National Water Information System. Agricultural district soil composition and characteristics data was obtained from the Natural Resource Conservation Service's Web Soil Survey. Additional information about irrigation district and reservation water pricing structures, irrigation technology and fallowing programs was obtained via personal communications with district and reservation water and agricultural managers and published reports.

4.2 Agricultural Districts of Interest

A total of 17 agricultural districts were included in this study (see Table 4.1). The districts include five Indian reservations, 11 irrigation districts and one private landowner. Two districts are located north of Lake Havasu and the remaining 15 are south of Lake Havasu, the majority of districts studied being clustered between Imperial Dam and the US-Mexico border (see Figure 4.1). Over 50 agricultural districts utilize water from the Lower Colorado River. This study was narrowed to 17 due to the unavailability of full-panel data for the remaining districts, meaning that water diversion and crop acreage data was available for all 12 years of interest (1996 – 2007) only for these 17 districts. In general, the Bureau of Reclamation kept closer and more complete records of the largest agricultural districts; therefore the 17 districts studied account for more than 70% of total water diversions from the Lower Colorado River Mainstem (see Figure 1.2).

Table 4.1 – Agricultural districts studied (average values for 1996 – 2007)

District	Total Diversions (acre-feet)	Total Ag. Area (acres)	Div./acre (AF/acre)
Imperial Irrigation District, CA	3,073,052	528,195	5.82
Palo Verde Irrigation District, CA	925,808	88,340	10.55
Colorado River Indian Reservation, AZ	613,554	75,350	8.15
Wellton-Mohawk Irrigation & Drainage District, AZ	407,957	88,143	4.64
Yuma Valley Irrigation District, AZ	352,405	77,123	4.58
Yuma Mesa Irrigation & Drainage District, AZ	212,139	17,686	12.04
Fort Mohave Indian Reservation, AZ	67,354	8,831	7.64
Yuma Irrigation District, AZ	65,938	17,860	3.69
Fort Yuma Indian Res., Bard Unit, CA	46,593	10,415	4.50
North Gila Valley Irrigation District, AZ	46,547	10,654	4.38
Fort Yuma Indian Res., Indian Unit, CA	38,808	10,791	3.61
Mohave Valley Irrigation & Drainage District, AZ	36,860	5,020	7.34
Unit "B" Irrigation & Drainage District, AZ	27,248	2,099	13.20
Cibola Valley Irrigation & Drainage District, AZ	24,520	3,805	6.40
Fort Mohave Indian Reservation, CA	21,007	3,346	6.28
Sturges Gila Monster Ranch, AZ	10,619	2,821	3.79
North Cocopah Indian Reservation, AZ	3,918	455	8.81
Total of district averages	**5,974,327**	**950,933**	**6.79**

Figure 4.1 – Agricultural districts studied (highlighted), excluding Imperial Irrig. Dis.

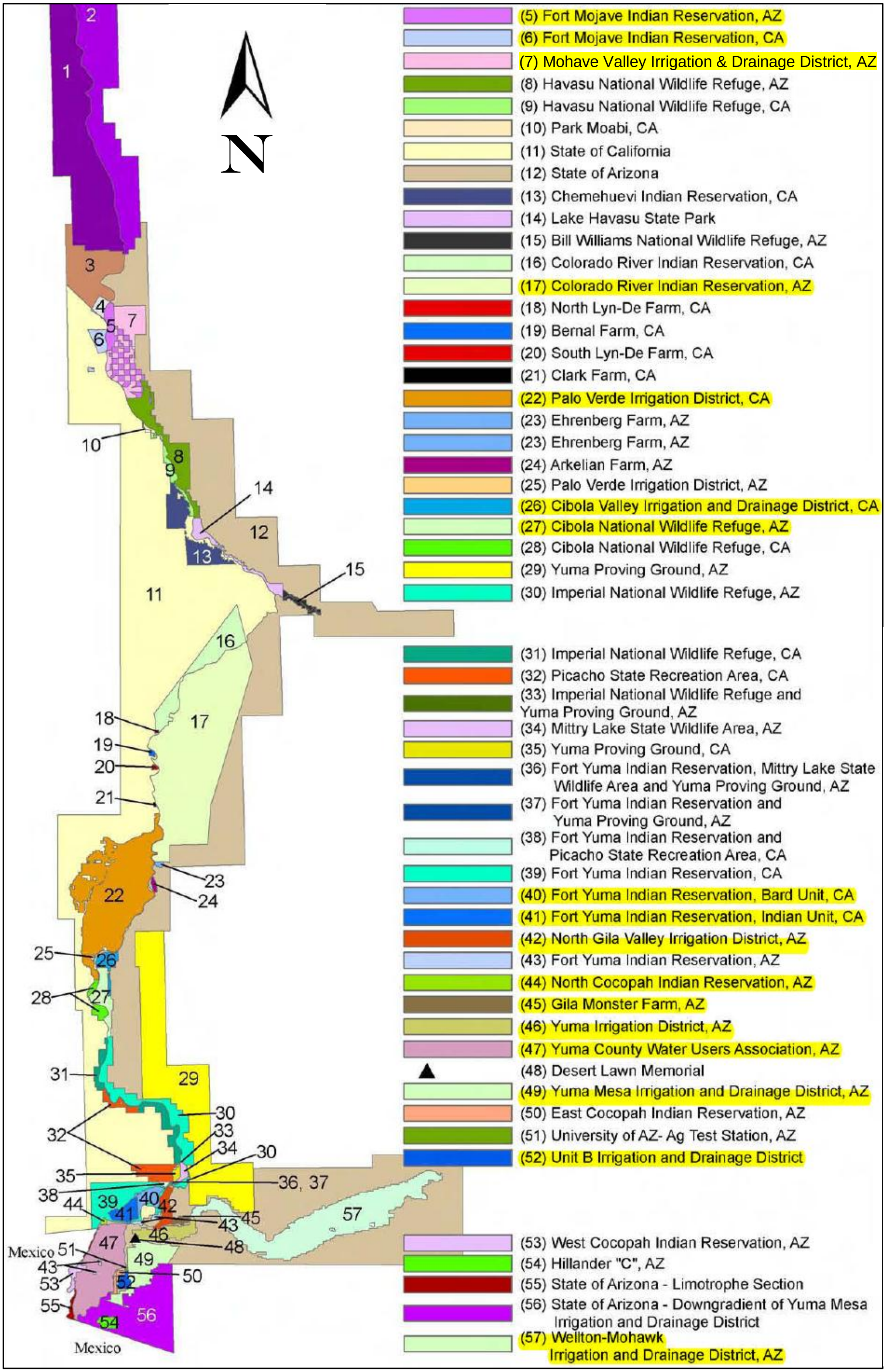
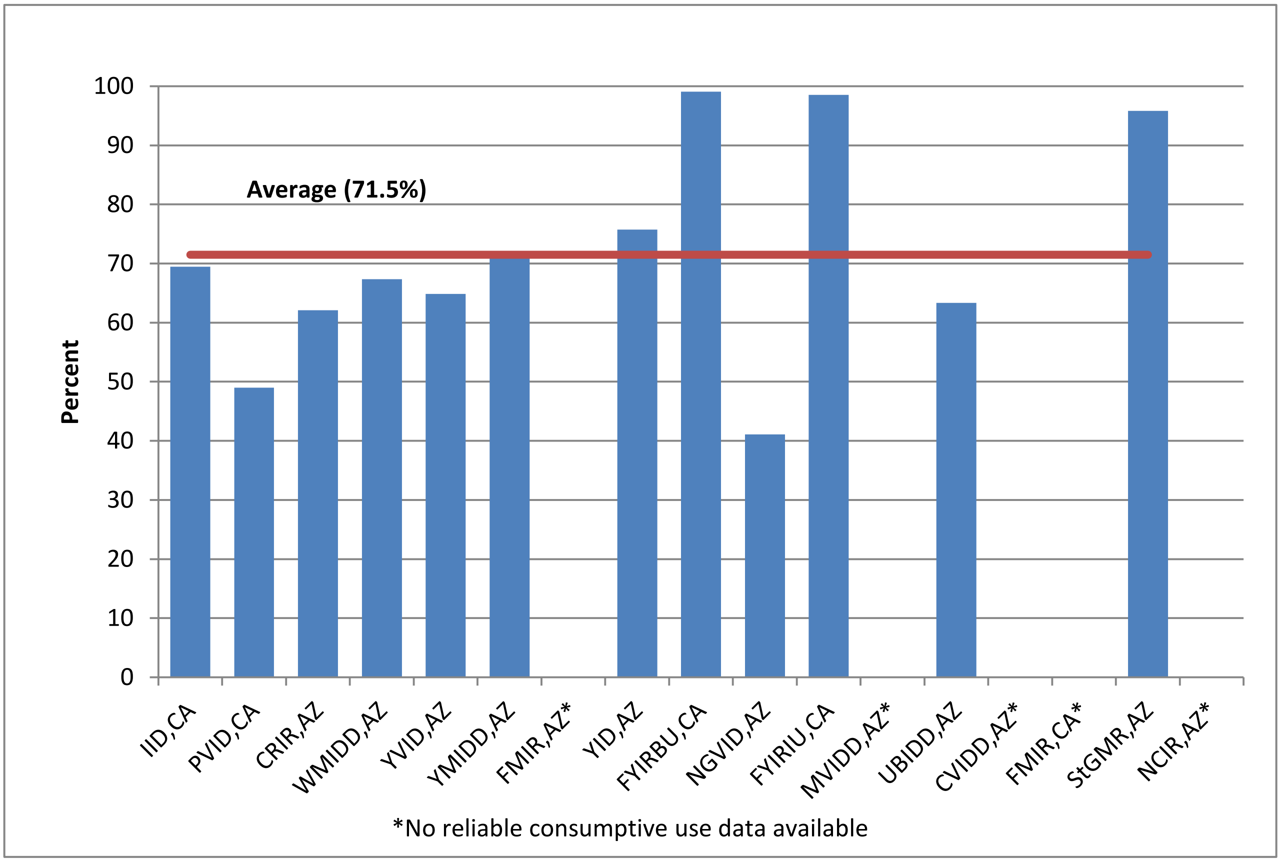


Figure from USBR Lower Colorado River Accounting System Report, 2007

4.3 Consumptive Use

As explained in chapter 1.2.3, consumptive use is measured as diversions less returns to the river. Two major agricultural districts do not divert their agricultural runoff back to the Colorado River. These are Coachella Valley Irrigation and Drainage District and Imperial Irrigation and District (IID). Of these two, only IID is included in this study. IID is by far the largest single district diverter of Colorado River water (more than 50% of water diversions amongst the 17 districts of interest, see Table 4.1) but discharges all of its runoff and drainage to the Salton Sea. Because there are close to zero "returns" recorded, the USBR reports the IID as consuming close to 98% of the water it diverts. Outreach to the USBR provided us with a

Figure 4.2 – Percent of diversions consumed (listed largest to smallest by diversion)



remedy to this issue. USBR representatives stated that about 90% of IID runoff and drainage is captured by the Alamo River and the New River, both of which empty into the Salton Sea. The remaining 10% of runoff and drainage is delivered to the Salton Sea by more than 35 “direct to sea drains”. The U.S. Geological Survey (USGS) manages a number of streamflow measurement stations along the Alamo and New rivers, but no flow measurements for the direct to sea drains are taken. To develop data that would account for 90% of IID’s agricultural runoff and drainage, we subtracted the annual flow of the Alamo and New rivers measured at the point where the rivers enter IID (on the US-Mexico border) from the annual flow measured at the point where the rivers discharge into the Salton Sea. Subtracting these proxy “returns” values from annual diversions yielded our new annual consumptive use values for IID. Average consumption as a percent of diversions for IID from 1996 – 2007 using these new values is 69.5%, a more reasonable number than the 98% we derived using the USBR data and well within one standard deviation of the district average of 71.5% (see Figure 4.2).

A closer look at Figure 4.2 will reveal that there is considerable disparity in district consumption percentage rates. The percent of diverted water that is consumed depends upon a number of different factors including soil composition, water pricing structure, irrigation technology, cropping choice, and reporting accuracy. Evaporative losses from canals and reservoirs will increase percent consumption so those districts with extensive open canal systems will experience higher consumption rates than those pumping groundwater from the floodplain. Those districts with consumptive use at over 90% of diversions likely have runoff and drainage either draining to a source other than the Colorado River or the returns to the Colorado River are not being wholly accounted for. It is noteworthy to mention that none of the six largest districts by diversions (making up over 90% of all diversions for districts of interest) fall into this category; as mentioned earlier in this chapter, more comprehensive records have been compiled for the largest agricultural districts.

Consumptive use is generally a good indicator of agricultural water consumption despite district consumptive use by non-agricultural sectors. A number of the agricultural districts include homes and even small cities within their boundaries that use some portion of the district's water entitlement, but this is a very small portion of total water use. Consider for example the metropolitan area of El Centro, California[6] which is completely contained by and receives Colorado River water from IID; with 39,384 households (U.S. Census Bureau, 2000) and an average household consumption of about 0.25 AF per year (Planning Division, 2001), total residential consumption of water within IID is about 9800 AF annually. This constitutes about 0.3% of IID's average annual Colorado River diversion.

4.4 Water Price Variable

Due to variation in irrigation infrastructure, soil types, and water entitlement priorities amongst agricultural districts, the price districts charge farmers for water varies throughout the region. For example, Mohave Valley Irrigation and Drainage District (MVIDD), where farmers pump all irrigation water from the ground, there is no cost for water except for the energy cost associated with pumping. Imperial Irrigation District (IID) on the other hand has an extensive irrigation canal system that spreads across hundreds of miles and the charge to farmers is $20

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[6] The El Centro metropolitan area includes the cities of El Centro, Calexico, and Brawley, among others.

per AF of water for all water delivered (as of 2011). More common is a pricing system such as that used by the Colorado River Indian Reservation (CRIR) (see Table 4.2). This pricing structure (as of 2000) requires farmers to pay a flat fee of $38.5 for the first five AF of water per acre of land, regardless of whether or not they divert all five AF per acre. To divert more than this allotted amount farmers are charged $17 per AF for all water in excess of five AF per acre.

The flat fee for the first block of water has increased over the timeframe of this study due to inflation and infrastructure improvements, but the amount of water allotted for this first block of water has remained constant for all districts employing such a system. Variation in the amount of water allotted for this first block tends to be positively correlated with sandier soil types. For example, in year 2010 Yuma Mesa Irrigation and Drainage District (YMIDD), which

Table 4.2 – Water pricing and diversions per acre

District	Price/pricing system	As of:	*ZeroMC_AF**	Div./acre (96'-07'avg.)
IID,CA	$20/AF for all water delivered	2011	0	5.82
PVID,CA	$55 flat rate charge per acre of land	2010	12	10.55
CRIR,AZ	$38.5 for first 5AF/ac, $17/AF for >5 AF/ac	2000	5	8.15
WMIDD,AZ	$84 flat payment for first 4 AF/ac. Increasing rate per AF for all AF beyond 4 AF/acre	2010	4	4.64
YVID,AZ	$86 for first 5 AF/acre	2010	5	4.58
YMIDD,AZ	$70 for first 9 AF/acre	2010	9	12.04
FMIR,AZ	$0/AF for all water	2011	11	7.64
YID,AZ	$35 for first 5 AF/ac	2008	5	3.69
FYIRBU,CA	$68.5 for first 5AF/ac. $14.5/AF > limit	2011	5	4.50
NGVID,AZ	$38 for first 5 AF/acre	2010	5	4.38
FYIRIU,CA	$73 for first 5AF/ac. $14.5/AF > limit	2011	5	3.61
MVIDD,AZ	No cost as of 2009. Limited to 7 AF/ac.	2009	8	7.34
UBIDD,AZ	$150 for first 10 AF/ac	2010	10	13.20
CVIDD,AZ	$11/AF for all water delivered. Informally limited to 6 AF/ac.	2011	0	6.40
FMIR,CA	$0/AF for all water	2011	5	6.28
StGMR,AZ	Pay an undisclosed amount for all AF of water diverted	2010	3.25	3.79
NCIR,AZ	$86 for first 5 AF/acre	2010	5	8.81
	*censored at 12 AF/acre	**Average Div./acre for all districts**		**6.79**

has a sandier soil (see Figure 4.5) and therefore lower water retention, charges $70 for the first nine AF per acre and then a marginally higher cost for diversions beyond this amount (as of 2010). Soil composition variables are discussed in a chapter 4.9.

Table 4.3 – Correlation of 4 variables relevant to water pricing structure

	ZeroMC_AF	div/acre	%sand	%clay
ZeroMC_AF	**1**			
div/acre	**0.508**	**1**		
%sand	**0.235**	**0.652**	**1**	
%clay	**-0.162**	**-0.512**	**-0.881**	**1**

The variable developed as a proxy for water price, *ZeroMC_AF*, is the amount of water (measured in AF per acre of land in production) that a farmer receives in the first block before a marginal cost is incurred. For IID the variable value is 0, for CRIR the variable value is 5, and for YMIDD the variable value is 9. For those districts with no established first block of water but experience an institutional water constraint, *ZeroMC_*AF assumes a value equal to the number of AF per acre they could divert before exceeding this constraint. We reason that there is some cost – whether it is a fine or a water debt that must be paid back the following year – for exceeding an institutional water ceiling. The variable is censored at 12, so for those districts that do not charge farmers for irrigation water at any diversion amount and divert well below their institutional water ceiling, such as PVID,CA, the variable assumes a value of 12. *ZeroMC_AF* is constant for a given district over the study period (1996 – 2007) and is used as the exclusive water variable in all variable water input models. See Table 4.2 for all district water pricing structures and *ZeroMC_AF* values. The variable has a minimum of 0, a maximum of 12, a mean of 6.59, and a standard deviation of 3.814.

4.5 Water Quantity Variable

The variable we developed for water quantity, *prop_t1div*, is the total amount of water the district diverted the previous year divided by the district's maximum total agricultural acreage. The denominator (maximum total agricultural acreage) is the highest single year value assumed for total cropland acreage over the 12 years studied, as this is a good indicator of the total arable land within the district[7]. State water law in both Arizona and California is administered according to the prior appropriation doctrine, which grants chronologically senior water users more certainty over water supply. The agricultural districts of interest were established relatively early in time and all receive at least a portion of their water at a high priority (see Table 1.1). Thus, lagged water diversions serves as a strong predictor of current year's water diversions (correlation coefficient for lagged and current diversions is 0.998). We use lagged diversions rather than current year diversions to avoid an endogeneity issue. When farmers are making cropping decisions at the beginning of the growing season, they do not know how much water they will actually use, so using current year

Table 4.4 – Summary statistics for *prop_t1div* (water quantity var.)

District	min	mean	max	st. dev.
CRIR,AZ	7.01	7.49	8.66	0.469
CVIDD,AZ	3.08	5.92	7.08	1.356
FMIR,AZ	6.08	7.05	8.50	0.626
FMIR,CA	4.16	5.46	7.85	1.252
FYIRBU,CA	3.03	3.83	4.56	0.478
FYIRIU,CA	2.47	3.18	3.91	0.562
IID,CA	5.07	5.56	5.89	0.267
MVIDD,AZ	5.95	6.97	8.61	0.734
NCIR,AZ	2.39	6.55	10.95	2.621
NGVID,AZ	3.83	4.06	4.36	0.178
PVID,CA	8.17	9.41	10.20	0.592
StGMR,AZ	1.47	3.17	4.66	0.889
UBIDD,AZ	8.92	10.33	12.10	1.089
WMIDD,AZ	3.73	4.06	4.41	0.180
YID,AZ	3.30	3.51	3.77	0.141
YMIDD,AZ	8.58	10.21	11.45	0.925
YVID,AZ	3.68	4.08	4.32	0.180
Totals	1.47	5.93	12.10	2.494

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[7] Maximum total agricultural acreage counts many acres more than once, as multi-cropping is a common practice in this region due to favorable year-round climate. It is effectively a measure of the maximum number of agricultural production acres in a given year.

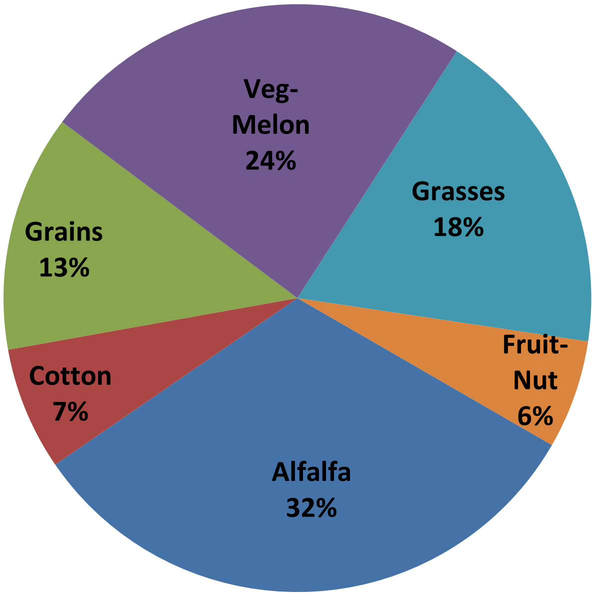
water in functions designed to predict cropping decisions is unrealistic and furthermore introduces contemporaneous correlation with the error term. Lagged water diversions are not contemporaneously correlated with the error term and correspond to an adaptive expectations model.

We divide lagged diversions by maximum total agricultural acreage to account for the total land constraint that each district faces and to generate a more realistic coefficient when estimating the functions econometrically. To use actual lagged diversions would skew all results toward the few largest districts, and especially toward Imperial Irrigation District, which makes up more than 50% of water diversions amongst the 17 districts of interest (see Table 4.1). Such analysis would be informative for total water use for the region, but it would not shed much light on how cropping decisions are made at the farm-level within individual districts. Dividing lagged diversions by maximum total agricultural acreage normalizes the variable, in effect rendering it the number of AF per acre a district is diverting, and thereby negating the enormous discrepancy in district size. This allows us to observe the relative effect that water quantity has on farmers' cropping decisions.

4.6 Crop-Groups studied

All agricultural crops grown in each district were sorted into one of six crop-groups: alfalfa, cotton, grains, vegetable-melon, grasses, and fruit-nut. The alfalfa crop-group includes alfalfa hay and seed. Cotton includes both Pima and Upland varieties, though Upland comprises the lion's share in all districts. The remaining four crop-groups include numerous crops of the designated title, but are generally dominated by one or two of the individual crops. Crops were allocated to crop-groups by similarities in growing cycle, price structure, and irrigation requirements. For example, both fruit and nut trees require a planning horizon beyond the single season, so even if prices are down for fruits or nuts, the multi-year commitment to growing the orchards will not be ignored and the trees will receive at least enough irrigation water to sustain them until markets are more favorable. By contrast, if cotton prices are down for a given year, we hypothesize that the agriculturalist will allocate less land to this crop the following year. Treating crops at this aggregate level does not allow for differentiation amongst some individual crops, such as wheat and corn, but this trade-off allows us to identify larger trends (see Figure 4.4).

Figure 4.3 – Crop-groups by percent of all acres planted over the study period



Due to the mild winters with a minimum of frost and long hot summers, the agricultural districts along the Lower Colorado

River have a year-round growing season. This allows for multi-cropping practices, meaning that the same acre of land can produce two or more crops, of the same or different varieties, in the same year. This means that in a given year, a district might have more cultivated acres than total arable acres available. This also makes it difficult to determine when the farmers are making their land allocation decisions, as they are actually doing it at multiple times throughout the year for certain crops.

4.7 Dependent Variable

The dependent variable used for all regressions is *proportion of total arable land dedicated to crop-group*. This is constructed as the district's annual crop-group acreage divided by the district's maximum total agricultural acreage. The crop-group proportion variable denominator (maximum total agricultural acreage) is the highest single year value assumed for total cropland acreage over the 12 years studied, as this is a good indicator of the total arable land within the district. The sum of the variables for any given year within one district, therefore, does not equal one (with the exception of the year upon which the denominator is based).

Table 4.5 – Dependent variable summary stats

Dependent variable		**Mean**	**Std. dev.**	**Min**	**Max**
prop_alfalfa	overall	0.237	0.227	0.000	0.771
	between		0.223	0.003	0.593
	within		0.066	0.025	0.538
prop_cotton	overall	0.133	0.138	0.000	0.653
	between		0.128	0.003	0.470
	within		0.059	-0.077	0.406
prop_grains	overall	0.124	0.107	0.000	0.466
	between		0.097	0.016	0.326
	within		0.050	-0.202	0.264
prop_vegmel	overall	0.231	0.198	0.000	0.578
	between		0.194	0.006	0.496
	within		0.062	-0.078	0.526
prop_grasses	overall	0.100	0.061	0.000	0.286
	between		0.043	0.053	0.238
	within		0.045	-0.013	0.273
prop_fruitnut	overall	0.063	0.121	0.000	0.601
	between		0.121	0.000	0.463
	within		0.029	-0.015	0.290
Observations: N = 204, n = 17, T = 12					

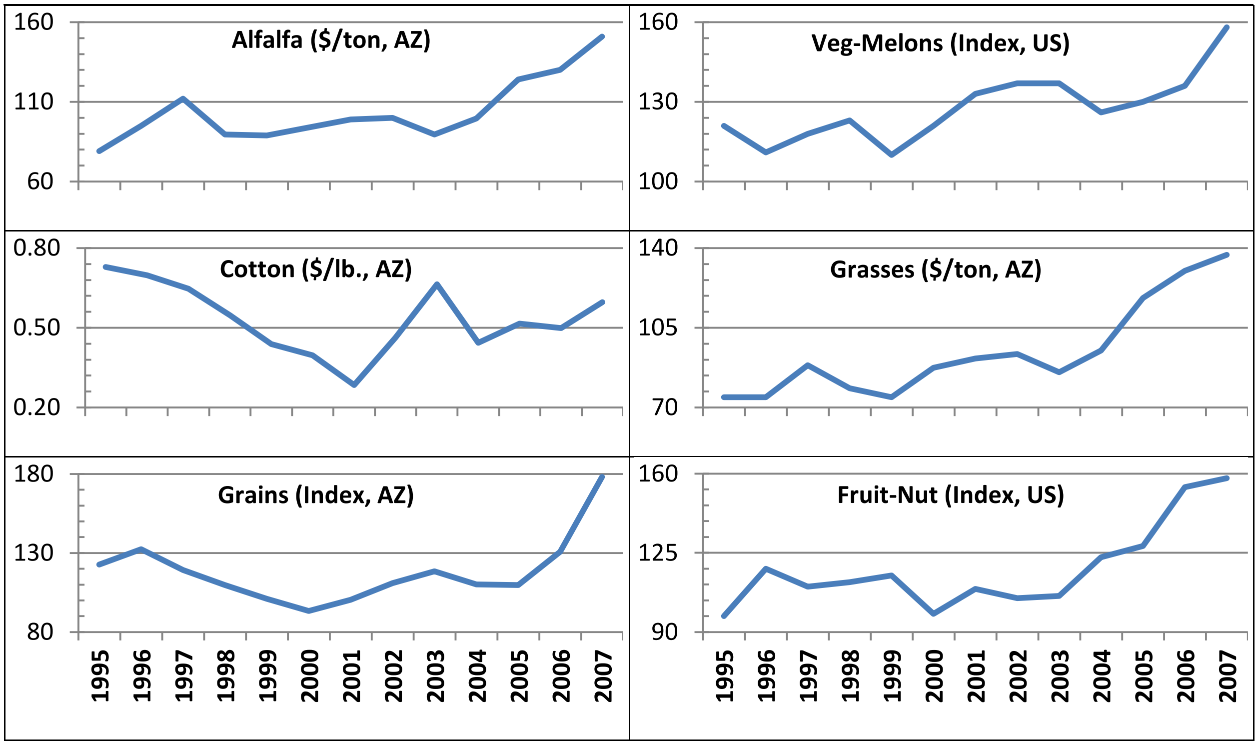
Normalizing crop-group acreage by total arable land allows us to readily interpret coefficients at the district level. The dependent variables of the six cropland allocation regressions are named *prop_alfalfa, prop_cotton, prop_grains, prop_vegmel, prop_grasses,* and *prop_fruitnut*.

4.8 Crop Output Prices

Crop taking prices were obtained from NASS. Where available, Arizona prices were used, as at the state-level Arizona is more representative of the region and climate of the Lower Colorado River than is California. Prices for alfalfa (*npr_alfalfa*), cotton (*npr_cotton*), grains (*npr_grains*) and grasses (*npr_grasses*) are Arizona values for $/ton, $/pound, index number, and $/ton, respectively. Alfalfa and cotton crop-groups only consist of alfalfa and cotton, respectively, so prices were used directly from NASS' Arizona price listings. Our grasses crop-group consists primarily of Bermuda and Sudan grasses, which in NASS is classified as "Other Hay" ("other" being exclusive of alfalfa). NASS does not have a price category associated closely with our grains crop-group, so we constructed a Laspeyres index for Arizona prices of durum wheat, corn, and barley based on 1990 – 1992 prices, as NASS uses for their indices. Vegetables-melons (*npr_vegmel*) and fruits-nuts (*npr_fruitnut*) are national index number values for NASS categories "Commercial Vegetables" and "Fruit & Nuts", respectively. For those variables which an index number is used, the index base is 1990-1992=100. Price trends for the crop-groups studied are displayed in Figure 4.4.

Decisions made before and during the growing season depend on commodity prices expected to prevail at harvest. We use the standard practice in the econometric literature on agricultural production of using the price at harvest in the previous year, i.e., a one-year lag (Negri & Moore, 2009). All crop taking prices are for the previous year and normalized by the price of production items (a national index number for typical farm input items) in the current year since a normalized quadratic profit function requires a numeraire price, hence the “npr” prefix preceding those relevant variables (Negri & Moore, 2009). Figure 4.4 shows the non-normalized crop-group price trends. As one might expect, the general price trend is upward over the 12 year study period.

Figure 4.4 – Crop-group taking price trends (non-normalized)



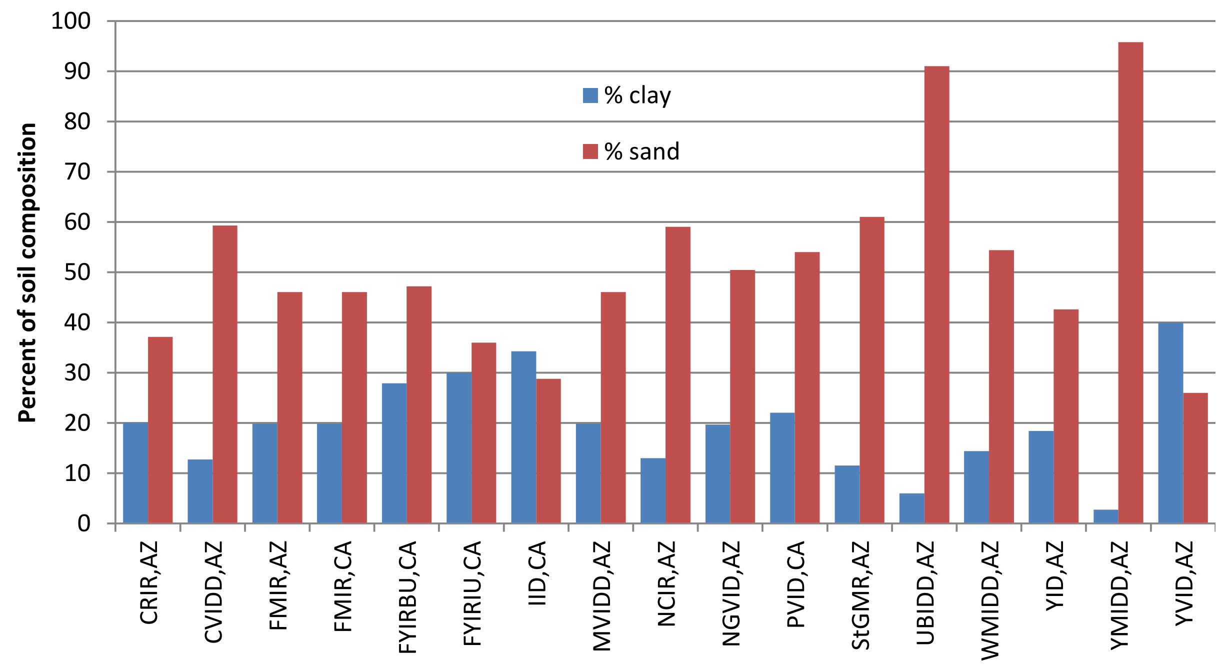
4.9 Soil Characteristics

A major factor in determining what crops farmers will grow and how much water is necessary for them to grow those crops is the soil composition of the farmland. The Natural

Resource Conservation Service's (NRCS) Web Soil Survey is a comprehensive soil mapping tool and was used to map and compile the soils of the agricultural districts studied. The mapping software allows for areas of up to 10,000 acres to be defined and described at one time. This acreage constraint was not a limitation for the two smallest districts of interest, but all other districts had to be mapped in 10,000 acre or fewer segments and the data compiled using weighted averages by segment size.

Commonly used in the agricultural economics literature are a percent clay variable and a percent slope variable (see Negri and Moore, 2009). In any of the agricultural districts we studied, slopes were generally 0% with a few values of 1%. Negligible slopes are due to laser leveling techniques for optimized irrigation and a generally flat floodplain to begin with.

Figure 4.5 – Soil composition and classification variables



Drainage class	4	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3
Hydrologic soil group	5	4	3	3	6	1	4	3	6	4	4	4	1	3	4	3	3

Table 4.6 – Soil classification variables

Soil drainage class		Hydrologic soil group		
Variable value	**NRCS definition**	**Variable value**	**NRCS class**	**NRCS definition**
1	excessively drained	1	A	High infiltration
2	somewhat excessively drained	2	A/B	
3	well drained	3	B	moderate infiltration
4	moderately well drained	4	B/C	
5	somewhat poorly drained	5	C	slow infiltration
6	poorly drained	6	C/D	
7	very poorly drained	7	D	very slow infiltration

Percent clay is an excellent measure for water retention and potential soil fertility, but it excludes some vital information about the soil. Soil is composed three dominant parent materials: clay, silt, and sand. Clay is the finest (having the smallest grains), sand is the coarsest (having the largest grains), while silt is between these two in texture and grain size. Finer grain size means more surface area and consequently greater water retention; hence clayey soils retain water at a greater rate than do sandy soils. Due to the smaller pore size (space between soil grains) clayey soils also have much slower water infiltration rates than sandy soils. In both water retention and water infiltration, silty soils generally fall between clayey and sandy soils. To avoid perfect multicollinearity, percent clay (*clay*) and percent sand (*sand*) were included as variables while percent silt was excluded.

The NRCS also specifies soil drainage classifications and hydrologic soil groupings which we hypothesize are good indicators of irrigation quantity and frequency requirements. Drainage class (*drnge*) is defined by the NRCS as the natural soil drainage with no alterations of the water regime by human activities. Seven classes are recognized and used as the variable values. Each district is assigned the district soil average (see Table 4.6).

Hydrologic soil groups (*hydrgrp*) are based on estimates of runoff potential according to the rate of water infiltration when the soils are not protected by vegetation and are thoroughly wet (NRCS, 2009). Soils are assigned to one of four groups according to the rate of water infiltration. NRCS specifies 4 main groups (A, B, C, D) with A having the highest infiltration rate and D having a very slow infiltration rate (see Table 4.6). Variable values are assigned as the district average. See Figure 4.5 to observe all soil composition and classification variables by district.

4.10 Indian Reservation Indicator

An indicator variable was created to evaluate the effect of a district being an Indian reservation. Five Indian Reservations are represented in the panel giving the indicator variable (*IndianRes*) a mean value of 0.294 across all 204 observations. We hypothesize that Indian reservation agricultural and irrigation infrastructure might lag technologically compared to surrounding agricultural districts, as general infrastructure investments on Indian reservations tend to be below the national average (GAO, 2011). Outdated irrigation technologies might lead to higher water diversions per acre and outdated agricultural technologies could lead to a reservation bias toward crops that require less mechanized agricultural techniques.

Informal interviews via phone and email correspondence with district representatives indicated that most agricultural production on at least two Indian reservations (Fort Mohave Indian Reservation, CA and North Cocopah Indian Reservation, AZ) is conducted by non-tribal farmers through land leases. These land leases to non-tribal entities could negate some of the effect that we hypothesize the indicator variable will capture.

4.11 Elevation

The average elevation of an agricultural district might impact a number of factors involved in crop productivity and water usage. More power is required to pump river water to districts sitting higher above the river. Climatic variables such as temperature and rainfall might differ by elevation. Soils tend to be sandier and less fertile as districts are higher above the floodplain (see Table 4.7). Such soils generally require more irrigation water and limit crop selection.

Table 4.7 – Correlation of elevation with three related variables

	Elevation	%sand	%clay	div/ac.
Elevation	**1**			
%sand	**0.694**	**1**		
%clay	**-0.623**	**-0.881**	**1**	
div/ac.	**0.351**	**0.652**	**-0.512**	**1**

As the law of gravity dictates, the elevation of the Colorado River constantly decreases from its headwaters to its mouth at the Gulf of California. The elevation variable was therefore constructed to report the difference between the average elevation of the agricultural district and the elevation of the Colorado River at its nearest point to the district. The variable was censored at zero (the elevation of the river) due to the presence of Imperial Irrigation District (IID) in the study. IID is on average about 120 feet below sea level and about 225 feet below the Colorado River Mainstem at the closest point (about 50 miles away). IID has no physical characteristics that would account for a variable value of -225 compared to the overall average of 33 (excluding IID). As no pumping costs are involved moving water downhill to IID and soil characteristics of IID are similar to the overall profile of the region (see Figure 4.5), we censor elevation (and consequently IID) at zero rather than compromise the explanatory value of the variable.

4.12 Land Fallowing Programs

Land fallowing for water conservation and out of district water transfers has been implemented in at least two of the agricultural districts of interest, Imperial Irrigation District (IID) and Palo Verde Irrigation District (PVID). These two California agricultural districts are the two largest by acreage and water diversions along the Lower Colorado. The acres fallowed by year and all relevant information that was available concerning the fallowing programs are displayed in Table 4.8. The fallow variable we use in the model is *prop_fallow* which represents the proportion of total arable land dedicated to fallowing. This is constructed as the acreage fallowed each year in the IID and PVID land fallowing programs divided by maximum total agricultural acreage, for each district. The *prop_fallow* variable denominator (maximum total agricultural acreage) is the highest single year value assumed for total cropland acreage over the 12 years studied, as this is a good indicator of the total arable land within the district. The variable assumes a value of zero for all districts other than IID and PVID, and assumes a value of zero for IID and PVID in those years a fallowing program is not in place.

4.12.1 PVID Fallowing Program

PVID entered a two-year test land fallowing program from August 1, 1992 to July 31, 1994. The program called for 20,215 acres of land to be fallowed with the saved irrigation water diverted by Metropolitan Water District (MWD), which supplies water to Los Angeles and San Diego. Payments to fallowing farmers were $620 per fallowed acre per year, totaling about $25 million during the two-year period (Smith, 2005). In 2003, PVID came to the aid of Coachella Valley Water District (CVWD) by implementing a six-month fallowing program. This effort fallowed 17,109 acres of land to make 40,590 AF of water available for diversion by the

CVWD, which was experiencing a water shortage. CVWD paid PVID farmers a flat rate of $750 per acre of land that was fallowed. CVWD holds a lower priority entitlement to Colorado River water than both PVID and IID and in 2003, due to a shortage on the Colorado River, CVWD had its typical annual diversion cut by 31%, prompting the short-term fallowing program with PVID (CVWD, 2003).

Table 4.8 – Fallowing programs for districts of interest

Palo Verde Irrigation District, CA					Imperial Irrigation District, CA				
Cal. Year	Acres fallowed	AF saved	AF/acre saved	% of dist. fallowed	Year (7/1 - 6/30)	Acres fallowed	AF saved*	AF/acre saved*	% of dist. fallowed
1992	8423	28301	3.36						
1993	20215	92989	4.60						
1994	11792	64689	5.49						
2003	17109	40590	4.75	17.5	2003 - 2004	5764	38641	6.7	1.0
2004	5526	12917	2.34	5.6	2004 - 2005	12127	67273	5.5	2.2
2005	22774	108666	4.77	23.3	2005 - 2006	11676	69764	6	2.1
2006	19968	105039	5.26	20.4	2006 - 2007	17984	96395	5.4	3.2
2007	14689	72310	4.92	14.9	2007 - 2008	16172	89512	5.5	2.9
2008	19332	94303	4.88	19.7	***at farm as opposed to at river; not specified for PVID**				

In 2005 the PVID entered into a 35 year fallowing program in conjunction with the Metropolitan Water District (MWD). Under the terms of the agreement, PVID farmers receive payments to take up to 29% (about 26,000 acres) of their land out of production each year for the 35 years, with a required minimum of 7% (about 6,000 acres) (PVID, 2011). MWD can request the maximum amount of water for only 10 of the 35 years (with a one year notice given to the PVID) and did so for the first time in 2008, much earlier than the 2015 date estimated by officials in 2005 (Bowles, 2008). The fallowing is estimated to supply Southern California with an estimated 25,000 to 111,000 AF of water per year and up to 3.63 MAF of water over the term of the program (PVID, 2011). It is not possible to measure the exact amount of water conserved through fallowing because the types and acreage of crops that would have been grown on the fallowed lands absent the fallowing program are unknown (PVID, MWD, USBR, 2010).

The payment schedule is specified in the *Forbearance and Fallowing Program Agreement* between MWD and PVID (MWD-PVID, 2004). The agreement specifies that participating farmers receive an initial payment of $3,170 per water toll acre of their maximum fallowing commitment. At the district level, this initial payment amounts to about $82 Million. Each contract year, MWD makes a payment to participating farmers for each fallowed acre. This payment is $602 in the first year with an annual escalation for the first 10 years of 2.5%. Annual escalation for the remaining 25 years is subject to the CPI but cannot exceed 5% or drop below 2.5%. In years when 29% of PVID land is fallowed, the payment at the district level is about $16 million.

In 2003 the Riverside County Agricultural Commissioner valued the gross returns on PVID’s 106,582 acres of agricultural land to be $91,978,200 (PVID, 2005). This is an average value of $863 per acre of agricultural land. The payments of $602 per acre of fallowed land for the MWD-PVID fallowing program appear reasonable, as the expected gross return value of $863 does not account for agricultural input costs.

4.12.2 IID Fallowing Program and QSA

Agriculture and associated irrigation has a longer history in Southern California than urbanization and subsequent urban water demands. The result is that Agricultural districts such as IID and PVID have some of the most senior water rights along the Colorado River. To accommodate explosive population growth and resultant urban water demands in the latter part of the 20th century, urban water districts had to strike expensive deals with agricultural districts to procure additional Colorado River water (Committee on the Scientific Bases of Colorado River Basin Water Management, 2007).

Imperial Irrigation District is the largest irrigation district in the United States and its right to consume more than 2.6 MAF of Colorado River water comprises more than half of California's 4.4 MAF total allocation (IID, 2011). Appropriately, the IID has the long history of conservation, fallowing, and water transfer programs. The first water reallocation programs implemented on the IID were efficiency initiatives while in more recent years these initiatives have been supplemented with fallowing to make even more water available for urban use and Salton Sea maintenance (IID, 2005).

IID began canal lining and water delivery automation initiatives in the early 1950's. In 1988, IID finalized a 35 year water conservation and transfer agreement with MWD. Under this agreement, MWD paid for water conservation measures in exchange for procurement and transfer of the water conserved, estimated to be over 100,000 AF per year (IID, 2011). More relevant to this study, in 1998 IID and San Diego County Water Authority (SDCWA) entered into a similar long-term conservation and water transfer agreement to make available to SDCWA a minimum annual quantity of 130,000 AF and a maximum annual quantity of 200,000 AF, all to be provided by efficiency projects (IID, 2011).

The most recent conservation by efficiency initiative is the Quantification Settlement Agreement (QSA), which became effective in October 2003. The QSA was designed to settle certain disputes among the United States, the State of California, IID, MWD Coachella Valley Water District and SDCWA regarding the reasonable and beneficial use of Colorado River

Water. This set of contracts identifies the conserved water volumes and transfer schedules for IID along with the price and payment terms (IID, 2011). The agreement specifies that IID will transfer to SDCWA up to 200,000 AF and to CVWD and MWD combined up to 103,000 AF per year of water conserved from delivery system improvements and on-farm efficiency improvements. Additionally, IID will transfer up to 67,000 AF per year of conserved water from the lining of the All-American Canal to SDCWA and certain San Luis Indian Tribes in exchange for the payment of canal lining project costs.

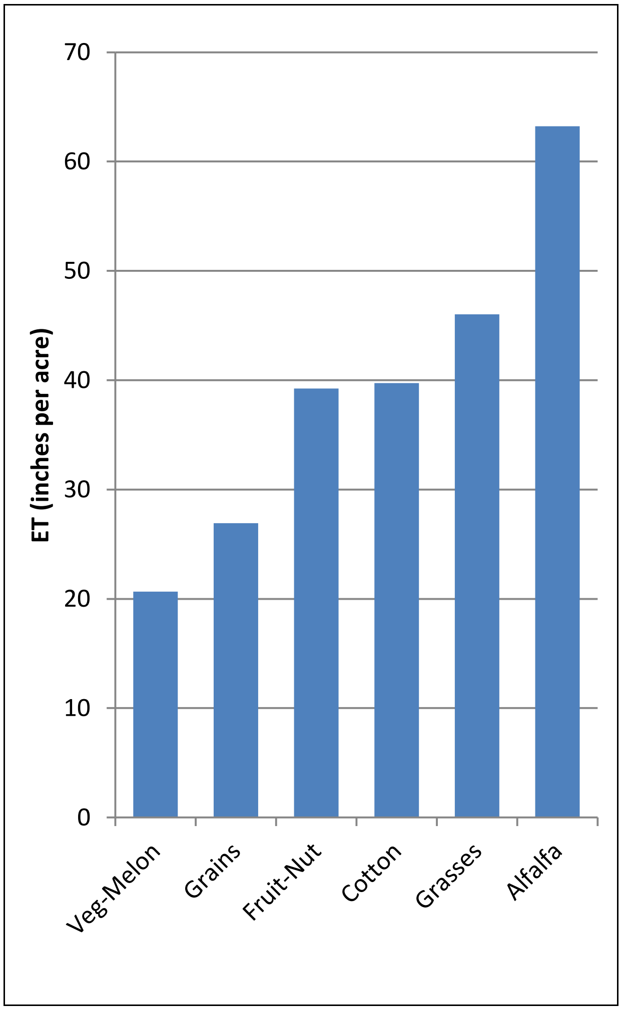
In December of 2003 the IID implemented a 13-month Emergency Fallowing Program in order to meet the water conservation target set by the QSA (IID, 2011). This effort put 5,764 acres of cropland to fallow, conserving 38,641 AF of water for transfer outside of IID. A total of $1,774,782 in payments was made to participating farmers. Fallowing has been in place each year subsequent to the 2003 Emergency Fallowing Program and is slated to continue for 15 years total. Fallowed acreage ramps up for the first 10 years and then decreases for the next five years and is expected to be entirely substituted with efficiency conservation projects by the end of this period. As of 2008, 63,723 total acres have been fallowed resulting in 415,290 AF of water being conserved for transfer. Total fallowing payments to farmers through 2008 are $19,884,763, equating to an average cost of about $55 per AF of water conserved.

The fallowing initiatives of PVID and IID have profound implications for the purposes of this study. Farm-level cropland allocation modifications in response to recent fallowing may be an indication of how agriculture along the Lower Colorado River will react in the future as urban water demand continues to increase and global climate change renders Colorado River flows less predictable.

4.13 Water Demand by Crop-Group

An important component of land allocation decisions when irrigation water is a constraint is the amount of water a crop requires throughout the growing season. The USBR has compiled this data annually as total crop evapotranspiration (total ET) for each district. Total ET is defined as the crop's evapotranspiration rate (ET rate) multiplied by the total acreage of that crop in the district. ET rate for a particular crop takes into consideration effective precipitation that the district has experienced in that year, a crop reference value that is determined by years of empirical evidence, and a coefficient that considers variables such as wind. As Imperial Irrigation District (IID) constitutes more than half of total crop acreage and water diversions for this study, we have used 2003 – 2006 averages of IID crop ET rates to develop representative crop-group ET rates for the crop-groups we have generated. These results are displayed in Figure 4.6.

Figure 4.6 – Crop-group evapotranspiration rates (2003 – 2006 average for IID)



It is noteworthy that alfalfa, the largest crop-group by proportion in this study (about 32% of all agricultural acreage between 1996 and 2007, see Figure 4.3), also has the highest ET rate by a considerable margin at 63.22

inches per acre. The next highest crop-group ET rate is grasses (about 18% of all agricultural acreage between 1996 and 2007) at 46.03 inches per acre. The lowest crop-group ET rate is veg-melon (about 24% of all agricultural acreage between 1996 and 2007) at 20.65 inches per acre.

4.14 Water Regime Assignments

As we established in chapter 3.3, farmers in each of the 17 districts of interest experience a unique set of water constraints and for more insightful econometric estimation we assign each district to one of three water regimes according to these constraints. Regime 1 includes those districts experiencing no water quantity constraint and no water price constraint, Regime 2 includes those districts experiencing a water price constraint and no water quantity constraint, and Regime 3 includes those districts experiencing a water quantity constraint and no water price constraint.

Districts assigned to Regime 1 must meet both the following criteria: (1) average district diversions or consumption over the study period must be less than 90% of the diversion or consumption ceiling and (2) average district diversions per acre over the study period must be less than 90% of the amount where a marginal cost is imposed. This would also include those districts that experience no onset of marginal cost and divert/consume less than 90% of the institutional water ceiling.

Districts assigned to Regime 2 must meet both the following criteria: (1) average district diversions or consumption over the study period must be less than 90% of the diversion or consumption ceiling and (2) average district diversions per acre over the study period must be greater than or equal to 90% of the amount where a marginal cost is imposed. Regime 2 also includes those districts that experience a constant marginal cost for all AF of water diverted and divert/consume less than 90% of the institutional water quantity constraint.

Regime 3 includes districts where average district diversions or consumption over the study period are greater than or equal to 90% of the diversion or consumption ceiling, regardless of water pricing structure. As can be observed in Table 4.9, Regime 1 includes four districts, Regime 2 includes six districts, and Regime 3 includes 7 districts. The implications of this are smaller panels for each set of regressions, a reasonable tradeoff for more informative

Table 4.9 – Water Regime Assignments

District	Diversion ceiling	Avg. diversion	Cons. ceiling	Avg. cons.	% of ceiling	Avg. div/ac.[a]	Zero MC_AF	Water Regime
FMIR,AZ	103,535	67,354			65	7.64	11	1
PVID,CA		925,808	219,780+	454,485	-	10.55	12	1
YID,AZ		65,938	67,278	49,872	74	3.69	5	1
FYIRIU,CA	BU for 25,000 ac.[b]	38,808		38,219	-	3.61	5	1
FYIRBU,CA		46,593		46,181	-	4.50	5	2
IID,CA		3,073,052	2,600,000+	2,136,546	82	5.82	0	2
NCIR,AZ	10,817	5,443			50	8.81	5	2
StGMR,AZ	9,156+	10,619		10,173	-	3.79	3.25	2
UBIDD,AZ	6,800+	27,248		17,361	-	13.20	10	2
YVID,AZ	254,200+	352,405		228,760	-	4.58	5	2
CVIDD,AZ	31,120	27,871			91	6.40	0	3
CRIR,AZ	662,402	613,554		381,482	93	8.15	5	3
FMIR,CA	16,720	21,007			126	6.28	5	3
MVIDD,AZ	41,000	36,860			90	7.34	8	3
NGVID,AZ	49,000	46,547	41,203	19,125	95	4.38	5	3
WMIDD,AZ		407,957	278,000	274,629	99	4.64	4	3
YMIDD,AZ		212,139	141,519	152,884	108	12.04	9	3

A "+" following diversion ceiling or consumption ceiling means that the district possesses unquantified water rights certificates beyond the stated quantity.

[a] Units are diversions divided by total cropped acres (not total arable acres) averaged over the study period.

[b] Beneficial Use; meaning no more water than can be put to beneficial use on 25,000 acres for both FYIRBU,CA and FYIRIU,CA combined. See chapter 1.2.2 for more information on Lower Colorado River water entitlements.

results.

Looking at Table 4.10, we see that water regimes vary considerably across any strictly cross-sectionally variant variables, such as soil and elevation. There are a number of interesting observations when comparing these variables across the three water regimes. It is notable that Regime 2 districts – those constrained by a marginal cost for water – tend to plant less alfalfa and more veg-melon. Alfalfa is the most water intensive of all the crop-groups studied, while veg-melon is the least water intensive. If soil conditions are fit for veg-melon production it is a more valuable to produce than alfalfa and other crop-groups (YCWUA, 2011). The relatively high clay content in Regime 2 (22.2%) is an indication of fertile soil, which is required for veg-melon production. It is fitting then that districts with adequate soil conditions but facing a water price constraint would choose to grow more veg-melon and grow less of other more water intensive less valuable crop-groups.

The clay content of Regime 1 soils (22.5%) is similar to that of Regime 2 soils. However, Regime 1 districts experience no water price constraint and no water quantity constraint. It is reasonable then that veg-melon makes up the largest percentage of crops grown (26.6%), but the cheap plentiful water also allows them to produce nearly as much alfalfa (26.4%).

In Regime 3 we districts with slightly sandier, more elevated farms. Initially it may strike the reader as unreasonable that these districts, which are approaching or exceeding their institutional water constraint, would produce more alfalfa than any other crop-group. We see, however, that mean clay content in Regime 3 soils is 15.7% and sand is 55.4%, indicating well-drained soils. This is also supported by the hydrological group and drainage class. Alfalfa prefers well-drained soils and doesn't have the stringent soil fertility requirements of veg-melon (USDA, 2011). The data indicates that farmers in Regime 3 receive water cheaply enough to divert right up to the institutional limit in growing a water intensive crop on well-drained soils.

Table 4.10 – Summary statistics by water regime (average values across study period*)

Variable	Units	Regime 1	Regime 2	Regime 3	Overall
ZeroMC_AF	AF of water at no MC	8.25 (3.30)	4.71 (2.98)	5.14 (2.71)	5.72 (3.26)
Prop_t1div	Lagged div/acres	5.79 (2.66)	5.59 (2.70)	6.31 (2.17)	5.93 (2.49)
Alfalfa	% of arable acres	26.43 (25.70)	10.73 (13.52)	33.14 (22.12)	23.65 (22.70)
Cotton	% of arable acres	14.00 (12.14)	5.40 (7.26)	19.72 (15.52)	13.32 (13.80)
Grains	% of arable acres	14.41 (11.64)	16.44 (11.47)	7.74 (7.25)	12.38 (10.70)
Veg-melon	% of arable acres	26.57 (23.06)	32.07 (14.25)	13.42 (17.77)	23.10 (19.83)
Grasses	% of arable acres	9.48 (4.73)	12.26 (7.41)	8.33 (4.94)	9.99 (6.12)
Fruit-nut	% of arable acres	1.31 (1.33)	8.83 (9.09)	6.99 (16.36)	6.30 (12.13)
Clay	% composition	22.50 (4.60)	22.17 (12.61)	15.71 (5.96)	19.59 (9.25)
Sand	% composition	44.75 (6.52)	52.17 (22.07)	55.43 (17.87)	51.76 (18.11)
Drainage	See Table 4.6	3.00 (0.00)	3.00 (0.58)	2.86 (0.35)	2.94 (0.42)
Hydro. group	See Table 4.6	3.75 (0.44)	4.00 (1.84)	3.14 (0.99)	3.59 (1.33)
Elevation	Feet above river	17.50 (8.04)	27.50 (33.45)	42.00 (47.42)	31.12 (37.73)
Fallow	% of arable acres	1.70 (5.42)	0.14 (0.56)	0.00 (0.00)	0.45 (2.72)
Indian Res.	(1=yes, 0=no)	0.50 --	0.17 --	0.29 --	0.29 --

Standard deviations in parentheses
*Note that the units for crop-group is "percent of arable acres", not "percent of cropped acres", therefore in any given year and the average over all years the sum of the crop-group variables will not equal 100%.

Land use as a percent of available arable acres shows some variance by water regime. Table 4.11 shows that average land use as a percent of maximum total agricultural acreage in Regime 1 is significantly higher than the overall average. This corroborates with the suggestion made in chapter 3.4 that Regime 1 farmers likely experience a land constraint. Regimes 2 and 3 utilize less of their available arable land on average than Regime 1, and neither Regime 2 nor

Table 4.11 – Percent of arable land planted by water regime (average over study period)

	Mean	t-ratio[a] (df)
Regime 1	93.85***	t(47)= 6.22
Regime 2	85.87*	t(71)= -2.49
Regime 3	89.35	t(83)= 0.25
Overall	89.18	

[a]t-test for H_0: regime mean = overall mean. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

Regime 3 uses a percentage significantly different from the overall mean of 89.18% at the 0.05 level or higher. This difference in percent land utilization by water regime also corroborates with the suggestion in chapter 3.4 that in the presence of a water quantity or water price constraint, available land might fail to constrain farmers' land allocation decisions. This simple analysis fails to take into account the complexity contributed by multi-cropping, a ubiquitous practice in this region. Further complexity is added when one considers that districts face absolute water quantity constraints while farmers experience water constraints through the onset of a marginal price or a limit to the number of AF per acre that can be applied to their fields imposed by the respective district.

We incorporate total arable land as a possible constraint into our analysis by using maximum total agricultural acreage as the denominator for the dependent variable (proportion of crop-group *n*) and the water quantity variable (*prop_t1div*).

CHAPTER 5

ECONOMETRIC ISSUES, EMPIRICAL SPECIFICATION, AND MODEL SELECTION TESTS

The panel we have compiled for analysis consists of observations for 17 agricultural districts over a 12 year time period. Due to the relative proximity of n and T (17 and 12, respectively) this panel is not clearly classified as a long panel (n<<T) or a short panel (n>>T). There are several tests and estimation techniques excluded for panel data models that fall within either of these two classifications from which our dataset is generally spared. Proceeding prudently, we test our panel for issues common to time-series, cross-section data.

5.1 Testing for Contemporaneous Correlation

Contemporaneous correlation may arise in panel data due to the presence of spatial dependence and common shocks and unobserved components that become part of the error term (Sarafidis & De Hoyos, 2006). The panel data for this study is acutely susceptible to these issues, as most districts are clustered in a relatively homogenous geographic and climatic region and experience shocks such as weather phenomena and crop blights in common. If the contribution to the error terms resultant of the presence of these common factors are uncorrelated with the included regressors "…the standard fixed-effects (FE) and random effects (RE) estimators are consistent, although not efficient, and the estimated standard errors are biased." (Sarafidis & De Hoyos, 2006)

Table 5.1 – Testing for contemporaneous correlation

(*H_0 : No contemporaneous correlation*)

Crop-Group	**Pesaran statistic**	***p*-value**
Alfalfa	2.383	0.0172
Cotton	2.096	0.0361
Grains	2.728	0.0064
Veg-Melon	-0.031	1.0246
Grasses	-1.511	1.8692
Fruit-Nut	6.775	0.0000

A commonly used method to test for the presence of contemporaneous correlation for panels consisting of large T and small n is the Lagrange multiplier test statistic proposed by Breusch and Pagan (1980) (Sarafidis & De Hoyos, 2006). Our panel consists of 17 agricultural districts with data spanning 12 years (T = 12, n = 17), rendering the Lagrange multiplier test statistic invalid. Stata offers the *xtcsd* command with the *pesaran* option to test for contemporaneous correlation in panel data models following the methods of Pesaran (2004), a valid test in the presence of T < n (StataCorp, 2011). The *xtcsd* command allows us to test the null hypothesis of no contemporaneous correlation. We run Pesaran's test for each crop-group land allocation function to determine the presence or absence of contemporaneous correlation. As we can observe in Table 5.1, we reject the null hypothesis of no contemporaneous correlation for four of the six crop groups at the 95% level (alfalfa, cotton, grains, and fruit-nut)[8]. The tests indicate that contemporaneous correlation is not present in the veg-melon and grasses regressions. We therefore proceed under the assumption that contemporaneous correlation is an issue overall and should be corrected for.

5.2 Testing for Autocorrelation

The most typical assumption for the presence of temporal dependence in panel data models is that the errors show first-order autocorrelation (Beck & Katz, 1995). Autocorrelation may cause standard errors of the coefficients to be smaller than they should be and yield an artificially high R-squared value (Drukker, 2003). Stata provides the *xtserial* command to invoke

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[8] See chapters 4.6 and 4.7 for information on crop-group and dependent variable construction.

Table 5.2 – Testing for autocorrelation

(*H_0 : no first-order autocorrelation*)

Crop-Group	F(1, 16)	Prob > F
Alfalfa	7.323	0.0156
Cotton	9.214	0.0079
Grains	15.511	0.0012
Veg-Melon	2.608	0.1259
Grasses	5.184	0.0369
Fruit-Nut	0.954	0.3432

the Wooldridge test for first-order autocorrelation within random effects panel data models. The null hypothesis for this test is no first-order autocorrelation. We employ this command to test our six crop-group allocation regressions for first-order autocorrelation. As Table 5.2 displays, the null hypothesis is rejected for four of the six crop-groups at the 95% level. We assume that first-order autocorrelation is not an issue for only veg-melon and fruit-nut, as we fail to reject the null hypothesis for these crop-groups. We therefore proceed under the assumption that first-order autocorrelation is an issue overall and should be corrected for.

5.3 Addressing Censored Dependent Variables

Past research estimating farm-level cropland allocation functions using time-series, cross-sectional data has relied upon the Tobit model specification (see Huffman 1988; Moore and Negri 1992; Moore and Dinar 1995; Negri and Moore 2009). In each of the studies referenced, at least one crop or crop-group studied assumed zero values for 40% or more of observations. Under these conditions, optimal land allocation functions should be censored at zero and estimated using a Tobit model in order to produce unbiased coefficient estimates. Some notable drawbacks when estimating panel data as a Tobit model are the limited ability to correct for contemporaneous correlation, heteroskedasticity, and autocorrelation. Moore and Negri (1992) choose to ignore "…inefficient estimation and potential bias from other sources of

Table 5.3 – Summary of zero values by crop-group

Crop-Group	# of obs. = zero	% of obs. = zero
Alfalfa	11	5%
Cotton	17	8%
Grains	15	7%
Veg-Melon	24	12%
Grasses	5	2%
Fruit-Nut	52	25%
N=nT = 204	**Avg: 20.6**	**Avg: 10%**

heteroskedasticity…in favor of eliminating the bias associated with censored data." The fact that corn assumes zero values for 51% of observations in their study makes that tradeoff econometrically rational.

As can be observed in Table 5.3, no crop-groups in our study approach 40% of zero values as a percentage of total observations. The crop-group with the highest count of zero values is fruit-nut at 52 observations (25%) and on average 10% of observations assume a zero value. Due to the presence of autocorrelation and contemporaneous correlation in our panel (see chapters 5.1 and 5.2) and the minimal number of zero values our crop-groups assume, we deem it prudent to ignore the bias associated with censored dependent variables. We proceed with a model that corrects for autocorrelation and contemporaneous correlation without accounting for censored observations on the dependent variable.

5.4 Model Specification

Ordinary least squares (OLS) is optimal for panel data models if the errors are assumed to be generated in a spherical manner. In particular, it is necessary to assume that all the error processes are homoscedastic and independent of each other. Beck and Katz (1995) state this assumption as "…errors for a particular unit at one time are unrelated to errors for that unit at all other times [no autocorrelation] and that errors for one unit are unrelated to the errors for every other unit [no contemporaneous correlation]." Under these assumptions panel data models should be estimated by OLS and OLS standard errors are correct. OLS is not optimal in the presence of non-spherical errors, however, and if the errors are not spherical there is no guarantee that the OLS standard errors will be correct (Beck & Katz, 1995).

If the regression errors meet one or more of the panel error assumptions of contemporaneous correlation or autocorrelation, then the OLS coefficient estimates will be consistent but inefficient and the standard errors inaccurate (Beck & Katz, 1995). A correction of the standard errors allows for accurate variability estimates of the coefficients. Stata provides the *xtpcse* panel data regression command for making such corrections. *Xtpcse* calculates panel-corrected standard error estimates for panel data models where the parameters are estimated by OLS or Prais-Winston regressions (StataCorp, 2011). This command assumes that the disturbances are heteroskedastic and contemporaneously correlated across panels, while the addition of the option *correlation(ar1)* specifies for the correction of first-order autocorrelation. As the tests we conducted in chapters 5.1 and 5.2 above reveal that our data suffers both contemporaneous correlation and first-order autocorrelation, we proceed employing the *xtpcse* model specification to estimate our optimal land allocation equations.

As we demonstrated in the previous chapter, the data suggest that agricultural districts along the Lower Colorado River fall within one of three water regimes: (1) districts experiencing no water quantity constraint and no water price constraint, (2) districts experiencing a water price constraint and no water quantity constraint, and (3) districts experiencing a water quantity constraint and no water price constraint.

For each of the three water regimes we outline a procedure to compare competing water constraint models. These procedures are empirical means to serve as a proxy for testing the hypotheses we generated in Chapter 3 concerning the factors contributing farmers' profit maximizing production decisions.

5.4.1 Regime 1: Competing Crop-Level Land Allocation Models

Regime 1 districts are those where the aggregate of farms experience no marginal cost for water and approach neither the point which a marginal cost will be incurred, nor the point which an institutionally established water ceiling will be binding. In chapter 3.4 we established that neither water quantity (fixed water) nor water price (variable water) variables are significant factors in Regime 1 farmers' optimal cropping decisions. We employ simple χ^2 tests to determine the significance of water variables in Regime 1.

To test for the significance of water variables we develop two versions of the full model, one including fixed water and all other non-water variables and a second including variable water and all other non-water variables. The corresponding restricted model excludes any water variable but includes all other regressors from the full models. We can then estimate the two full models and perform a χ^2 test to determine the probability that the coefficient on the water variable is equal to zero in each.

The general forms of the competing crop-level land allocations models are given below:

Full model 1: Fixed water $n_j^* = W_F(p, r, W, N, k)$ (21)

Full model 2: Variable water $n_j^* = W_V(p, r, r_W, N, k)$ (22)

Restricted model: No water variable $n_j^* = (p, r, N, k)$ (23)

$j = 1, \ldots, m$

where:

n_j^*= Optimal proportion of arable land dedicated to crop-group j

p= Crop-group output prices

N= Fixed land

r_W= Water price

r= Input prices

W= Water quantity

k= Other exogenous variables

The null hypotheses for testing the explanatory value of fixed water and variable water models versus the restricted model are $H1_0$: coefficient on $W = 0$ and $H2_0$: coefficient on $r_W = 0$, respectively. If we fail to reject $H1_0$ and $H2_0$ then we have evidence that neither fixed water nor variable water play a role in Regime 1 farmer's cropping decisions.

5.4.2 Regimes 2 and 3: Competing Crop-Level Land Allocation Models

Districts within Regime 2 are those where the aggregate of farms: (1) approach or are just beyond the point of water use where a marginal cost is incurred and (2) are not approaching or exceeding the institutionally established water ceiling. The results we derive in chapter 3.4 suggest that water price should have more explanatory power for predicting Regime 2 farmers' cropping decisions than water quantity. Districts within Regime 3 are those where the aggregate of farms approach or exceed the institutionally established water ceiling, regardless of water pricing. The results we derive in chapter 3.4 suggest that water quantity should have more explanatory power in Regime 3 farmers' cropping decisions than water price. For Regime 2 and Regime 3, a water price or quantity variable is assumed to play a significant role in cropping decisions.

To determine the preferred model for each regime, we employ the methods of Moore and Dinar (1995) independently for Regimes 2 and 3. This method calls for conducting a pair of non-nested tests in which competing estimated crop-level land allocation functions, one with irrigation water as a fixed factor and the other with irrigation water as a variable factor, are compared.

The general form of the competing crop-level land allocation models is given below:

Model 1: Fixed water $$n_j^* = W_F(p, r, W, N, k) \tag{24}$$

Model 2: Variable water $$n_j^* = W_V(p, r, r_W, N, k) \tag{25}$$

j = crop-groups 1,…,*m*

where:

n_j^*= Optimal proportion of arable land dedicated to crop-group *j*

p= Crop-group output prices

N= Fixed land

r_W= Water price

r= Input prices

W= Fixed water

k= Other exogenous variables

To compare the two models we use the *J* test proposed by Davidson and MacKinnon (1981). This test relies on a simple approach: if Model 1 has better explanatory power than Model 2, Model 1 is superior, and vice versa (Baum, 2006). Stata's command *nnest* performs the *J* test in a series of steps (StataCorp, 2011). The test first generates the predicted values of each model independently. Let $\widehat{W}_F$ and $\widehat{W}_V$ be the predicted values of n_j^* using the estimates of Model 1 and Model 2, respectively. Both models are then re-estimated with the predicted values of the other model's dependent variable as an additional explanatory variable. Thus, in general form, the two estimating functions are:

$\widehat{W}_V$ in fixed water model $$n_j^* = \alpha W_F(p, r, N, W, k) + \beta\widehat{W}_V, \tag{26}$$

$\widehat{W}_F$ in variable water model $$n_j^* = \gamma W_V(p, r, N, r_W, k) + \varepsilon\widehat{W}_F. \tag{27}$$

j = crop-groups 1,…,m

The non-nested test assesses the significance of the estimated coefficients for $\widehat{W}_V$ and $\widehat{W}_F$ in equations (26) and (27), respectively. If the estimate of β is not significantly different from zero, then W_V (the variable input model) can be rejected. Likewise, if the estimate of ε is not significantly different from zero, then W_F (the fixed input model) can be rejected (Dupont, 2001). The *J* test can result in four possibilities: reject both, reject neither, or reject either one of the two hypotheses. Only in the last two cases does the *J* test deliver a definitive verdict. In the event that both models are not rejected or that both are rejected we can assess the *J* test statistic qualitatively and make model choices based on relative preferability.

5.5 Crop-Group Output Price Tests for Significance

The results we derive in chapter 3.4 suggest that Regime 1 farmers treat a crop's own-price as the principal factor in determining the amount to land to allocate to that crop. The results in chapter 3.4 also suggest that farmers in Regimes 2 and 3 treat cross-prices and a crop's own-price as factors in determining the amount of land to allocate to that crop.

The explanatory power of own-output and cross-output prices can be tested using simple χ^2 tests for significance in a manner similar to the tests employed in chapter 5.4.1. The full model in this case will include both own and cross-prices for crop-groups. The χ^2 tests can then be employed to the test null hypotheses: $H1_0$: that jointly, coefficients on cross-prices equal zero, and $H2_0$: the coefficient on own-price equals zero. If we reject both $H1_0$ and $H2_0$ then we have evidence that all prices matter to the regime of interest regarding farmers' cropping decisions. If we reject $H1_0$ but fail to reject $H2_0$ then we have evidence that crop-group own-price is the driving price factor for the regime of interest regarding farmers' cropping decisions. If we fail to reject $H1_0$ but do reject $H2_0$ then we have evidence that crop-group cross-prices are the driving price factor for this regime. Lastly, a failure to reject both $H1_0$ and $H2_0$ suggests that no crop-group output prices factor into cropping decisions for the regime of interest.

CHAPTER 6

EMPIRICAL RESULTS

6.1 Model Selection Tests

In Chapter 1 we assert that evaluating the role of water variables in crop-level land allocation regressions is limited and unenlightening at the regional level. Our basis for this is that each agricultural district faces a unique set of water constraints which dictates the amount of water farmers will allocate to each crop group. It is important, however, to observe what is happening at the regional level to allow us to compare this to regression results for the water regimes we have developed. If we find the regional level results reflecting more closely one of the three regimes we have defined, than the regression results from this regime might be the more telling for how farmers are responding to water constraints in aggregate, and thus would be the most useful for policy analysis purposes.

Analyzing crop-level land allocation regressions at the regional level is also important for evaluating the impact of temporally-constant, spatially-variant regressors. For the purpose of this study these are physical characteristics unique to each district, such as soil composition and elevation. Observing how these variables influence land allocation decisions at the regional level will aid in understanding why districts plant more or less of particular crop-groups. For example, we explain in chapters 4.9 and 4.14 that soil characteristics can play a role in determining a district’s suitability for growing certain crop-groups. It is logical to expect that districts with similar physical characteristics, ceteris paribus, would treat water constraints in a similar manner and therefore fall into the same water regime. To examine the effect of soil variables in only the regime level crop allocation regressions might therefore be uninformative due to a lack in variability across districts. In this same light, evaluating these cross-sectionally variant regressors at the regional level might further substantiate water regime assignments. With this in mind we review the model selection test and land allocation regression results for all 17 districts of interest as well as for the three water regimes.

When analyzing results of a non-nested hypothesis test (in this case the *J* test) it is important to realize that, as we explain in chapter 5.4.2, the test can result in four possibilities: reject both models, reject neither model, or reject either one of the two models and not the other. Only in the last two cases does the *J* test deliver a definitive verdict. We use the *J* test in the model selection tests for all districts, Regime 2, and Regime 3. The *J* test is performed using an ordinary least squares model.

6.1.1 All Districts (N = 17, T = 12)

As we observe in Table 6.1, we reject both the variable water input model and the fixed water input model at the 0.01 level for alfalfa and at the 0.05 level for fruit-nut. Qualitatively, we see that the test statistic favors the fixed water model slightly over the variable water model for both of these crop-groups. In two cases, those of grains and veg-melon, we observe definitive and significant results indicating that the variable input water model should be rejected and the fixed input water model preferred. For cotton the fixed model can be rejected only at the 0.10 level, while the variable model can be rejected at the 0.01 level, again indicating that the fixed water model is preferred. For grasses we cannon reject either model with any confidence. Overall the results indicate that the fixed water model is preferable to the variable water model at the regional level. Crop-level land allocation functions at the regional level should therefore include water quantity (*prop_t1div*) as an exogenous variable and exclude water price (*ZeroMC_AF*).

Table 6.1 – Non-nested hypothesis tests of competing water models for all districts

Crop-group	Null Hypothesis		*J* test statistic[c] t(188)	Comments[d]
	Model[a]	Restrictions[b]		
Alfalfa	VIM	$\varepsilon = 0$	10.775***	Reject variable water model
	FIM	$\beta = 0$	2.839***	Reject fixed water model
Cotton	VIM	$\varepsilon = 0$	3.010***	Reject variable water model
	FIM	$\beta = 0$	1.716*	Cannot reject fixed water model
Grains	VIM	$\varepsilon = 0$	5.211***	Reject variable water model
	FIM	$\beta = 0$	0.935	Cannot reject fixed water model
Veg-Melon	VIM	$\varepsilon = 0$	10.738***	Reject variable water model
	FIM	$\beta = 0$	-1.264	Cannot reject fixed water model
Grasses	VIM	$\varepsilon = 0$	1.496	Cannot reject fixed water model
	FIM	$\beta = 0$	1.505	Cannot reject fixed water model
Fruit-Nut	VIM	$\varepsilon = 0$	2.555**	Reject variable water model
	FIM	$\beta = 0$	2.225**	Reject fixed water model

[a] VIM represents variable input model and FIM represents fixed input model

[b] In the restrictions, ε represents the coefficient on $\widehat{W}_F$(the predicted values from the estimated regression using fixed water), while β represents the coefficient on $\widehat{W}_V$(the predicted values from the estimated regression using variable water).

[c] *J* test statistic is the t-ratio with 188 degrees of freedom. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

[d] The criterion is to reject a particular model if the coefficients of the predicted values from the alternative model are significantly different from zero within the particular model at the 0.10 level. Refer to chapter 5.4.2 for further explanation of the non-nested hypothesis test.

6.1.2 Regime 1 (N = 4, T = 12)

The null hypothesis we tested to determine the explanatory power of fixed water is that the coefficient on *prop_t1div* (γ) equals zero when included as an independent variable in the crop-level land allocation regressions for Regime 1. The results we observe in Table 6.2 show that we fail to reject the null hypothesis at any level of significance for any crop-group. We can therefore state that *prop_t1div* provides no additional explanatory value to the model for Regime 1 and we therefore proceed with this variable excluded from the land allocation equations for this regime. Due to collinearity issues, reliable results could not be obtained for the water price variable (*ZeroMC_AF*) as an independent variable in Regime 1. This is likely due to there being only four districts included in Regime 1 and the lack of variability for *ZeroMC_AF* amongst these few districts (only 3 unique values). This is a reasonable outcome, as these districts were assigned to Regime 1 due to their not experiencing any marginal cost or to their never approaching the onset of a marginal cost. These findings are consistent with result (10) in chapter 3.4.

Table 6.2 – χ^2 test results for competing water models in Regime 1

	Null Hypothesis				
Crop-group	Model[a]	Restrictions[b]	χ^2 statistic	Prob > χ^2=…	Comments[c]
Alfalfa	VIM	--	--	--	--
	FIM	$\gamma = 0$	2.64	0.1045	Fail to reject H_0
Cotton	VIM	--	--	--	--
	FIM	$\gamma = 0$	2.19	0.1388	Fail to reject H_0
Grains	VIM	--	--	--	--
	FIM	$\gamma = 0$	0.65	0.4218	Fail to reject H_0
Veg-Melon	VIM	--	--	--	--
	FIM	$\gamma = 0$	0.17	0.6766	Fail to reject H_0
Grasses	VIM	--	--	--	--
	FIM	$\gamma = 0$	0.50	0.4788	Fail to reject H_0
Fruit-Nut	VIM	--	--	--	--
	FIM	$\gamma = 0$	0.23	0.6295	Fail to reject H_0

[a] VIM represents variable input model and FIM represents fixed input model

[b] In the restrictions, γ represents the coefficient on *prop_t1div* (the water quantity variable in the fixed water input model). Due to a lack of variability and resultant collinearity in *ZeroMC_AF*, VIM cannot be reliably tested in Regime 1.

[c] The criterion is to reject a particular model if the coefficient on the water input variable is not significantly different from zero (fail to reject H_0) at the 0.05 level. Refer to chapter 5.4.1 for further explanation of this procedure.

6.1.3 Regime 2 (N = 6, T = 12)

As we observe in Table 6.3, we cannot reject either the variable water input model or the fixed water input model for four crop-groups (alfalfa, cotton, grasses and fruit-nut) with any level of confidence. Qualitatively, we see that the test statistic favors the variable water input model slightly for three of these four crop-groups (alfalfa, cotton, and grasses). In the remaining two crop-groups, grains and veg-melon, we see more definitive results. The variable water model is rejected at the 0.01 level for grains while the fixed water model is rejected at the 0.1 level for veg-melon. Overall the results indicate that the variable water model is preferable to the fixed water model for districts in Regime 2. Crop-level land allocation functions should therefore include *ZeroMC_AF* as an exogenous variable and exclude water quantity (*prop_t1div*). These findings are consistent with result (15) in chapter 3.4.

Table 6.3 – Non-nested hypothesis tests of competing water models in Regime 2

Crop-group	Null Hypothesis		*J* test statistic[c] t(58)	Comments[d]
	Model[a]	Restrictions[b]		
Alfalfa	VIM	$\varepsilon = 0$	0.620	Cannot reject variable water model
	FIM	$\beta = 0$	0.946	Cannot reject fixed water model
Cotton	VIM	$\varepsilon = 0$	0.942	Cannot reject variable water model
	FIM	$\beta = 0$	--	Cannot reject fixed water model
Grains	VIM	$\varepsilon = 0$	3.320***	Reject variable model
	FIM	$\beta = 0$	0.198	Cannot reject fixed model
Veg-Melon	VIM	$\varepsilon = 0$	0.856	Cannot reject variable water model
	FIM	$\beta = 0$	1.964*	Reject fixed water model
Grasses	VIM	$\varepsilon = 0$	0.731	Cannot reject variable water model
	FIM	$\beta = 0$	1.278	Cannot reject fixed water model
Fruit-Nut	VIM	$\varepsilon = 0$	0.723	Cannot reject variable water model
	FIM	$\beta = 0$	0.113	Cannot reject fixed water model

[a] VIM represents variable input model and FIM represents fixed input model

[b] In the restrictions, ε represents the coefficient on $\widehat{W}_F$(the predicted values from the estimated regression using fixed water), while β represents the coefficient on $\widehat{W}_V$(the predicted values from the estimated regression using variable water).

[c] *J* test statistic is the t-ratio with 58 degrees of freedom. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

[d] The criterion is to reject a particular model if the coefficients of the predicted values from the alternative model are significantly different from zero at the 0.10 level within the particular model. Refer to chapter 5.4.2 for further explanation of the non-nested hypothesis test.

6.1.4 Regime 3 (N = 7, T=12)

As we observe in Table 6.4, we cannot reject either the variable water input model or the fixed water input model for five crop-groups (cotton, grains, veg-melon, grasses and fruit-nut) with any level of confidence. Qualitatively, we see that the test statistic favors the fixed water model slightly for three of these five crop-groups (cotton, veg-melon, and fruit-nut). For both grains and grasses, the variable water model is favored slightly in qualitative terms. Alfalfa is the only crop-group that gives us a significant and definitive result. We see that the variable water model is rejected at the 0.05 level for alfalfa, resulting in four of the six crop-groups at least slightly favoring the fixed water model. Overall the results indicate that the fixed water input model is preferable to the variable water input model for districts in Regime 3. Crop-level land allocation functions should therefore include *prop_t1div* as an exogenous variable and exclude water price (*ZeroMC_AF*). These findings are consistent with result (20) in chapter 3.4.

Table 6.4 – Non-nested hypothesis tests of competing water models in Regime 3

Crop-group	Null Hypothesis		*J* test statistic[c] t(15)	Comments[d]
	Model[a]	Restrictions[b]		
Alfalfa	VIM	$\varepsilon = 0$	2.631**	Reject variable water model
	FIM	$\beta = 0$	1.615	Cannot reject fixed water model
Cotton	VIM	$\varepsilon = 0$	1.216	Cannot reject variable water model
	FIM	$\beta = 0$	0.715	Cannot reject fixed water model
Grains	VIM	$\varepsilon = 0$	1.004	Cannot reject variable water model
	FIM	$\beta = 0$	1.461	Cannot reject fixed water model
Veg-Melon	VIM	$\varepsilon = 0$	0.830	Cannot reject variable water model
	FIM	$\beta = 0$	0.615	Cannot reject fixed water model
Grasses	VIM	$\varepsilon = 0$	0.148	Cannot reject variable water model
	FIM	$\beta = 0$	0.761	Cannot reject fixed water model
Fruit-Nut	VIM	$\varepsilon = 0$	1.012	Cannot reject variable water model
	FIM	$\beta = 0$	0.179	Cannot reject fixed water model

[a] VIM represents variable input model and FIM represents fixed input model

[b] In the restrictions, ε represents the coefficient on $\widehat{W}_F$(the predicted values from the estimated regression using fixed water), while β represents the coefficient on $\widehat{W}_V$(the predicted values from the estimated regression using variable water).

[c] *J* test statistic is the t-ratio with 15 degrees of freedom. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

[d] The criterion is to reject a particular model if the coefficients of the predicted values from the alternative model are significantly different from zero at the 0.10 level within the particular model. Refer to chapter 5.4.2 for further explanation of the non-nested hypothesis test.

6.2 Regression Results

6.2.1 All Districts (N = 17, T = 12)

For comparison purposes we display regression results for both the variable water and fixed water input models. We indicate the preferred model results with (PREF) after the table title. Crop-group land allocation estimates for all districts of interest using the variable water model are displayed in Table 6.5, while estimates using the fixed water model (the preferred based on the *J* test results) are displayed in Table 6.6. We observe that *ZeroMC_AF* in the variable water model is significant in four crop-groups (alfalfa, grains, veg-melon, and fruit-nut) while in the fixed water model *prop_t1div* is significant in two (alfalfa and veg-melon). The two competing models are very comparable at the regional level, so for conciseness we will focus on the fixed water input model (results displayed in Table 6.6) as it is preferred.

In general, the crop-group output price variables do not perform well as an indicator of farmer cropping decisions at the regional level. A crop-group's own-price is significant at the 0.10 level or better in only three of the six crop-groups (grains, grasses, and fruit-nut). For fruit-nut the result is especially counterintuitive, as it is significant at the 0.10 level with a negative coefficient. The result can be interpreted as farmers deciding to plant 6.2% less fruit and nut orchards when prices for these crops rise by one unit. Annual price fluctuations likely have less impact on the land allocation decisions to these crops, however, because as we describe in chapter 4.6 orchards require a planning horizon beyond the single season and will be maintained at least at minimum requirements in a down-price year.

The location-specific physical variables – notably the soil composition and elevation variables – are significant for most crop-groups. Percent clay is significant at the 0.01 level for all crop-group regressions. The results indicate that a 1% increase in soil clay content across the region would result in 1.6% less alfalfa, 2.5% less cotton, 0.5% more grains, 1.6% more veg-melon, 0.6% more grasses and 1.6% more fruit-nut. Percent sand has a similar impact to that of percent clay at the regional level. We see that percent sand is significant at the 0.01 level for four of the six crop-group regressions and the coefficient signs match those of percent clay for each crop-group. For a crop such as alfalfa, where both the percent sand and percent clay variables have a negative coefficient, we might expect to see percent silt have a strong positive coefficient were it included in the model. Elevation is significant at the 0.10 level or better in five of the six crop-groups, though the coefficients on elevation tend to be very near or equal to zero, making it difficult to discern meaningful insight about the effect of district elevation on cropping choice at the regional level.

We observe that the Indian Reservation indicator variable is significant at the 0.10 level or better in the cotton and grains land allocation regressions. The results indicate that Indian Reservation farmers tend to allocate about 6% less land to cotton and about 5% more land to grains than non-Indian Reservation districts in the region.

Table 6.5 – Crop-group estimates for model using variable water input and all districts

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Variable Water Input	0.040***	0.004	-0.011***	-0.021***	0.000	-0.003**
Prices						
Alfalfa	0.058	0.104	-0.124	-0.185**	-0.149***	0.047
Cotton	7.415	-7.822	-9.467	25.011***	-1.878	-2.940
Grains	-0.023	0.132	0.298**	-0.31***	-0.075**	0.071*
Veg-Melon	0.009	-0.049	-0.052	0.086	0.009	-0.006
Grasses	0.048	-0.165	0.099	0.214*	0.148***	-0.021
Fruit-Nut	0.152*	-0.306***	-0.144	0.226***	0.088***	-0.058*
Soil						
Clay	-0.009*	-0.023***	0.003***	0.006	0.006***	0.016***
Sand	-0.004*	-0.008***	-0.001	-0.003*	0.003***	0.010***
Drainage	0.242***	-0.062**	-0.037	-0.204***	0.122***	-0.006
Hydro group	-0.063**	0.056***	0.009	0.024	-0.016	-0.033**
Other						
Fallow	-0.083	-0.069	-0.157	-0.156	-0.288**	-0.033
Elevation	-0.002***	-0.001***	0.000***	0.001***	0.000***	0.000***
Indian Res.	0.003	-0.056**	0.055*	-0.044	-0.01	0.004
rho	0.857	0.727	0.627	0.684	0.37	0.879

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6.6 – Crop-group estimates for model using fixed water input and all districts(PREF)

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Fixed Water Input	0.036***	0.007	-0.013	-0.044***	-0.002	-0.002
Prices						
Alfalfa	0.019	0.098	-0.108	-0.122	-0.145***	0.050
Cotton	16.712*	-5.924	-13.113	14.175	-2.224	-3.452
Grains	-0.120	0.112	0.333**	-0.215*	-0.072**	0.079*
Veg-Melon	0.022	-0.046	-0.053	0.087	0.011	-0.007
Grasses	0.144	-0.148	0.061	0.073	0.141***	-0.028
Fruit-Nut	0.200**	-0.296***	-0.163	0.180*	0.088***	-0.062*
Soil						
Clay	-0.016***	-0.025***	0.005***	0.016***	0.006***	0.016***
Sand	-0.008***	-0.009***	0.001	0.002	0.003***	0.01***
Drainage	0.010	-0.087***	0.026	-0.077**	0.120***	0.013
Hydro group	0.003	0.068***	-0.014	-0.044**	-0.018	-0.037***
Other						
Fallow	0.025	-0.073	-0.195	-0.081	-0.261**	-0.041
Elevation	-0.001***	-0.001***	0.000	0.001*	0.000**	0.000***
Indian Res.	0.029	-0.057**	0.049*	-0.041	-0.008	0.001
rho	0.725	0.704	0.57	0.637	0.364	0.842

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

6.2.2 Regime 1 (N = 4, T = 12)

In chapter 3.4 we predicted that a crop-group's own output price would play a significant role in Regime 1 cropping choice regressions. Table 6.7, however, displays that own-price is significant for only two of the six crop-groups, grains and veg-melon. For two of the crop-groups, alfalfa and fruit-nut, we see that no output prices are significant at the 0.05 level. That cross-prices tend to be more significant than own-price across all crop-groups might indicate that farmers in Regime 1 experience a land constraint.

Percent clay and percent sand are both significant at the 0.01 level for the same four crop-groups (alfalfa, cotton, grains, and veg-melon) though with opposite signs on the coefficients for each crop-group. Stata omitted soil drainage class and hydrological soil group variables crop-group regressions due to collinearity. This might be a due to a higher degree of homogeneity across Regime 1 soils compared to soils across the region, an expectation we suggest earlier in this chapter.

The fallowing variable is significant at the 0.10 level for alfalfa and at the 0.01 level for veg-melon. The only Regime 1 district that employs a fallowing program over the study period is Palo Verde Irrigation District (PVID). This result indicates that during the years of the fallowing program PVID fallowed land that was typically dedicated to alfalfa and veg-melon. The elevation variable is significant at the 0.01 level for all crop-groups except fruit-nut. The coefficients for elevation have the greatest absolute magnitude in the alfalfa and veg-melon crop-group regressions. This result indicates that if elevation were one foot higher across Regime 1, districts would allocate 1.7% less land to alfalfa and 1.6% more land to veg-melon. Lastly, the Indian Reservation indicator variable is significant at the 0.01 level for all crop-group regressions except grasses. This result is not unexpected as two of the four districts included in Regime 1 are Indian Reservations. The results indicate that farmers on the two Indian Reservations tend to allocate more land to alfalfa and cotton while allocating less land to grains, veg-melon, and fruit-nut.

Table 6.7 – Regime 1 crop-group estimates

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Prices						
Alfalfa	0.103	-0.160*	-0.016	-0.174**	-0.054	-0.042
Cotton	3.832	6.776	-19.297**	25.858***	-13.012***	1.672
Grains	-0.209	0.219**	0.451***	-0.370***	-0.062	-0.013
Veg-Melon	0.084	-0.102*	-0.093*	0.174***	0.051	0.031*
Grasses	-0.118	0.218*	0.017	0.044	0.038	0.022
Fruit-Nut	0.159	-0.121	-0.329***	0.339***	0.047	0.013
Soil						
Clay	-0.024***	-0.019***	0.018***	0.029***	0.002	0.001
Sand	0.021***	0.010***	-0.006***	-0.015***	0.001	0.000
Drainage[a]	--	--	--	--	--	--
Hydro group[a]	--	--	--	--	--	--
Other						
Fallow	-0.274*	0.060	-0.101	-0.297***	-0.14	-0.004
Elevation	-0.017***	-0.002**	0.008***	0.016***	0.002***	0.000
Indian Res.	0.196***	0.213***	-0.113***	-0.261***	0.025	-0.024***
rho	0.39	0.293	-0.034	-0.06	0.322	-0.013

[a] Omitted due to collinearity.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

6.2.3 Regime 2 (N = 6, T = 12)

For comparison purposes we display regression results for both the variable water and fixed water input models. We indicate the preferred model results with (PREF) after the table title. Crop-group land allocation estimates for Regime 2 districts using the variable water model (the preferred based on the *J* test results) are displayed in Table 6.8, while estimates using the fixed water model are displayed in Table 6.9. The water price variable (*ZeroMC_AF*) is significant at the 0.01 level in all six crop-group regressions, while the water quantity variable (*prop_t1div*) is significant at only the 0.10 in just two of the crop-group regressions. This result is consistent with our prediction in chapter 3.4 and the finding of the non-nested hypothesis test for Regime 2 in chapter 6.1.3. We will focus on the variable water input model as it is preferred.

When agricultural production is constrained by water price, the amount of water a farmer receives at no marginal cost (*ZeroMC_AF*) has a significant impact on cropping choices. We observe in Table 6.8 that if farmers receive more water at no marginal cost they will allocate less land to alfalfa, grasses, and fruit-nut, while allocating more land to cotton, grains, and veg-melon. This is nearly the complete opposite result of what we expected. The negative coefficients on alfalfa and grasses are counterintuitive because these are the two thirstiest crop-groups studied (see Figure 4.6), so we would expect land allocation to increase to these crops if marginal cost free water increases. The positive coefficients on grains and veg-melon are counterintuitive because these are the two least water intensive crop-groups studied (see Figure 4.6), so we would expect land allocation to decrease to these crops if marginal cost free water increases.

Three crop-group own output prices are significant at the 0.05 level in the land allocation regressions for Regime 2, alfalfa, veg-melon, and grasses. Fruit-nut is significant in own-price at the 0.1 level, though with a negative coefficient. As we elaborated in two previous sections, fruit-nut prices likely play a small role in their own and other crop-groups' annual land allocation decisions due to the multi-year planning horizon required for orchards. In four of the six crop-group regressions we see that at least half of cross-prices are significant at the 0.10 level. This is an expected result for farmers making land allocation decisions under the constraint of a marginal cost for water.

The four soil variables are significant at the 0.05 level for all six crop-group land allocation regressions in Regime 2. Like we observed in the regressions that included all districts of interest, percent clay and percent sand assume the same coefficient signs for each crop-group. The negative coefficient on percent clay in the veg-melon land allocation regression is an unexpected result as research suggested that clayey (relative to the region) fertile soils are ideal for this crop-group.

Of the six districts included in Regime 2, only Imperial Irrigation District (IID) employed a fallowing program during the study period. We see that the fallowing program variable is significant at the 0.1 level for alfalfa and veg-melon, while it is significant at the 0.01 level for fruit-nut. The negative coefficient that fallow assumes in the alfalfa regression is a logical result as the IID fallowing program requires minimum amounts of water to be conserved (see chapter 4.12.2) and alfalfa is the thirstiest crop-group studied (see Figure 4.6). The fallow variable also indicates that at least a portion of the land taken out of alfalfa production is reallocated to veg-melon and fruit-nut, as the variable assumes a positive coefficient for these two crop-groups. We observe that elevation is significant at the 0.10 level or better for all crop-group regressions. The coefficient for elevation assumes the opposite sign as that of percent sand for all crop-group regressions. Recalling Table 4.7, percent sand and elevation have a correlation of 0.69, so it was unexpected that both variables would be significant for all crop-group regressions (due to the probability of multicollinearity) and also unexpected that the variable coefficients would assume opposite signs. Stata omitted the indicator variable for Indian Reservation due to collinearity. This is likely due to there being only one qualifying district included in Regime 2 (North Cocopah Indian Reservation) coupled with the fact that *ZeroMC_AF* assumes the same value for all years across the study period within a district.

Table 6.8 – Regime 2 crop-group estimates for model using variable water input (PREF)

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Variable Water Input	-0.237***	0.139***	0.149***	0.222***	-0.112***	-0.147***
Prices						
Alfalfa	0.269**	0.204***	-0.530***	-0.334**	-0.330***	0.192***
Cotton	-9.884	-1.435	-6.887	58.582***	18.645**	-2.757
Grains	0.313**	-0.087**	0.217	-0.689***	-0.255**	0.138**
Veg-Melon	-0.134	0.015	0.029	0.303***	0.011	0.020
Grasses	-0.209	-0.259***	0.324	0.543***	0.475***	-0.131*
Fruit-Nut	-0.169	-0.104***	0.070	0.386***	0.247***	-0.108*
Soil						
Clay	0.165***	-0.142***	-0.060***	-0.154***	0.066***	0.101***
Sand	0.082***	-0.067***	-0.035***	-0.080***	0.033***	0.054***
Drainage	-1.165***	1.039***	0.618***	1.138***	-0.509***	-0.863***
Hydro group	-0.599***	0.562***	0.127**	0.559***	-0.215***	-0.321***
Other						
Fallow	-2.238*	-0.104	-1.809	1.313*	-0.608	1.568***
Elevation	-0.029***	0.032***	0.006*	0.029***	-0.011***	-0.019***
Indian Res.[a]	--	--	--	--	--	--
rho	0.406	0.345	0.082	-0.125	0.026	0.245

[a] Omitted due to collinearity.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6.9 – Regime 2 crop-group estimates for model using fixed water input

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Fixed Water Input	-0.002	0.004*	0.021*	-0.007	-0.004	0.002
Prices						
Alfalfa	0.266**	0.214***	-0.486***	-0.348**	-0.339***	0.196***
Cotton	-10.204	-1.092	-3.364	55.785***	17.961**	-2.544
Grains	0.310**	-0.078*	0.262	-0.689***	-0.263**	0.142**
Veg-Melon	-0.128	0.005	-0.039	0.321***	0.023	0.016
Grasses	-0.210	-0.259***	0.338*	0.533***	0.472***	-0.131*
Fruit-Nut	-0.160	-0.122***	-0.034	0.419***	0.265***	-0.116*
Soil						
Clay	0.194***	-0.166***	-0.140***	-0.154***	0.088***	0.111***
Sand	0.085***	-0.073***	-0.064***	-0.071***	0.038***	0.052***
Drainage	-0.793***	0.855***	0.672***	0.659***	-0.373***	-0.590***
Hydro group	-1.117***	0.905***	0.786***	0.890***	-0.505***	-0.592***
Other						
Fallow	-2.239*	0.073	-1.542*	1.237*	-0.655	1.591***
Elevation	-0.060***	0.052***	0.044***	0.050***	-0.028***	-0.035***
Indian Res.	-0.836***	0.509***	0.698***	0.701***	-0.417***	-0.492***
rho	0.39	0.36	0.065	-0.073	0.026	0.247

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

6.2.4 Regime 3 (N = 7, T=12)

For comparison purposes we display regression results for both the variable water and fixed water input models. Crop-group land allocation estimates for Regime 3 districts using the variable water model (the preferred based on the *J* test results) are displayed in Table 6.10, while estimates using the fixed water model are displayed in Table 6.11. The water price variable (*ZeroMC_AF*) is significant at the 0.10 level in all five or the six crop-group regressions, while the water quantity variable (*prop_t1div*) is significant at the 0.10 in just two of the crop-group regressions. This result is unexpected as our prediction in chapter 3.4 and the finding of the non-nested hypothesis test for Regime 3 in chapter 6.1.4 suggested that the fixed water input model was preferred. The non-nested hypothesis test compares the explanatory power of the two models, not strictly the significance of the competing water variables within their respective models. The finding that the fixed water input model is preferred (however slightly and insignificantly, see chapter 6.1.4) is likely due to the interaction of *prop_t1div* with the remaining independent variables in the model yielding greater explanatory power than the comparative interactions of *ZeroMC_AF* with the remaining independent variables in the variable water input model. We will focus on the fixed water input model as it is preferred.

We observe in Table 6.8 that *prop_t1div* is significant at the 0.10 level or better for alfalfa and veg-melon. Districts were assigned to Regime 3 if they consistently used water in amounts approaching or exceeding the institutional water constraint. Regime 3 districts therefore show little variation across time in their diversions, which might help explain the lack of significance the water quantity variable assumes when used as a regressor in Regime 3.

Alfalfa and grains own output prices are significant at the 0.01 level in the land allocation regressions for Regime 3. All other crop-groups' own output price fails to be significant at any level. In three of the six crop-group regressions we see that at least half of cross-prices are significant at the 0.05 level. This is an expected result for farmers making land allocation decisions in the face of a water quantity constraint.

The four soil variables are significant at the 0.10 level in four of the six crop-group land allocation regressions in Regime 3. Like we observed in the regressions that included all districts of interest and those for Regime 2, percent clay and percent sand assume the same coefficient signs for each crop-group. The strong positive coefficient on percent clay in the veg-melon land allocation regression is an expected result, though overall the soil variables do not reflect the outcomes suggested in the literature.

None of the seven agricultural districts included in Regime 3 employed a fallowing program during the study period, which is reflected in Stata’s omission of the fallow variable in the crop-group regressions. We observe that elevation is significant at the 0.10 level or better in five of the six crop-group regressions. The coefficient for elevation assumes the same sign as that of percent sand for all crop-group regressions, an expected result due to the strong positive correlation of 0.69 between the two variables (see Table 4.7). Regime 3 includes two Indian Reservations, Colorado River Indian Reservation and Fort Mohave Indian Reservation, AZ. The results indicate that farmers on these two Indian Reservations tend to allocate about 5% more land to grains than non-Indian Reservation districts in Regime 3, but the results tell us nothing significant about land allocations to the remaining crop-groups on Indian Reservations.

Table 6.10 – Regime 3 crop-group estimates for model using variable water input

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Variable Water Input	0.140***	0.024*	-0.041***	-0.113***	-0.004	0.007***
Prices						
Alfalfa	-0.168**	0.250**	0.055	-0.001	-0.033	0.012
Cotton	23.870***	-15.286	-11.419*	5.154	-11.331	-3.140
Grains	-0.214*	0.158	0.331***	-0.183*	0.061	0.091***
Veg-Melon	0.051	-0.007	-0.081**	-0.029	-0.022	-0.031*
Grasses	0.424***	-0.418***	0.022	-0.077	-0.074	-0.020
Fruit-Nut	0.429***	-0.503***	-0.238***	0.115	-0.032	-0.045*
Soil						
Clay	-0.205***	-0.086***	0.071***	0.210***	0.009	0.014***
Sand	-0.032***	-0.007**	0.008***	0.026***	0.002	0.007***
Drainage	1.265***	0.714***	-0.409***	-1.135***	-0.028	-0.136***
Hydro group	0.196**	0.126**	-0.070***	-0.262***	0.015	-0.067***
Other						
Fallow[a]	--	--	--	--	--	--
Elevation	-0.006***	-0.003***	0.002***	0.006***	0.001*	0.000
Indian Res.	0.304***	0.017	-0.055**	-0.302***	-0.013	0.020***
rho	0.601	0.435	0.289	0.358	0.289	0.723

[a] Omitted due to collinearity.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6.11 – Regime 3 crop-group estimates for model using fixed water input (PREF)

Independent Variables	Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
Fixed Water Input	0.026**	-0.004	-0.007	-0.010*	-0.003	0.003
Prices						
Alfalfa	-0.273***	0.267**	0.093	0.048	-0.017	0.004
Cotton	33.574***	-16.796	-13.765**	1.469	-12.37	-2.029
Grains	-0.387***	0.185	0.373***	-0.120	0.079	0.074**
Veg-Melon	0.094*	-0.013	-0.087**	-0.039	-0.025	-0.025
Grasses	0.557***	-0.439***	-0.026	-0.138	-0.094	-0.010
Fruit-Nut	0.573***	-0.525***	-0.271***	0.067	-0.046	-0.029
Soil						
Clay	-0.334***	-0.123***	0.111***	0.335***	0.009	0.010*
Sand	-0.119***	-0.028	0.035***	0.105***	0.003	0.004*
Drainage	-3.254***	-0.278	0.946***	2.805***	0.045	-0.334***
Hydro group	1.038***	0.308**	-0.323***	-0.993***	0.001	-0.029*
Other						
Fallow[a]	--	--	--	--	--	--
Elevation	-0.003***	-0.003***	0.002***	0.004***	0.000	0.000*
Indian Res.	-0.060	-0.060	0.053*	0.012	-0.007	0.004
rho	0.578	0.442	0.307	0.406	0.291	0.691

[a] Omitted due to collinearity.
*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

6.3 Crop-Group Output Price Tests

In chapter 3.4 we derive the expected crop-level land allocation functions from the multioutput profit equations for each water regime. These results suggest that a crop-group's own output price as well as the output cross-prices will have significant explanatory power in farmers' land allocation decisions. Table 6.12 displays the results of significance tests on the coefficients of crop output prices for the preferred water input model in each regime and for all districts. The three hypotheses tested for each group are: (1) H_0^1: all price coefficients jointly equal zero, (2) H_0^2: cross-price coefficients jointly equal zero, and (3) H_0^3: own-price coefficient equals zero. All results bolded in the table reject the null hypothesis at the 0.05 level.

In the all districts model, we fail to reject H_0^1 for three of the six crop-groups, indicating that crop-output prices are not a particularly strong indicator of land allocation at the regional level. We fail to reject H_0^2 for four of the six crop-groups, indicating that cross-prices have less explanatory power when own-price is excluded. Own-price coefficients are different from zero at the 0.05 level for only two crop-groups at the regional level.

In Regime 1, the performance of all prices is slightly better than for the all districts model as we fail to reject H_0^1 for two of the six crop-groups. Cross-prices perform slightly worse when own-price is excluded for Regime 1, as we fail to reject H_0^2 for three crop-groups. Own-prices perform more poorly than we expected for Regime 1, as only two crop-group own-price coefficients are different from zero at the 0.05 level.

In Regime 2 we see the strongest overall performance of crop-group prices at explaining cropping decisions. We reject H_0^1 and H_0^2 for all crop-groups and we reject H_0^3 for three of the six crop-groups. This is strong evidence that the interaction of crop-group prices play an important role in Regime 2 farmers' cropping decisions and the findings are consistent with result (15) in chapter 3.4.

The crop-group price significance test results for Regime 3 are similar to the results we observed for Regime1. H_0^1 is rejected for four crop-groups, H_0^2 is rejected for three crop-groups, and H_0^3 is rejected for only two crop-groups. Across all water regimes (including the all districts model) we observe that crop-group prices have the most explanatory power when tested jointly, suggesting that output price interactions capture predictive qualities in the regressions that a crop's own-price does not.

Table 6.12 – χ^2 test results for crop output prices from land allocation regressions*

Water Regime	Null Hypothesis	Probability > χ^2 = …					
		Alfalfa	Cotton	Grains	Veg-Melon	Grasses	Fruit-Nut
All	H_0^1: All price coefficients jointly = 0	**0.015**	**0.000**	0.056	0.374	**0.000**	0.076
	H_0^2: Cross-price coefficients jointly = 0	0.253	**0.001**	0.353	0.299	**0.000**	0.055
	H_0^3: Own-price coefficient = 0	0.824	0.408	**0.018**	0.172	**0.000**	0.070
1	H_0^1: All price coefficients jointly = 0	0.120	**0.000**	**0.000**	**0.000**	**0.000**	0.206
	H_0^2: Cross-price coefficients jointly = 0	0.146	0.104	**0.000**	**0.000**	**0.000**	0.259
	H_0^3: Own-price coefficient = 0	0.306	0.430	**0.000**	**0.000**	0.520	0.617
2	H_0^1: All price coefficients jointly = 0	**0.000**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**
	H_0^2: Cross-price coefficients jointly = 0	**0.004**	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**
	H_0^3: Own-price coefficient = 0	**0.030**	0.645	0.229	**0.000**	**0.000**	0.060
3	H_0^1: All price coefficients jointly = 0	**0.000**	**0.000**	**0.000**	**0.045**	0.188	0.154
	H_0^2: Cross-price coefficients jointly = 0	**0.000**	**0.000**	**0.001**	0.382	0.295	0.111
	H_0^3: Own-price coefficient = 0	**0.003**	0.181	**0.000**	0.437	0.379	0.345

*Results displayed are for the preferred water input model within each regime (see chapter 6.1)

Bold indicates significance at the 0.05 level

CHAPTER 7
DISCUSSION AND CONCLUSIONS

7.1 Model Selection Tests and Water Variable Concerns

In chapter 3.4 we derive the expected crop-level land allocation functions from the multioutput profit equations for each water regime. The derived results suggested the significant water input variable for farmers' cropping decisions in each water regime. The results of the χ^2 test (for Regime 1) and the non-nested hypothesis tests (for Regimes 2 and 3) suggest that our water regime assignments are justified in all three instances, though not without some ambiguity for Regimes 2 and 3. A possible explanation for the lack of definitive results in the non-nested hypothesis tests for Regimes 2 and 3 is the nature of the water input variables.

The water price variable, *ZeroMC_AF*, is not a water price at all, but a proxy we developed to indicate a water price constraint – the constraint being the number of AF per acre a farmer can divert at no marginal cost before paying a marginal cost for additional AF of water. Not only do we expect the sign on the coefficient of this variable to be opposite that of the sign for a variable reflecting the actual price paid for water, but *ZeroMC_AF* assumes the same value for the entire study period in any given district, so we lose any temporal variance that actual price paid would include. The concept behind comparing a land allocation model that includes water prices versus a model that includes water quantity is to determine whether water is treated as a variable or fixed input. *ZeroMC_AF* lacks the variability that an actual water price variable would exhibit and thereby may be compromising the conceptual integrity that was the foundation of the model selection tests.

Further complications with *ZeroMC_AF* arise due to the heterogeneity of district water pricing structures across the region. For a clear example of one such complication we can observe two districts that charge a constant marginal cost for all water diverted. Imperial Irrigation District (IID) charges farmers $20 per AF for all water diverted (as of 2011) and therefore *ZeroMC_AF* assumes a value of zero, as IID farmers receive no water free of a marginal cost. Cibola Valley Irrigation District (CVID) charges farmers $11 per AF for all water diverted (as of 2011), so like IID, *ZeroMC_AF* assumes a value of zero, as CVID farmers receive no water free of a marginal cost. One of the issues with *ZeroMC_AF* is now strikingly obvious – IID farmers pay nearly twice as much for all of their water as CVID farmers, but the water price variable assumes an identical value for both districts. On the other end of the water pricing structure spectrum are districts such as Palo Verde Irrigation District (PVID) that pay no marginal cost for any amount of water diverted. To keep *ZeroMC_AF* within a reasonable range, we censor the variable (and therefore PVID) at 12.

Comprehensive annual water pricing data for all districts over the entire study period would have allowed us to construct a water price variable that would accurately reflect the prices farmers pay for water at all water pricing tiers. Such data, however, is not available for all districts of interest. Smaller districts are especially hard to establish communication with and some treat inquiries concerning current and historical water prices with suspicion.

For water to be quantity constrained at the farm-level, any water price must be insignificant in the multioutput profit equation to the extent that farmers divert water up to the limit dictated by the district. For water to be constrained at the district level however, the district must consistently approach the institutional water constraint set at the state and federal level. The criteria we use to assign a district to Regime 3 (water quantity constrained regime) is that average district water use over the study period must be greater than or equal to 90% of the total district entitlement. A problem arises if a district lacks a fully quantified water entitlement. We see a number of examples of this in Table 4.9. The table shows that 11 of the 17 districts of interest have fully quantified water use entitlements, whether for diversions or consumptive use. The data is not available to determine a water ceiling for the six remaining districts and they are therefore preemptively excluded from Regime 3.

There is evidence that some districts set the amount of water farmers can divert at no marginal cost such that this amount diverted for all arable district acres would be just less than the institutional water ceiling imposed on the district (see NGVID and WMIDD in Table 4.9). Such an approach creates an economic disincentive to farmers for diverting quantities of water that put the district at risk of exceeding its water ceiling. In essence, the district-level water quantity constraint is experienced at the farm-level as a water price constraint. We assume that district-level data is representative of the aggregate of farmers, who, in the districts described, are likely making cropping decisions based on a water price constraint, yet this district will be assigned to Regime 3 (the water quantity constrained regime) for econometric analysis.

Lastly, the data suggests that a number of districts migrate between regimes in different study years. A number of factors might influence such behavior. If crop output prices rise for water intensive crops, such as alfalfa, and the marginal cost charged for water beyond the first block is not concurrently raised within a Regime 2 district, farmers within the district may deem it economically beneficial to purchase excess water at a marginal cost to increase alfalfa production; thereby putting the district at risk of exceeding its water ceiling and consequently pushing the district into Regime 3. If the marginal cost for excess water is adjusted upwards or if alfalfa price decreases, the district may once again move into Regime 2 where cropping decisions are constrained by water price. Some Regime 1 districts may be constrained by water quantity in years when crop output prices rise for water intensive crops. We address this issue by making water regime assignments based on average district values over the 12 year study period under the assumption that this captures the general tendencies of district behavior.

It is clear from the issues we have discussed in the preceding paragraphs that water regime assignments and their preferred model selection by comparison of the water input variables we have developed is not an unambiguous affair. Despite the concerns we have detailed, the results of the model selection tests are encouraging, as the findings are all consistent with the theory we lay out in chapter 3.4.

7.2 Interpretation and Implications of Regression Results

There is considerable discrepancy in the performance of the two water input variables in the crop-group land allocation regressions. The water quantity variable does not perform well on balance, as it is significant at the 0.10 level or better in only two of six crop-group regressions for all districts and in only two of six crop-group regressions for Regime 3. The water price variable performs substantially better for Regime 2, as it is significant at the 0.01

level in all crop-group regressions, though the coefficient signs for *ZeroMC_AF* in the land allocation equations are not what we expected to see.

Despite the water quantity variable's significance in only two crop-group regressions at the regional level and in Regime 3, it sheds light on land allocation decisions for a large proportion of total acreage. At the regional level and in Regime 3, the water quantity variable is significant in the same two crop-group regressions, those of alfalfa and veg-melon. Alfalfa and veg-melon are the two largest crop-groups by percent of arable land at the regional level (23.7% and 23.1%, respectively) and the first and third largest crop-groups by percent of arable land in Regime 3 (33.1% and 13.4%, respectively). Of the arable land actually cropped at the regional level, alfalfa and veg-melon make up 26.6% and 25.9%, respectively. Of arable land actually cropped in Regime 3, alfalfa and veg-melon make up 37.1% and 14.8%, respectively. This suggests that the water quantity constraint has significant explanatory power for at least 52% of acreage decisions based on intra-crop competition (land actually cropped as opposed to total arable land) at the regional level and in Regime 3.

As we point out in the chapters 6.2.1 and 6.2.3, the signs on the water quantity coefficient in the alfalfa and veg-melon land allocation regressions make intuitive sense. The coefficients on water quantity in the alfalfa regressions assume a positive sign and in the veg-melon regressions a negative sign at both the regional level and in Regime 3. This indicates that producers reallocate land from crop-groups with low water requirements to crop-groups with high water requirements as the water constraint relaxes. Figure 4.6 shows that alfalfa has the highest water requirements of all crop-groups studied at 63 inches per acre, while veg-melon has the lowest water requirements of all crop-groups studied at 21 inches per acre. The implications to agricultural water demand are quite clear: farmers in districts with a more relaxed water quantity constraint (where *prop_t1div* assumes a higher value) will make cropping decisions in expectation of diverting more water and farmers in districts with a more stringent water quantity constraint (where *prop_t1div* assumes a lesser value) will make cropping decisions in expectation of diverting less water.

The unexpected coefficient signs on *ZeroMC_AF* in the Regime 2 land allocation regressions deserve some discussion. We will first focus on alfalfa. There is no evidence that crop output prices are driving the counterintuitive results. Alfalfa has one of the strongest positive own-price coefficients in Regime 2 at 0.269 with 95% confidence. However, the regression predicts at the 0.01 significance level that an extra AF per acre of water at no marginal cost to districts in Regime 2 would result in a 23.7% decrease in alfalfa production. At the regional level (see Table 6.5) *ZeroMC_AF* assumes a positive coefficient value significant at the 0.01 level in the alfalfa regression, in agreement with our expectations. Upon closer inspection of the data, it is revealed that *ZeroMC_AF* assumes a value of 5 for three of the six districts within Regime 2. Of those three districts, only one allocates an average of 1% or more of arable land to alfalfa. The lowest value *ZeroMC_AF* assumes in Regime 2 is 0, for Imperial Irrigation District (IID) which allocates an average of 31% of total arable land to alfalfa. The highest value *ZeroMC_AF* assumes in Regime 2 is 10, for Unit “B” Irrigation and Drainage District which allocates an average of 23.5% of arable land to alfalfa. The remaining value assumed by *ZeroMC_AF* in Regime 2 is 3.25 for Sturges Gila Monster Ranch which allocates an average of 6% of arable land to alfalfa. These statistics demonstrate one of the shortcomings of our water price variable. It is apparent that total water costs to IID farmers are equal to or less than the total water costs to farmers in districts with the tiered pricing structure, but *ZeroMC_AF* fails to reflect this and describes IID as experiencing the highest water costs by a significant degree, skewing the regression coefficients as a result. The constant marginal cost IID is paying for water over the study period (*ZeroMC_AF* = 0 means zero AF of water at no marginal cost) is clearly low enough that they can afford to dedicate 31% of land to the most water intensive crop-group. IID uses a different water pricing structure than the other districts included in Regime 2 and it is obviously not incorporated into the water pricing variable in an efficient manner. We suspect that this issue is responsible for the counterintuitive coefficient signs on *ZeroMC_AF* for all of the land allocation regressions for Regime 2. The intuitive results we observe at the regional level is likely due to the increased panel size consisting of enough districts with no constant marginal cost for water (15 of 17 districts) that the coefficient skewing effect of the two districts where *ZeroMC_AF* = 0 is negated.

Our results indicate that cropping patterns have a fairly elastic response to a water quantity constraint, at the margins. Alfalfa and veg-melon acreage allocations at the regional level respond at the 0.10 significance level to a change in the water quantity constraint. Acreage allocation to grains at the regional level responds at the 0.115 significance level to a change in the water quantity constraint. At the regional level, if farmers receive one less AF of water per total arable acres: alfalfa acreage allocation decreases by 15.2%, from 23.7% of total arable acreage to 20.1% of total arable acres; veg-melon acreage allocation increases by 19%, from 23.1% of total arable acres to 27.5% of total arable acres; and grains acreage allocation increases by 10.5%, from 12.4% of arable acres to 13.7% of arable acres.

Cropping patterns respond significantly to the water pricing variable in Regime 2, but as we discussed there are likely some flaws in the predictive accuracy of this variable, at least at the water regime level. At the regional level, the water price constraint elicits a response comparable to that of the water quantity constraint in magnitude and significance for the alfalfa, veg-melon, and grains land allocation regressions. At the regional level, these three crop-groups, as well as fruit-nut, respond to a change in *ZeroMC_AF* at the 0.05 significance level. If farmers across the region receive one less AF of water per acre at no marginal cost: alfalfa acreage allocation decreases by 16.9%, from 23.7% of total arable acreage to 19.7% of total arable acres; veg-melon acreage allocation increases by 9%, from 23.1% of total arable acres to 25.2% of total arable acres; grains acreage allocation increases by 8.9%, from 12.4% of arable acres to 13.5% of arable acres; and fruit-nut acreage allocation increases by 4.8%, from 6.3% of total arable acres to 6.6% of total arable acres. As with the water quantity constraint, cropping decisions are relatively elastic to a marginal change in the water price constraint at the regional level.

We can observe how farmers make cropping decisions in the absence of water price and water quantity constraints in the Regime 1 regression results. An analytic advantage of Regime 1 containing only four districts is that we can easily compare the statistics of the individual districts. We expect that in the absence of water price and water quantity constraints, crop-group output prices would be the major driver of land allocation decisions. This however does not appear to be the case overall. Notable exceptions are the own-prices for veg-melon and grains, which both have a positive coefficient significant at the 0.01 level. Veg-melon and grains make up 26.6% and 14.4% of average Regime 1 total arable acreage over the study period, respectively (see Table 4.10). Veg-melon makes up the largest proportion of acreage of any crop-group in Regime 1, while grains makes up the third largest. These two crop-groups also happen to demand the least water of any of the six (see Figure 4.6). It is initially counterintuitive that with no water price or quantity constraint these two crop-groups comprise 41% of total arable acres and 44% of all cropped acres. A possible explanation for this is that physical characteristics such as soil type and elevation dictate what crop-groups are preferable for production in Regime 1.

A closer look at the data reveals that of the four districts in Regime 1, two (PVID and FMIR,AZ) allocate about 55% of cropped acreage to alfalfa and less than 8% to veg-melon, while the remaining two districts (FYIRIU and YID) allocate about 53% of cropped acreage to veg-melon and less than 3% to alfalfa. The alfalfa dominant districts have sandier soils (on average 11% more sand and 6% less clay) than the veg-melon dominant districts, but elevation is not significantly different and each the alfalfa dominant and the veg-melon dominant groups consist of one Indian Reservation and one non-Indian Reservation.

A factor not considered in the study up to this point is proximity to markets. Geographical analysis reveals that the two veg-melon dominant districts border one another and they both border the city of Yuma, AZ, the self-proclaimed “winter vegetable capital of the nation” and home to nine salad plants and 23 cooling plants specially designed for vegetable processing and shipping (Yuma Visitors Bureau, 2011). The alfalfa dominant districts on the other hand are both more than 70 miles north of the Yuma area and its vegetable processing facilities. Multi-year contracts with vegetable processors are common (Moore & Dinar, 1995) and FYIRIU and YID likely have such contracts with Yuma area processors. PVID and FMIR,AZ are considerably distant from any densely populated cities rendering alfalfa the crop-group of choice as it stores well and travels well compared to veg-melon. Key markets for these alfalfa dominant districts are likely dairies and other livestock operations.

In general, the crop-group output price variables do not perform well statistically in the crop-level land allocation equations at the regional level or for any water regime. Certain rigidities may make prices relatively ineffective determinants of producer decisions along the Lower Colorado River. The rigidities include multiyear contracts with vegetable processors, which are common in the region; long-term alfalfa hay supply contracts with dairies and other livestock operations (dairies consume about 65% of alfalfa produced in the west (Hoyt, 2011)); and crop rotations that include forage and grain crops to sustain land productivity. Two possible econometric explanations for the output price variables' ineffective performance are the multicollinearity we see across the output prices (see Figure 4.4) and the inability of lagged prices to adequately capture the complexity of economic forces along the Lower Colorado River. Despite the poor performance of the price variables, the focus of this research resides in quantifying the effect of water constraints on multioutput production. The estimation procedures preserve the unbiasedness and efficiency of the water price and water quantity constraints' coefficients since output prices have little correlation with either.

Location-specific physical variables function differently in a multioutput production model with fixed allocable inputs versus variable inputs. If water is modeled as fixed, as at the regional level and in Regime 3, crops compete for the fixed input. The physical variables in the equations measure a location's comparative advantage in producing a crop rather than its absolute advantage (Moore & Negri, 1992). For example, a positive coefficient on percent sand in the grasses land allocation equation (see Table 6.6) implies that sandy soil increases acreage allocated to grasses because grasses is a relatively profitable use of sandy, marginal land. It does not imply that sandy soil will have greater grasses production than a clayey soil. Within this framework, the soil and elevation coefficients are generally statistically significant and consistent with an agronomic approach.

7.3 Conservation Policy Implications

An important consideration for developing effective water conservation policy is knowledge of the factors constraining current consumption. For example, if a farmer doesn't divert the next unit of water due to water price, a policy that increases water price will encourage the farmer to use less water. In contrast, if a farmer doesn't divert the next unit of water due to having met or exceeded the institutional water allotment, a policy that decreases water allotment size will encourage the farmer to use less water. The model selection tests indicate that districts along the Lower Colorado are heterogeneous in the factors that constrain their water diversions. Table 7.1 summarizes the policy implications suggested by the model selection tests.

Table 7.1 – Conservation policy implications suggested by model selection tests

Regional Water Policy	**Implications by water regime**		
	Regime 1	**Regime 2**	**Regime 3**
Marginally stricter water **Quantity** constraint	No effect	No effect	Reallocation of some cropland
Marginally stricter water **Price** constraint	Reallocation of some cropland	Reallocation of some cropland	No effect

Observing Table 7.1, we see that a marginally stricter water quantity constraint would fail to reduce agricultural water demand in districts falling within regimes 1 and 2. Regime 1 and 2 districts never approach their water ceiling and therefore would not respond to an incrementally lower water ceiling. Regime 3 districts, on the other hand, are already constrained by an institutional water ceiling. An incrementally lower water ceiling would therefore have a land reallocation effect and result in overall water diversion reduction from Regime 3 districts.

A marginally stricter water price constraint would result in some cropland reallocation and overall water diversion reduction in Regime 1 and Regime 2. Regime 1 districts currently pay no marginal cost for diversions. A regional policy requiring some marginal cost, however little, would force Regime 1 farmers to reassess their profit maximizing crop mix. Regime 2 districts are already constrained by the marginal cost of the next unit of water. This water price constraint would be amplified by a stricter water price constraint, resulting in a reassessment of Regime 2 farmers' profit maximizing crop mix and a reallocation of land to less water intensive crops. Regime 3 districts, those experiencing a water quantity constraint, would not respond to a marginally stricter water price constraint. Regime 3 districts are already paying whatever costs are required to use their full Colorado River water allocation, and often exceeding their allocation, therefore, a regional policy imposing marginally stricter water pricing would not elicit a cropland reallocation response or overall water diversion reduction from these districts.

7.4 Summary and Conclusions

Agricultural cropping decisions play a major role in determining demand for irrigation water, and as irrigated agriculture accounts for about 85% of total Lower Colorado use (Soley, 1998), cropping decisions are a major driver of regional water demand. For example, a reallocation of one quarter of Arizona's irrigated cotton and alfalfa to higher value, less water intensive citrus and vegetable crops, ceteris paribus, would result in a 362,000 AF per year decrease in state agricultural water demand (Sonoran Institute, 2007). This study attempts to quantify the variables that underlie farmers' cropping decisions along the Lower Colorado River by building on and refining the body of research that has investigated this issue in other regions of the American West.

This study lays out the framework for more accurate and comprehensive analysis of the role played by different water constraints in irrigated agricultural production along the Lower Colorado River. With some modifications, these techniques can be adapted for conducting studies in other Bureau of Reclamation project settings as well.

The empirical evidence – based on estimated equations of six crop-groups for 17 agricultural districts along the Lower Colorado River – demonstrates that water quantity and water price constraints perform strongly as determinants of land allocation decisions. Further, the results demonstrate that cropping decisions are fairly elastic in response to the tightening of the water quantity and water price constraints, at least at the margins.

This study, and especially the results of the model selection tests, has important implications to conservation policy along the Lower Colorado River. The model selection tests indicate that a *one-size-fits-all* approach to regional water policy is not adequate and that policy prescription by water regime would better accomplish conservation policy objectives.

Important data to include for future refinement and potential explanatory improvement of this study is: comprehensive agricultural district water price data, location specific climate data, data detailing multi-year contracts between farmers and processors, and data detailing the proximity of agricultural districts to vegetable processing facilities, dairies, and major livestock operations.

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000US06025&_geoContext=01000US|04000US06|16000US0621782&_street=&_county=imperial&_cityTown=imperial&_state=04000US06&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pct

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DATA APPENDIX

Crop-Group Construction

	LCRAS Study Years[1]	Crop-Group Assignments for Study					
		Alfalfa	**Cotton**	**Grains**	**Veg-Melons**	**Grasses**	**Fruit-Nut**
LCRAS crop assignment labels[2]	1995-1998	Alfalfa-1a Alfalfa-1b Alfalfa-1c	Cotton	Small Grain Corn	Lettuce-early Lettuce-late Melons- spring Melons- fall Tomatoes Vegetables Crucifers	Bermuda Sudan	Citrus Dates Safflower
	1999-2007	Alfalfa-perennial Alfalfa-annual Alfalfa-seed	Cotton	Small Grain (includes oats, rye, barley, millet, and wheat) Field Grain (includes field and sweet corn, sorghum, and milo)	Lettuce-early Lettuce-late Lettuce-Spring Lettuce-Fall Melons-spring Melons-fall (Aug 20 - Dec 17) Tomatoes Legumes (includes Solanum Vegetables [green beans, dry beans, garbonzo beans, peas, peanuts, fresh peppers, & potatoes]) Crucifers (broccoli, cauliflower, cabbage, bok-choy, mustard, kale, & okra) Small Vegetables (carrots, celantro, celery, garlic, onions, parsley, & radishes) Root Vegetables (tables beets, parsnips, turnips, & rutabagas) Perennial Vegtables (artichokes & asparagus) Herbs-miscellaneous	Bermuda Grass Bermuda w/ rye Sudan	Cane/Bamboo Citrus- young (1 to 2 meters tall) Citrus- mature (3+ meters tall) Citrus- declining Dates Safflower Orchards Sugar Beets (Winter) Sugar Beets (Summer) Grapes

[1] There is a definitive change in LCRAS crop labeling between 1998 and 1999. In general, the crop labeling becomes more detailed and additional crops are specified.

[2] All of the crop labels used by LCRAS from 1995 through 2007. Terminology for the same crop changes year to year, such as “Lettuce-early” and “Lettuce-Spring”.

Variable Key

Variable	Description	Source
district	Agricultural district of interest. Full district name for each abbreviation is described in Table 4.1	Lower Colorado River Accounting System and Water Accounting Reports, USBR
year	Year of observation	
prop_t1div	t1_div / max_totagac	see t1_div and max_totagac
ZeroMC_AF	AF/acre district farmers are entitled to divert before a marginal cost for water is incurred	http://www.ag-management.com, http://www.iid.com/index.aspx?page=137, http://pvid.org/Data/Sites/1/PVIDDocs/ASSESSMENTS.pdf, http://www.wellton-mohawk.org/irrigation.html, http://asfmraaz.com/forum/2010/moody_presentation.pdf, http://www.gpo.gov/fdsys/pkg/FR-2011-05-09/html/2011-11165.htm
prop_alfalfa	q_alfalfa / max_totagac	see q_alfalfa and max_totagac
prop_cotton	q_cotton / max_totagac	see q_cotton and max_totagac
prop_grains	q_grains / max_totagac	see q_grains and max_totagac
prop_vegmel	q_vegmel / max_totagac	see q_vegmel and max_totagac
prop_grasses	q_grasses / max_totagac	see q_grasses and max_totagac
prop_fruitnut	q_fruitnut / max_totagac	see q_fruitnut and max_totagac
npr_alfalfa	p1_alfalfa / proditems	see p1_alfalfa and proditems
npr_cotton	p1_cotton / proditems	see p1_cotton and proditems
npr_grains	p1_grains / proditems	see p1_grains and proditems
npr_vegmel	p1_vegmel / proditems	see p1_vegmel and proditems
npr_grasses	p1_grasses / proditems	see p1_grasses and proditems
npr_fruitnut	p1_fruitnut / proditems	see p1_fruitnut and proditems
prop_fallow	FllwPrgm / max_totagac	see FllwPrgm and max_totagac
Elevation	Mean elevation difference in feet between district and Colorado River at nearest point	Google Earth
IndianRes	Indicator variable for Indian Reservations; 1 = Indian Reservation, 0 = Not Indian Reservation	LCRAS and Water Accounting Reports, USBR
clay	District soil mean percent clay	NRCS Web Soil Survey
sand	District soil mean percent sand	NRCS Web Soil Survey
drnge	District soil mean drainage classification number	NRCS Web Soil Survey
hydrgrp	District soil mean hydrologic soil group number	NRCS Web Soil Survey
q_totagac	District total planted agricultural acres by calendar year	Lower Colorado River Accounting System, USBR
q_alfalfa	District planted alfalfa acres by calendar year	Lower Colorado River Accounting System, USBR
q_cotton	District planted cotton acres by calendar year	Lower Colorado River Accounting System, USBR
q_grains	District planted grains acres by calendar year	Lower Colorado River Accounting System, USBR

Variable	Description	Source
q_vegmel	District planted vegetable-melon acres by calendar year	Lower Colorado River Accounting System, USBR
q_grasses	District planted grasses acres by calendar year	Lower Colorado River Accounting System, USBR
q_fruitnut	District planted fruit-nut acres by calendar year	Lower Colorado River Accounting System, USBR
FllwPrgm	Acres fallowed due to a coordinated fallowing plan by calendar year	http://www.iid.com/index.aspx?page=190, http://www.pvid.org/mwdpvid-program.aspx
p1_alfalfa	Arizona alfalfa output price in $/ton lagged by one year	National Agricultural Statistical Service, USDA
p1_cotton	Arizona upland cotton output price in $/pound lagged by one year	National Agricultural Statistical Service, USDA
p1_grains	Custom Laspeyres index for Arizona durum wheat, corn, and barley prices lagged one year	National Agricultural Statistical Service, USDA
p1_vegmel	National index price value for “Commercial Vegetables” lagged one year	National Agricultural Statistical Service, USDA
p1_grasses	Arizona “Other Hay” output price in $/ton lagged by one year	National Agricultural Statistical Service, USDA
p1_fruitnut	National index price value for “Fruit & Nuts” lagged one year	National Agricultural Statistical Service, USDA
proditems	National index number for typical farm input items	National Agricultural Statistical Service, USDA
div	Total annual district Colorado River diversions in AF by calendar year	Water Accounting Reports, USBR
cons	District consumptive use in AF by calendar year (div less calculated returns to the river)	Water Accounting Reports, USBR
t1_div	div lagged one year	see div
t1_cons	cons lagged one year	see cons
max_totagac	The highest value assumed by q_totagac during the 12 years of study	Lower Colorado River Accounting System, USBR
AG_ET	Total annual district agricultural evapotranspiration in AF by calendar year	Lower Colorado River Accounting System, USBR
cons_div	cons / div	see cons and div
div_acre	div / q_totagac	see div and q_totagac
cons_acre	cons / q_totagac	see cons and q_totagac
cons_ceiling	Consumptive use entitlement in AF per calendar year (for those districts where applicable)	http://www.usbr.gov/lc/region/g4000/contracts/entitlements.html, http://www.adwr.state.az.us/AzDWR/StateWidePlanning/CRM/documents/CopyofAzCRPrioritiesListing-Alpha05-2009_web.pdf, http://www.adwr.state.az.us/AzDWR/StateWidePlanning/CRM/Overview.htm
div_ceiling	Diversion entitlement in AF per calendar year (for those districts where applicable)	
prop_ceiling	Proportion of entitlement utilized: (cons / cons_ceiling) or (div / div_ceiling), whichever entitlement system applies to each district	see cons, cons_ceiling, div, and div_ceiling
alfalfa_ET	Evapotranspiration rate for alfalfa in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
cotton_ET	Evapotranspiration rate for cotton in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
grains_ET	Evapotranspiration rate for grains in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
vegmel_ET	Evapotranspiration rate for vegmel in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
grasses_ET	Evapotranspiration rate for grasses in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
fruitnut_ET	Evapotranspiration rate for fruitnut in feet/acre (calculated as IID average from 2003 – 2006)	Lower Colorado River Accounting System, USBR
regime	District water regime assignment	Regime assignments detailed in chapter 4.14

Data as used in Stata 11

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
1	CRIR,AZ	1996	8.051946	5	0.4620832	0.30154	0.0934279	0.0337456	0.0340851	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261
2	CRIR,AZ	1997	8.655742	5	0.5453013	0.2220444	0.075579	0.0371044	0.0674427	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
3	CRIR,AZ	1998	7.659246	5	0.5991269	0.1912695	0.0911604	0.0927853	0.0256336	0	0.9911504	0.0057257	1.053097	1.044248	0.7831858
4	CRIR,AZ	1999	7.177446	5	0.5774949	0.1497272	0.0894143	0.0948345	0.0281193	0.0000728	0.8063063	0.0049279	0.990991	1.108108	0.7072072
5	CRIR,AZ	2000	7.269419	5	0.5975814	0.0919868	0.0588984	0.0705072	0.0842537	0.0000715	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
6	CRIR,AZ	2001	7.617934	5	0.6070614	0.1201991	0.0507965	0.0285321	0.0923886	0.0002641	0.7833334	0.0033083	0.775	1.008333	0.7291667
7	CRIR,AZ	2002	7.104644	5	0.6560062	0.0854243	0.0655124	0.0383094	0.0757017	0.0010165	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
8	CRIR,AZ	2003	7.450515	5	0.6093687	0.1022183	0.066762	0.0370409	0.0968917	0.0011443	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
9	CRIR,AZ	2004	7.35174	5	0.5939374	0.1546385	0.0925397	0.0251288	0.0324061	0.0010164	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
10	CRIR,AZ	2005	7.099964	5	0.6308584	0.1248254	0.0598715	0.0208727	0.0489733	0.0017016	0.7107143	0.0031714	0.7857143	0.9	0.6785714
11	CRIR,AZ	2006	7.007033	5	0.6504963	0.1089285	0.0544872	0.0163937	0.0500502	0.0000648	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
12	CRIR,AZ	2007	7.454456	5	0.5892669	0.0867844	0.083501	0.0226444	0.0628564	0.0018205	0.8125	0.0031188	0.81875	0.85	0.8125
13	CVIDD,AZ	1996	6.694935	0	0.3605317	0.2603713	0.0451524	0.0018336	0.2275957	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261
14	CVIDD,AZ	1997	6.697914	0	0.3114829	0.4004126	0.0041256	0.0151272	0.1466881	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
15	CVIDD,AZ	1998	7.078386	0	0.4338758	0.4439606	0.0735732	0.0036672	0.044694	0	0.9911504	0.0057257	1.053097	1.044248	0.7831858
16	CVIDD,AZ	1999	6.635801	0	0.4402934	0.3382993	0.0256704	0.002292	0.044694	0	0.8063063	0.0049279	0.990991	1.108108	0.7072072
17	CVIDD,AZ	2000	6.170066	0	0.3043319	0.4597548	0.0686317	0.014584	0.0417901	0	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
18	CVIDD,AZ	2001	6.895485	0	0.2598143	0.5386041	0.0073344	0.0233692	0.0682764	0	0.7833334	0.0033083	0.775	1.008333	0.7291667
19	CVIDD,AZ	2002	6.028421	0	0.3001765	0.4839675	0.0316457	0	0.0400871	0	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
20	CVIDD,AZ	2003	6.204217	0	0.3032271	0.5090145	0	0	0.0491222	0	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
21	CVIDD,AZ	2004	6.204217	0	0.3014325	0.53989	0	0	0.0329613	0	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
22	CVIDD,AZ	2005	6.204446	0	0.1755398	0.6529842	0	0	0.0084873	0	0.7107143	0.0031714	0.7857143	0.9	0.6785714
23	CVIDD,AZ	2006	3.076782	0	0.2774284	0.49989	0	0.005973	0.0022737	0	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
24	CVIDD,AZ	2007	3.122851	0	0.2636122	0.5163351	0.0027962	0.0216227	0.011868	0.0238735	0.8125	0.0031188	0.81875	0.85	0.8125
25	FMIR,AZ	1996	6.897311	11	0.3619522	0.4875079	0.0113275	0.0027525	0.073682	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261
26	FMIR,AZ	1997	7.20253	11	0.3868304	0.4288588	0.0154563	0.0027525	0.0688122	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
27	FMIR,AZ	1998	7.407051	11	0.4272708	0.3906415	0.0716705	0	0.1104171	0	0.9911504	0.0057257	1.053097	1.044248	0.7831858
28	FMIR,AZ	1999	6.551768	11	0.5159856	0.344061	0.0192674	0.0047639	0.0732585	0	0.8063063	0.0049279	0.990991	1.108108	0.7072072
29	FMIR,AZ	2000	8.495872	11	0.5103091	0.1661825	0.0013223	0.0134988	0.1723089	0	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
30	FMIR,AZ	2001	6.974698	11	0.4267246	0.2519098	0.0321226	0.0526657	0.1982331	0	0.7833334	0.0033083	0.775	1.008333	0.7291667
31	FMIR,AZ	2002	6.717235	11	0.4863307	0.2056828	0.0045225	0.0223798	0.2037487	0	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
32	FMIR,AZ	2003	6.561719	11	0.5474677	0.2654457	0.0154584	0	0.1083845	0	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
33	FMIR,AZ	2004	6.082787	11	0.5581378	0.3140144	0.0089763	0	0.0674455	0	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
34	FMIR,AZ	2005	7.316218	11	0.6153346	0.2733051	0	0.0010968	0.0466441	0	0.7107143	0.0031714	0.7857143	0.9	0.6785714
35	FMIR,AZ	2006	7.660809	11	0.6494251	0.2079293	0	0	0.0558067	0	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
36	FMIR,AZ	2007	6.787	11	0.5156701	0.3368389	0.0297226	0.004765	0.0518061	0	0.8125	0.0031188	0.81875	0.85	0.8125
37	FMIR,CA	1996	5.552163	5	0.4264697	0.2180427	0.1863368	0	0.1133094	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
38	FMIR,CA	1997	7.845639	5	0.5434175	0.1133094	0.1933537	0	0.0719879	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
39	FMIR,CA	1998	7.079501	5	0.5860385	0.1182472	0.1198065	0	0.0935583	0	0.9911504	0.0057257	1.053097	1.044248	0.7831858
40	FMIR,CA	1999	6.828713	5	0.6076089	0.1738624	0	0	0.0868013	0	0.8063063	0.0049279	0.990991	1.108108	0.7072072
41	FMIR,CA	2000	5.485892	5	0.386892	0.2543251	0	0.077934	0.1157523	0	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
42	FMIR,CA	2001	6.056077	5	0.3209152	0.4979248	0	0	0.0502174	0	0.7833334	0.0033083	0.775	1.008333	0.7291667
43	FMIR,CA	2002	4.810973	5	0.2647231	0.2951503	0	0	0.1177587	0	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
44	FMIR,CA	2003	4.286527	5	0.2589614	0.4011622	0.1487576	0.0204997	0.1706191	0	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
45	FMIR,CA	2004	4.283149	5	0.3779311	0.2862155	0.156497	0	0.0679493	0	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
46	FMIR,CA	2005	4.163082	5	0.5341058	0.1519594	0.0391125	0	0.1307762	0	0.7107143	0.0031714	0.7857143	0.9	0.6785714
47	FMIR,CA	2006	4.237929	5	0.563452	0.1211787	0.0749661	0	0.0561609	0	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
48	FMIR,CA	2007	4.892837	5	0.7712994	0.0703376	0	0	0	0	0.8125	0.0031188	0.81875	0.85	0.8125
49	FYIRBU,CA	1996	4.273249	5	0.0004043	0.0855572	0.2191493	0.3440078	0.0443959	0.1619764	0.6869565	0.0063391	1.069565	1.052174	0.6478261
50	FYIRBU,CA	1997	4.561863	5	0.0039625	0.0871745	0.2254569	0.3834708	0.0581433	0.1414362	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
51	FYIRBU,CA	1998	4.30042	5	0.0130196	0.0786026	0.1737021	0.3594534	0.0723759	0.126961	0.9911504	0.0057257	1.053097	1.044248	0.7831858
52	FYIRBU,CA	1999	4.028141	5	0.001213	0.0355814	0.1665049	0.5243409	0.1505741	0.1217855	0.8063063	0.0049279	0.990991	1.108108	0.7072072
53	FYIRBU,CA	2000	3.946304	5	0.0024705	0.0378999	0.2198528	0.3765818	0.0693514	0.123656	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
54	FYIRBU,CA	2001	4.070354	5	0.0182023	0.0561095	0.129032	0.3935525	0.1235379	0.1194962	0.7833334	0.0033083	0.775	1.008333	0.7291667
55	FYIRBU,CA	2002	3.734433	5	0.0129411	0.0353348	0.1715793	0.3761726	0.1176727	0.1175538	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
56	FYIRBU,CA	2003	3.818616	5	0.0075441	0.0483107	0.1322085	0.3132783	0.1621632	0.1121591	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
57	FYIRBU,CA	2004	3.798884	5	0.0059542	0.0700809	0.1369651	0.4489835	0.1698148	0.1031684	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
58	FYIRBU,CA	2005	3.029031	5	0.0122804	0.0556922	0.0999329	0.3785403	0	0.0895852	0.7107143	0.0031714	0.7857143	0.9	0.6785714
59	FYIRBU,CA	2006	3.116367	5	0.0193741	0.0536972	0.1259947	0.3354431	0.1845447	0.0843539	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
60	FYIRBU,CA	2007	3.295892	5	0.0097065	0.0296078	0.1180131	0.4416311	0.197722	0.0794728	0.8125	0.0031188	0.81875	0.85	0.8125
61	FYIRIU,CA	1996	3.23494	5	0.0038215	0.0328155	0.3646255	0.4990442	0.0266678	0.0471047	0.6869565	0.0063391	1.069565	1.052174	0.6478261
62	FYIRIU,CA	1997	2.757828	5	0.0014123	0.0358893	0.312453	0.4815149	0.0577386	0.0040708	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
63	FYIRIU,CA	1998	2.576055	5	0.0044862	0.0414555	0.2503944	0.4552626	0.086151	0.0023262	0.9911504	0.0057257	1.053097	1.044248	0.7831858
64	FYIRIU,CA	1999	2.607458	5	0.0022431	0.0048185	0.229459	0.5726506	0.1084987	0.0028246	0.8063063	0.0049279	0.990991	1.108108	0.7072072
65	FYIRIU,CA	2000	2.604467	5	0.0025704	0	0.2628942	0.4629596	0.1245675	0.0022921	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
66	FYIRIU,CA	2001	2.474452	5	0.003471	0.0014389	0.2455311	0.4997986	0.1077494	0.0062831	0.7833334	0.0033083	0.775	1.008333	0.7291667
67	FYIRIU,CA	2002	3.405497	5	0.0081532	0.0022472	0.257603	0.393503	0.1239943	0.0072368	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
68	FYIRIU,CA	2003	3.911603	5	0.0027125	0.001551	0.3453424	0.4503835	0.1003904	0.0037999	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
69	FYIRIU,CA	2004	3.85079	5	0.0040234	0.0089109	0.2897032	0.51824	0.1382835	0.0009363	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
70	FYIRIU,CA	2005	3.843064	5	0.0027407	0.0196436	0.2446089	0.5088041	0.2187562	0.0054465	0.7107143	0.0031714	0.7857143	0.9	0.6785714
71	FYIRIU,CA	2006	3.722104	5	0.0018269	0.0012611	0.2144486	0.5103983	0.1258028	0.0027482	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
72	FYIRIU,CA	2007	3.172466	5	0.0028687	0.0081715	0.2585642	0.4538918	0.1720328	0.0015369	0.8125	0.0031188	0.81875	0.85	0.8125
73	IID,CA	1996	5.702218	0	0.29855	0.0082713	0.2062805	0.1733967	0.2343788	0.0687446	0.6869565	0.0063391	1.069565	1.052174	0.6478261
74	IID,CA	1997	5.888328	0	0.3150134	0.0071369	0.1754641	0.1766038	0.2429413	0.0801637	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
75	IID,CA	1998	5.816071	0	0.3490154	0.0083414	0.1601044	0.1814523	0.2282881	0.0727984	0.9911504	0.0057257	1.053097	1.044248	0.7831858
76	IID,CA	1999	5.659499	0	0.3462991	0.0128195	0.0908852	0.2113536	0.2202308	0.0734546	0.8063063	0.0049279	0.990991	1.108108	0.7072072

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
77	IID,CA	2000	5.613326	0	0.3524904	0.0101409	0.1023852	0.1916507	0.2193948	0.0691005	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
78	IID,CA	2001	5.352614	0	0.3584929	0.0234314	0.0859451	0.1887905	0.2217516	0.0597201	0.7833334	0.0033083	0.775	1.008333	0.7291667
79	IID,CA	2002	5.736374	0	0.3423692	0.0158361	0.1022863	0.1814361	0.2152259	0.0568779	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
80	IID,CA	2003	5.807249	0	0.3199284	0.006328	0.1315999	0.1994132	0.2483614	0.0584401	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
81	IID,CA	2004	5.51244	0	0.2628969	0.0123616	0.1227842	0.2242991	0.2595724	0.0634085	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
82	IID,CA	2005	5.074576	0	0.2674499	0.015019	0.0622873	0.2312901	0.2448243	0.0622799	0.7107143	0.0031714	0.7857143	0.9	0.6785714
83	IID,CA	2006	5.142408	0	0.2783928	0.0089964	0.0557685	0.2543364	0.2525611	0.056888	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
84	IID,CA	2007	5.38294	0	0.220858	0.0010239	0.1082934	0.2595612	0.26585	0.1001361	0.8125	0.0031188	0.81875	0.85	0.8125
85	MVIDD,AZ	1996	7.217669	8	0.449812	0.4199248	0.0159774	0.0101504	0.1026316	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261
86	MVIDD,AZ	1997	8.607707	8	0.5296993	0.3650376	0.0270677	0.0048872	0.0733083	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
87	MVIDD,AZ	1998	8.007519	8	0.4990602	0.3672932	0.0486842	0.0033835	0.0599624	0	0.9911504	0.0057257	1.053097	1.044248	0.7831858
88	MVIDD,AZ	1999	5.952631	8	0.5528196	0.3109023	0.0026316	0.0007519	0.0825188	0.0016917	0.8063063	0.0049279	0.990991	1.108108	0.7072072
89	MVIDD,AZ	2000	6.575376	8	0.5399587	0.135985	0	0	0.2419229	0.0016523	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
90	MVIDD,AZ	2001	7.03609	8	0.4872086	0.3495602	0	0.0011898	0.1184981	0.0016523	0.7833334	0.0033083	0.775	1.008333	0.7291667
91	MVIDD,AZ	2002	6.930263	8	0.566938	0.1613007	0.0404323	0.0509662	0.0974474	0.0016523	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
92	MVIDD,AZ	2003	6.723684	8	0.5877331	0.1934361	0.0721729	0	0.0819248	0.0016523	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
93	MVIDD,AZ	2004	6.852632	8	0.5400413	0.3185827	0.0115188	0	0.0667406	0.0016523	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
94	MVIDD,AZ	2005	6.911842	8	0.693562	0.1676654	0	0	0.0542914	0.0016523	0.7107143	0.0031714	0.7857143	0.9	0.6785714
95	MVIDD,AZ	2006	6.076316	8	0.6741711	0.1007519	0.0150827	0	0.0684304	0.0016523	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
96	MVIDD,AZ	2007	6.80094	8	0.7343459	0.1109962	0.033438	0	0.0643177	0.0030564	0.8125	0.0031188	0.81875	0.85	0.8125
97	NCIR,AZ	1996	2.564371	5	0	0	0.4660906	0.4346688	0	0	0.6869565	0.0063391	1.069565	1.052174	0.6478261
98	NCIR,AZ	1997	2.38806	5	0.2443921	0.055861	0.0995025	0.1658375	0.0174566	0	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
99	NCIR,AZ	1998	3.531466	5	0	0	0	0.4695819	0.0803003	0.2478834	0.9911504	0.0057257	1.053097	1.044248	0.7831858
100	NCIR,AZ	1999	7.920049	5	0	0	0.4189579	0.3229467	0.0261849	0	0.8063063	0.0049279	0.990991	1.108108	0.7072072
101	NCIR,AZ	2000	8.548486	5	0	0	0.4290478	0.1292485	0	0	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
102	NCIR,AZ	2001	7.481889	5	0.0078904	0	0.3476128	0.3540019	0.0814349	0	0.7833334	0.0033083	0.775	1.008333	0.7291667
103	NCIR,AZ	2002	10.95051	5	0	0	0.3364581	0.2679585	0.0936545	0	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
104	NCIR,AZ	2003	6.272148	5	0.0078904	0	0.4301126	0.5619971	0	0	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
105	NCIR,AZ	2004	6.675395	5	0	0	0.3454308	0.3459021	0.0748189	0	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
106	NCIR,AZ	2005	6.739985	5	0	0	0.3549795	0.3884961	0.0824474	0	0.7107143	0.0031714	0.7857143	0.9	0.6785714
107	NCIR,AZ	2006	6.35594	5	0	0	0.317797	0.4863577	0.1248844	0	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
108	NCIR,AZ	2007	9.19438	5	0.0317186	0	0.365244	0.3952518	0.1152483	0	0.8125	0.0031188	0.81875	0.85	0.8125
109	NGVID,AZ	1996	3.99265	5	0.003147	0.1168755	0.3056072	0.404038	0.050614	0.0150356	0.6869565	0.0063391	1.069565	1.052174	0.6478261
110	NGVID,AZ	1997	4.24607	5	0.0112767	0.1378554	0.241706	0.460334	0.0784124	0.0122383	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
111	NGVID,AZ	1998	4.357089	5	0.0153853	0.1227324	0.2026309	0.4544771	0.0792865	0.0157349	0.9911504	0.0057257	1.053097	1.044248	0.7831858
112	NGVID,AZ	1999	3.987143	5	0.0171336	0.1049869	0.1098822	0.4577115	0.152891	0.0120634	0.8063063	0.0049279	0.990991	1.108108	0.7072072
113	NGVID,AZ	2000	3.844217	5	0.0115188	0.1491522	0.1523193	0.4906701	0.0878901	0.0142183	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
114	NGVID,AZ	2001	4.280337	5	0.014533	0.1302546	0.1499285	0.4736834	0.1579935	0.0057258	0.7833334	0.0033083	0.775	1.008333	0.7291667
115	NGVID,AZ	2002	4.03426	5	0.0127698	0.173968	0.2051625	0.4033946	0.1044607	0.0044888	0.8319328	0.0023866	0.8403361	1.117647	0.7689075

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
116	NGVID,AZ	2003	4.234531	5	0.0094855	0.1742809	0.1862482	0.4549029	0.1150485	0.0056497	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
117	NGVID,AZ	2004	3.950428	5	0.0122514	0.185458	0.1635899	0.5293404	0.1035437	0.0058167	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
118	NGVID,AZ	2005	3.82822	5	0.0049731	0.1889092	0.1549147	0.4864129	0.128682	0.0035657	0.7107143	0.0031714	0.7857143	0.9	0.6785714
119	NGVID,AZ	2006	3.918609	5	0.0183697	0.1475342	0.1500605	0.524786	0.1462902	0.0023192	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
120	NGVID,AZ	2007	3.991514	5	0.0132541	0.1118675	0.1778589	0.4849024	0.155323	0.005717	0.8125	0.0031188	0.81875	0.85	0.8125
121	PVID,CA	1996	8.799893	12	0.4883747	0.1560148	0.1606813	0.0868042	0.0888975	0.0192274	0.6869565	0.0063391	1.069565	1.052174	0.6478261
122	PVID,CA	1997	9.731245	12	0.6083751	0.1309773	0.0403439	0.1038261	0.0467973	0.0150511	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
123	PVID,CA	1998	9.368855	12	0.5927726	0.1465083	0.0697926	0.042815	0.0519028	0.0278047	0.9911504	0.0057257	1.053097	1.044248	0.7831858
124	PVID,CA	1999	9.383048	12	0.5960401	0.1437922	0.0184105	0.1405553	0.0617871	0.0286216	0.8063063	0.0049279	0.990991	1.108108	0.7072072
125	PVID,CA	2000	9.586861	12	0.5328537	0.1660656	0.0708997	0.1173932	0.056344	0.0273584	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
126	PVID,CA	2001	10.03502	12	0.5306852	0.1907055	0.0393221	0.1018611	0.0767356	0.0271026	0.7833334	0.0033083	0.775	1.008333	0.7291667
127	PVID,CA	2002	9.646799	12	0.5826684	0.1147762	0.0700565	0.0789653	0.0706234	0.0273489	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
128	PVID,CA	2003	10.19687	12	0.5051963	0.1629401	0.063198	0.0685496	0.066847	0.023931	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
129	PVID,CA	2004	9.367221	12	0.4706267	0.2317366	0.0962723	0.0643742	0.0479906	0.0247368	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
130	PVID,CA	2005	9.894928	12	0.4877179	0.1756449	0.0247473	0.0170913	0.0405333	0.0207622	0.7107143	0.0031714	0.7857143	0.9	0.6785714
131	PVID,CA	2006	8.173547	12	0.4511937	0.1379324	0.0137084	0.0297011	0.0541402	0.0218569	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
132	PVID,CA	2007	8.692882	12	0.470368	0.1832582	0.0177269	0.034651	0.0470239	0.0220847	0.8125	0.0031188	0.81875	0.85	0.8125
133	StGMR,AZ	1996	1.469438	3.25	0.1501707	0.0608129	0.2432516	0.2538008	0.1721998	0.019547	0.6869565	0.0063391	1.069565	1.052174	0.6478261
134	StGMR,AZ	1997	2.086565	3.25	0.244803	0.0294756	0.1914365	0.1945392	0.0890475	0.0031027	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
135	StGMR,AZ	1998	2.483401	3.25	0.2069501	0.1929879	0.0257524	0.2910332	0.0214086	0.0223394	0.9911504	0.0057257	1.053097	1.044248	0.7831858
136	StGMR,AZ	1999	3.668632	3.25	0.0058951	0.171269	0.0769469	0.486193	0.2212225	0.0322681	0.8063063	0.0049279	0.990991	1.108108	0.7072072
137	StGMR,AZ	2000	4.660254	3.25	0	0.2281756	0.1573131	0.471086	0.1035526	0.0398852	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
138	StGMR,AZ	2001	3.557865	3.25	0.0065529	0.2526683	0.0717592	0.4070059	0.1372634	0.0504716	0.7833334	0.0033083	0.775	1.008333	0.7291667
139	StGMR,AZ	2002	4.018927	3.25	0.0010394	0.2330282	0.1315358	0.4269966	0.1382532	0.059516	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
140	StGMR,AZ	2003	3.748061	3.25	0.0012566	0.2457524	0.1739001	0.4522029	0.0432082	0.0619733	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
141	StGMR,AZ	2004	3.521254	3.25	0	0.2353925	0.1884797	0.4346572	0.062054	0.0620323	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
142	StGMR,AZ	2005	3.312752	3.25	0.0035309	0.2686069	0.0813528	0.0342414	0.1284797	0.0590071	0.7107143	0.0031714	0.7857143	0.9	0.6785714
143	StGMR,AZ	2006	2.649395	3.25	0.0553615	0.2209649	0.1078064	0.2978095	0.0805119	0.0417127	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
144	StGMR,AZ	2007	2.894819	3.25	0	0.1270338	0.1977195	0.3651381	0.1075737	0.0414521	0.8125	0.0031188	0.81875	0.85	0.8125
145	UBIDD,AZ	1996	12.09893	10	0.3320598	0.0071451	0.0244438	0.1199627	0.0432467	0.3711699	0.6869565	0.0063391	1.069565	1.052174	0.6478261
146	UBIDD,AZ	1997	11.78718	10	0.3497345	0.006393	0.0526482	0.0846132	0.0496397	0.3407091	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
147	UBIDD,AZ	1998	9.77602	10	0.3260428	0	0.0691948	0.134629	0.1045443	0.2884369	0.9911504	0.0057257	1.053097	1.044248	0.7831858
148	UBIDD,AZ	1999	10.29272	10	0.3294274	0	0.0015042	0.0849892	0.0846132	0.2718904	0.8063063	0.0049279	0.990991	1.108108	0.7072072
149	UBIDD,AZ	2000	11.3408	10	0.2445246	0.0016359	0.0270913	0.153101	0.0910551	0.2646061	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
150	UBIDD,AZ	2001	11.42993	10	0.2633952	0.0097474	0.0061598	0.1175672	0.0656598	0.2451752	0.7833334	0.0033083	0.775	1.008333	0.7291667
151	UBIDD,AZ	2002	9.936221	10	0.2440583	0	0.0109395	0.0477482	0.084098	0.2534485	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
152	UBIDD,AZ	2003	9.353706	10	0.211266	0	0.017246	0.0937176	0.0608312	0.2465703	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
153	UBIDD,AZ	2004	9.700056	10	0.1498744	0.0086117	0.0312956	0.2066969	0.131534	0.2226756	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
154	UBIDD,AZ	2005	8.919358	10	0.0250305	0.024944	0.0124137	0.4464267	0.2858948	0.2052904	0.7107143	0.0031714	0.7857143	0.9	0.6785714

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
155	UBIDD,AZ	2006	9.004348	10	0.159336	0.0327998	0.0255193	0.1849532	0.1570834	0.1962311	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
156	UBIDD,AZ	2007	10.35252	10	0.1896125	0.0039937	0.0280502	0.1373216	0.1922712	0.1794401	0.8125	0.0031188	0.81875	0.85	0.8125
157	WMIDD,AZ	1996	3.896247	4	0.1378167	0.1653921	0.1741529	0.2581219	0.0827361	0.0207592	0.6869565	0.0063391	1.069565	1.052174	0.6478261
158	WMIDD,AZ	1997	4.161175	4	0.1583354	0.1794053	0.1508877	0.2498423	0.0910759	0.0193659	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
159	WMIDD,AZ	1998	4.161767	4	0.1558495	0.152271	0.1634876	0.2768463	0.0870163	0.0188547	0.9911504	0.0057257	1.053097	1.044248	0.7831858
160	WMIDD,AZ	1999	4.009796	4	0.1444023	0.1511884	0.1381676	0.310035	0.1029741	0.0172709	0.8063063	0.0049279	0.990991	1.108108	0.7072072
161	WMIDD,AZ	2000	3.838119	4	0.1362831	0.1610518	0.158616	0.2952399	0.0950052	0.0209797	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
162	WMIDD,AZ	2001	4.197792	4	0.1362831	0.1610518	0.158616	0.2952399	0.0950052	0.0209797	0.7833334	0.0033083	0.775	1.008333	0.7291667
163	WMIDD,AZ	2002	4.076915	4	0.158596	0.107154	0.1583955	0.3317565	0.1200245	0.0106051	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
164	WMIDD,AZ	2003	4.406296	4	0.166625	0.1308903	0.1644098	0.3232463	0.1316521	0.0047212	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
165	WMIDD,AZ	2004	4.15895	4	0.1335039	0.1334838	0.1455546	0.3546093	0.125191	0.0146747	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
166	WMIDD,AZ	2005	4.086679	4	0.0879643	0.1483554	0.1116181	0.4703366	0.1727829	0.0089426	0.7107143	0.0031714	0.7857143	0.9	0.6785714
167	WMIDD,AZ	2006	3.732549	4	0.1414859	0.1098849	0.1146011	0.3429773	0.1299923	0.0059329	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
168	WMIDD,AZ	2007	4.029513	4	0.1306544	0.0941826	0.1479603	0.3612246	0.1603636	0.0073634	0.8125	0.0031188	0.81875	0.85	0.8125
169	YID,AZ	1996	3.414286	5	0.0317899	0.0527338	0.307694	0.4700627	0.0632592	0.0346216	0.6869565	0.0063391	1.069565	1.052174	0.6478261
170	YID,AZ	1997	3.542888	5	0.0289047	0.0727694	0.2973823	0.4345863	0.0516652	0.0062511	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
171	YID,AZ	1998	3.368338	5	0.0332859	0.0789137	0.2743546	0.475459	0.0425824	0.0121282	0.9911504	0.0057257	1.053097	1.044248	0.7831858
172	YID,AZ	1999	3.298453	5	0.0224399	0.077952	0.1828319	0.5471599	0.1232592	0.0378273	0.8063063	0.0049279	0.990991	1.108108	0.7072072
173	YID,AZ	2000	3.420591	5	0.0228412	0.0805064	0.2137108	0.5610283	0.0721058	0.0222454	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
174	YID,AZ	2001	3.765738	5	0.0368351	0.0724654	0.1998675	0.5042018	0.1017004	0.0236757	0.7833334	0.0033083	0.775	1.008333	0.7291667
175	YID,AZ	2002	3.381909	5	0.02682	0.0665648	0.2137204	0.5099892	0.1323079	0.0261462	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
176	YID,AZ	2003	3.655195	5	0.0280077	0.0970927	0.230576	0.4932758	0.0917579	0.0219756	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
177	YID,AZ	2004	3.596423	5	0.0258914	0.0992068	0.2075788	0.4851066	0.0963388	0.0135222	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
178	YID,AZ	2005	3.666682	5	0.0120128	0.0989921	0.2406793	0.4666759	0.1303839	0.0407097	0.7107143	0.0031714	0.7857143	0.9	0.6785714
179	YID,AZ	2006	3.47808	5	0.0378161	0.0918957	0.1776621	0.468243	0.1320295	0.0163961	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
180	YID,AZ	2007	3.498703	5	0.0195136	0.0583641	0.2004707	0.538684	0.1798233	0.0031443	0.8125	0.0031188	0.81875	0.85	0.8125
181	YMIDD,AZ	1996	11.36722	9	0.1489023	0.001853	0.019765	0.0465617	0.0159165	0.5851091	0.6869565	0.0063391	1.069565	1.052174	0.6478261
182	YMIDD,AZ	1997	11.44638	9	0.1599726	0.0045611	0.0256564	0.0150138	0.0091223	0.6005029	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
183	YMIDD,AZ	1998	10.22618	9	0.2177945	0.0015204	0.0155364	0.0365366	0.0261315	0.5247214	0.9911504	0.0057257	1.053097	1.044248	0.7831858
184	YMIDD,AZ	1999	10.27331	9	0.2988974	0.0010453	0.0094549	0.0324981	0.046039	0.4787774	0.8063063	0.0049279	0.990991	1.108108	0.7072072
185	YMIDD,AZ	2000	10.73774	9	0.2531453	0.0002433	0.0125279	0.0867857	0.0429265	0.4711446	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
186	YMIDD,AZ	2001	11.11123	9	0.315211	0.0005549	0.0062222	0.0241337	0.016594	0.4610298	0.7833334	0.0033083	0.775	1.008333	0.7291667
187	YMIDD,AZ	2002	10.11851	9	0.3132963	0.0008224	0.0188551	0.0209694	0.0177196	0.4434618	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
188	YMIDD,AZ	2003	10.71545	9	0.2923526	0	0.0073349	0.0610523	0.0333743	0.4233367	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
189	YMIDD,AZ	2004	9.457671	9	0.2515712	0.0016791	0.0143795	0.1003428	0.0481956	0.3947136	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
190	YMIDD,AZ	2005	8.58445	9	0.1138167	0.0174511	0.0299985	0.2840071	0.166466	0.3882606	0.7107143	0.0031714	0.7857143	0.9	0.6785714
191	YMIDD,AZ	2006	9.420469	9	0.1379565	0.0036998	0.0202458	0.1700731	0.1170365	0.3896964	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
192	YMIDD,AZ	2007	9.048594	9	0.1586669	0.0041782	0.0119654	0.1285957	0.0956761	0.3896422	0.8125	0.0031188	0.81875	0.85	0.8125
193	YVID,AZ	1996	3.927355	5	0.0172803	0.0686114	0.2856646	0.3978652	0.0407496	0.0445858	0.6869565	0.0063391	1.069565	1.052174	0.6478261

row#	district	year	prop_t1div	ZeroMC_AF	prop_alfalfa	prop_cotton	prop_grains	prop_vegmel	prop_grasses	prop_fruitnut	npr_alfalfa	npr_cotton	npr_grains	npr_vegmel	npr_grasses
194	YVID,AZ	1997	4.082148	5	0.02989	0.0975743	0.2270783	0.4212533	0.0530232	0.0552021	0.7983193	0.0058571	1.109244	0.9327731	0.6260504
195	YVID,AZ	1998	4.001773	5	0.0168979	0.0765736	0.1776132	0.4669054	0.0941437	0.037377	0.9911504	0.0057257	1.053097	1.044248	0.7831858
196	YVID,AZ	1999	4.066548	5	0.006977	0.0376899	0.2068658	0.5777847	0.1423919	0.0282674	0.8063063	0.0049279	0.990991	1.108108	0.7072072
197	YVID,AZ	2000	4.298877	5	0.0051656	0.0475944	0.2568111	0.4568958	0.0777627	0.0256275	0.773913	0.0038174	0.8782609	0.9565217	0.6478261
198	YVID,AZ	2001	3.68105	5	0.006614	0.0445557	0.2247452	0.4673653	0.1037974	0.0222313	0.7833334	0.0033083	0.775	1.008333	0.7291667
199	YVID,AZ	2002	4.303385	5	0.009424	0.0472873	0.2311561	0.3874841	0.1098337	0.0250463	0.8319328	0.0023866	0.8403361	1.117647	0.7689075
200	YVID,AZ	2003	4.31917	5	0.0049764	0.0372022	0.254917	0.5122907	0.1017795	0.0292311	0.8064516	0.0037339	0.8951613	1.104839	0.7540323
201	YVID,AZ	2004	4.095384	5	0.0042437	0.0531631	0.2110642	0.5023597	0.1291271	0.0178438	0.6780303	0.0050303	0.8939394	1.037879	0.6477273
202	YVID,AZ	2005	4.030331	5	0.0019096	0.0695394	0.1967549	0.4774925	0.1345632	0.0174549	0.7107143	0.0031714	0.7857143	0.9	0.6785714
203	YVID,AZ	2006	3.991899	5	0.0105752	0.0530095	0.1791863	0.5204927	0.126947	0.0114296	0.8378378	0.0034865	0.7432432	0.8783784	0.7972973
204	YVID,AZ	2007	4.108689	5	0.0030498	0.034768	0.1945638	0.505782	0.160905	0.0117127	0.8125	0.0031188	0.81875	0.85	0.8125

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
1	CRIR,AZ	1996	0.8434783	0	10	1	20	37	3	3	76275	38108	24868	7705	2783	2811	0	0	79
2	CRIR,AZ	1997	0.9915966	0	10	1	20	37	3	3	78138	44971	18312	6233	3060	5562	0	0	95
3	CRIR,AZ	1998	0.9734513	0	10	1	20	37	3	3	82470	49410	15774	7518	7652	2114	0	0	112
4	CRIR,AZ	1999	1.009009	0	10	1	20	37	3	3	77493	47626	12348	7374	7821	2319	6	0	89.5
5	CRIR,AZ	2000	1	0	10	1	20	37	3	3	74495	49282.5	7586.15	4857.35	5814.73	6948.4	5.9	0	89
6	CRIR,AZ	2001	0.8166667	0	10	1	20	37	3	3	74160	50064.4	9912.82	4189.19	2353.04	7619.29	21.78	0	94
7	CRIR,AZ	2002	0.9159664	0	10	1	20	37	3	3	76035	54100.8	7044.94	5402.81	3159.38	6243.12	83.83	0	99
8	CRIR,AZ	2003	0.8467742	0	10	1	20	37	3	3	75330.2	50254.6	8429.94	5505.86	3054.76	7990.66	94.37	0	100
9	CRIR,AZ	2004	0.8030303	0	10	1	20	37	3	3	74195.5	48982	12753	7631.75	2072.37	2672.53	83.82	0	89.5
10	CRIR,AZ	2005	0.8785715	0	10	1	20	37	3	3	73159.4	52026.9	10294.3	4937.6	1721.37	4038.83	140.33	0	99.5
11	CRIR,AZ	2006	0.8648649	0	10	1	20	37	3	3	72608.3	53646.4	8983.33	4493.56	1351.99	4127.64	5.34	0	124
12	CRIR,AZ	2007	0.9625	0	10	1	20	37	3	3	69841.7	48596.8	7157.11	6886.33	1867.48	5183.77	150.14	0	130
13	CVIDD,AZ	1996	0.8434783	0	10	0	13	59	3	3	3908	1573	1136	197	8	993	0	0	79
14	CVIDD,AZ	1997	0.9915966	0	10	0	13	59	3	3	3829	1359	1747	18	66	640	0	0	95
15	CVIDD,AZ	1998	0.9734513	0	10	0	13	59	3	3	4363	1893	1937	321	16	195	0	0	112
16	CVIDD,AZ	1999	1.009009	0	10	0	13	59	3	3	3713	1921	1476	112	10	195	0	0	89.5
17	CVIDD,AZ	2000	1	0	10	0	13	59	3	3	3879	1327.8	2005.91	299.44	63.63	182.33	0	0	89
18	CVIDD,AZ	2001	0.8166667	0	10	0	13	59	3	3	3915	1133.57	2349.93	32	101.96	297.89	0	0	94
19	CVIDD,AZ	2002	0.9159664	0	10	0	13	59	3	3	3734	1309.67	2111.55	138.07	0	174.9	0	0	99
20	CVIDD,AZ	2003	0.8467742	0	10	0	13	59	3	3	3758.13	1322.98	2220.83	0	0	214.32	0	0	100
21	CVIDD,AZ	2004	0.8030303	0	10	0	13	59	3	3	3814.5	1315.15	2355.54	0	0	143.81	0	0	89.5
22	CVIDD,AZ	2005	0.8785715	0	10	0	13	59	3	3	3651.88	765.88	2848.97	0	0	37.03	0	0	99.5
23	CVIDD,AZ	2006	0.8648649	0	10	0	13	59	3	3	3427.42	1210.42	2181.02	0	26.06	9.92	0	0	124
24	CVIDD,AZ	2007	0.9625	0	10	0	13	59	3	3	3665.39	1150.14	2252.77	12.2	94.34	51.78	104.16	0	130
25	FMIR,AZ	1996	0.8434783	0	15	1	20	46	3	4	8852	3419	4605	107	26	696	0	0	79
26	FMIR,AZ	1997	0.9915966	0	15	1	20	46	3	4	8527	3654	4051	146	26	650	0	0	95
27	FMIR,AZ	1998	0.9734513	0	15	1	20	46	3	4	9446	4036	3690	677	0	1043	0	0	112
28	FMIR,AZ	1999	1.009009	0	15	1	20	46	3	4	9045	4874	3250	182	45	692	0	0	89.5
29	FMIR,AZ	2000	1	0	15	1	20	46	3	4	8158	4820.38	1569.76	12.49	127.51	1627.63	0	0	89
30	FMIR,AZ	2001	0.8166667	0	15	1	20	46	3	4	9084	4030.84	2379.54	303.43	497.48	1872.51	0	0	94
31	FMIR,AZ	2002	0.9159664	0	15	1	20	46	3	4	8715	4593.88	1942.88	42.72	211.4	1924.61	0	0	99
32	FMIR,AZ	2003	0.8467742	0	15	1	20	46	3	4	8848.6	5171.38	2507.4	146.02	0	1023.8	0	0	100
33	FMIR,AZ	2004	0.8030303	0	15	1	20	46	3	4	8960.23	5272.17	2966.18	84.79	0	637.09	0	0	89.5
34	FMIR,AZ	2005	0.8785715	0	15	1	20	46	3	4	8845.05	5812.45	2581.64	0	10.36	440.6	0	0	99.5
35	FMIR,AZ	2006	0.8648649	0	15	1	20	46	3	4	8625.72	6134.47	1964.1	0	0	527.15	0	0	124
36	FMIR,AZ	2007	0.9625	0	15	1	20	46	3	4	8867.93	4871.02	3181.78	280.76	45.01	489.36	0	0	130
37	FMIR,CA	1996	0.8434783	0	9	1	20	46	3	4	3634	1641	839	717	0	436	0	0	79
38	FMIR,CA	1997	0.9915966	0	9	1	20	46	3	4	3548	2091	436	744	0	277	0	0	95
39	FMIR,CA	1998	0.9734513	0	9	1	20	46	3	4	3531	2255	455	461	0	360	0	0	112

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
40	FMIR,CA	1999	1.009009	0	9	1	20	46	3	4	3341	2338	669	0	0	334	0	0	89.5
41	FMIR,CA	2000	1	0	9	1	20	46	3	4	3213	1488.71	978.61	0	299.88	445.4	0	0	89
42	FMIR,CA	2001	0.8166667	0	9	1	20	46	3	4	3344	1234.84	1915.95	0	0	193.23	0	0	94
43	FMIR,CA	2002	0.9159664	0	9	1	20	46	3	4	2607	1018.62	1135.7	0	0	453.12	0	0	99
44	FMIR,CA	2003	0.8467742	0	9	1	20	46	3	4	3847.87	996.45	1543.62	572.4	78.88	656.52	0	0	100
45	FMIR,CA	2004	0.8030303	0	9	1	20	46	3	4	3419.19	1454.23	1101.32	602.18	0	261.46	0	0	89.5
46	FMIR,CA	2005	0.8785715	0	9	1	20	46	3	4	3293.6	2055.17	584.72	150.5	0	503.21	0	0	99.5
47	FMIR,CA	2006	0.8648649	0	9	1	20	46	3	4	3138.93	2168.09	466.28	288.46	0	216.1	0	0	124
48	FMIR,CA	2007	0.9625	0	9	1	20	46	3	4	3238.51	2967.86	270.65	0	0	0	0	0	130
49	FYIRBU,CA	1996	0.8434783	0	6	0	28	47	3	6	10577	5	1058	2710	4254	549	2003	0	79
50	FYIRBU,CA	1997	0.9915966	0	6	0	28	47	3	6	11125	49	1078	2788	4742	719	1749	0	95
51	FYIRBU,CA	1998	0.9734513	0	6	0	28	47	3	6	10192	161	972	2148	4445	895	1570	0	112
52	FYIRBU,CA	1999	1.009009	0	6	0	28	47	3	6	12366	15	440	2059	6484	1862	1506	0	89.5
53	FYIRBU,CA	2000	1	0	6	0	28	47	3	6	10261	30.55	468.67	2718.7	4656.81	857.6	1529.13	0	89
54	FYIRBU,CA	2001	0.8166667	0	6	0	28	47	3	6	10387	225.09	693.85	1595.61	4866.67	1527.67	1477.69	0	94
55	FYIRBU,CA	2002	0.9159664	0	6	0	28	47	3	6	10279	160.03	436.95	2121.75	4651.75	1455.14	1453.67	0	99
56	FYIRBU,CA	2003	0.8467742	0	6	0	28	47	3	6	9591.86	93.29	597.41	1634.89	3874	2005.31	1386.96	0	100
57	FYIRBU,CA	2004	0.8030303	0	6	0	28	47	3	6	11561.8	73.63	866.62	1693.71	5552.13	2099.93	1275.78	0	89.5
58	FYIRBU,CA	2005	0.8785715	0	6	0	28	47	3	6	7865.16	151.86	688.69	1235.77	4681.03	0	1107.81	0	99.5
59	FYIRBU,CA	2006	0.8648649	0	6	0	28	47	3	6	9934.94	239.58	664.02	1558.05	4148.09	2282.08	1043.12	0	124
60	FYIRBU,CA	2007	0.9625	0	6	0	28	47	3	6	10834.5	120.03	366.13	1459.35	5461.21	2445.03	982.76	0	130
61	FYIRIU,CA	1996	0.8434783	0	17	1	30	36	3	4	11724	46	395	4389	6007	321	567	0	79
62	FYIRIU,CA	1997	0.9915966	0	17	1	30	36	3	4	10751	17	432	3761	5796	695	49	0	95
63	FYIRIU,CA	1998	0.9734513	0	17	1	30	36	3	4	10113	54	499	3014	5480	1037	28	0	112
64	FYIRIU,CA	1999	1.009009	0	17	1	30	36	3	4	11080	27	58	2762	6893	1306	34	0	89.5
65	FYIRIU,CA	2000	1	0	17	1	30	36	3	4	10295	30.94	0	3164.46	5572.65	1499.42	27.59	0	89
66	FYIRIU,CA	2001	0.8166667	0	17	1	30	36	3	4	10403	41.78	17.32	2955.46	6016.08	1296.98	75.63	0	94
67	FYIRIU,CA	2002	0.9159664	0	17	1	30	36	3	4	9542	98.14	27.05	3100.77	4736.6	1492.52	87.11	0	99
68	FYIRIU,CA	2003	0.8467742	0	17	1	30	36	3	4	10883.6	32.65	18.67	4156.89	5421.27	1208.4	45.74	0	100
69	FYIRIU,CA	2004	0.8030303	0	17	1	30	36	3	4	11556.7	48.43	107.26	3487.16	6238.06	1664.52	11.27	0	89.5
70	FYIRIU,CA	2005	0.8785715	0	17	1	30	36	3	4	12037	32.99	236.45	2944.36	6124.48	2633.17	65.56	0	99.5
71	FYIRIU,CA	2006	0.8648649	0	17	1	30	36	3	4	10309.5	21.99	15.18	2581.32	6143.67	1514.29	33.08	0	124
72	FYIRIU,CA	2007	0.9625	0	17	1	30	36	3	4	10798	34.53	98.36	3112.34	5463.5	2070.76	18.5	0	130
73	IID,CA	1996	0.8434783	0	0	0	34	29	4	5	550489	166072	4601	114746	96454	130376	38240	0	79
74	IID,CA	1997	0.9915966	0	0	0	34	29	4	5	554773	175230	3970	97604	98238	135139	44592	0	95
75	IID,CA	1998	0.9734513	0	0	0	34	29	4	5	556262	194144	4640	89060	100935	126988	40495	0	112
76	IID,CA	1999	1.009009	0	0	0	34	29	4	5	531254	192633	7131	50556	117568	122506	40860	0	89.5
77	IID,CA	2000	1	0	0	0	34	29	4	5	525758	196077	5641	56953	106608	122041	38438	0	89
78	IID,CA	2001	0.8166667	0	0	0	34	29	4	5	521847	199416	13034	47808	105017	123352	33220	0	94

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
79	IID,CA	2002	0.9159664	0	0	0	34	29	4	5	508441	190447	8809	56898	100926	119722	31639	0	99
80	IID,CA	2003	0.8467742	0.005181	0	0	34	29	4	5	536273	177964	3520	73204	110926	138154	32508	2882	100
81	IID,CA	2004	0.8030303	0.0160806	0	0	34	29	4	5	525847	146240	6876.28	68300.2	124769	144390	35271.8	8945	89.5
82	IID,CA	2005	0.8785715	0.0213946	0	0	34	29	4	5	491263	148772	8354.51	34648.1	128658	136186	34643.9	11901	99.5
83	IID,CA	2006	0.8648649	0.0266601	0	0	34	29	4	5	504498	154859	5004.36	31021.9	141478	140490	31644.6	14830	124
84	IID,CA	2007	0.9625	0.0307014	0	0	34	29	4	5	531632	122855	569.57	60239.5	144384	147882	55701.9	17078	130
85	MVIDD,AZ	1996	0.8434783	0	15	0	20	46	3	4	5311	2393	2234	85	54	546	0	0	79
86	MVIDD,AZ	1997	0.9915966	0	15	0	20	46	3	4	5320	2818	1942	144	26	390	0	0	95
87	MVIDD,AZ	1998	0.9734513	0	15	0	20	46	3	4	5206	2655	1954	259	18	319	0	0	112
88	MVIDD,AZ	1999	1.009009	0	15	0	20	46	3	4	5061	2941	1654	14	4	439	9	0	89.5
89	MVIDD,AZ	2000	1	0	15	0	20	46	3	4	4892	2872.58	723.44	0	0	1287.03	8.79	0	89
90	MVIDD,AZ	2001	0.8166667	0	15	0	20	46	3	4	5097	2591.95	1859.66	0	6.33	630.41	8.79	0	94
91	MVIDD,AZ	2002	0.9159664	0	15	0	20	46	3	4	4888	3016.11	858.12	215.1	271.14	518.42	8.79	0	99
92	MVIDD,AZ	2003	0.8467742	0	15	0	20	46	3	4	4984.41	3126.74	1029.08	383.96	0	435.84	8.79	0	100
93	MVIDD,AZ	2004	0.8030303	0	15	0	20	46	3	4	4993.01	2873.02	1694.86	61.28	0	355.06	8.79	0	89.5
94	MVIDD,AZ	2005	0.8785715	0	15	0	20	46	3	4	4879.35	3689.75	891.98	0	0	288.83	8.79	0	99.5
95	MVIDD,AZ	2006	0.8648649	0	15	0	20	46	3	4	4575.67	3586.59	536	80.24	0	364.05	8.79	0	124
96	MVIDD,AZ	2007	0.9625	0	15	0	20	46	3	4	5033.54	3906.72	590.5	177.89	0	342.17	16.26	0	130
97	NCIR,AZ	1996	0.8434783	0	16	1	13	59	3	3	516	0	0	267	249	0	0	0	79
98	NCIR,AZ	1997	0.9915966	0	16	1	13	59	3	3	333	140	32	57	95	10	0	0	95
99	NCIR,AZ	1998	0.9734513	0	16	1	13	59	3	3	458	0	0	0	269	46	142	0	112
100	NCIR,AZ	1999	1.009009	0	16	1	13	59	3	3	439	0	0	240	185	15	0	0	89.5
101	NCIR,AZ	2000	1	0	16	1	13	59	3	3	320	0	0	245.78	74.04	0	0	0	89
102	NCIR,AZ	2001	0.8166667	0	16	1	13	59	3	3	453	4.52	0	199.13	202.79	46.65	0	0	94
103	NCIR,AZ	2002	0.9159664	0	16	1	13	59	3	3	400	0	0	192.74	153.5	53.65	0	0	99
104	NCIR,AZ	2003	0.8467742	0	16	1	13	59	3	3	572.85	4.52	0	246.39	321.94	0	0	0	100
105	NCIR,AZ	2004	0.8030303	0	16	1	13	59	3	3	438.89	0	0	197.88	198.15	42.86	0	0	89.5
106	NCIR,AZ	2005	0.8785715	0	16	1	13	59	3	3	473.13	0	0	203.35	222.55	47.23	0	0	99.5
107	NCIR,AZ	2006	0.8648649	0	16	1	13	59	3	3	532.2	0	0	182.05	278.61	71.54	0	0	124
108	NCIR,AZ	2007	0.9625	0	16	1	13	59	3	3	519.84	18.17	0	209.23	226.42	66.02	0	0	130
109	NGVID,AZ	1996	0.8434783	0	18	0	20	50	3	4	10243	36	1337	3496	4622	579	172	0	79
110	NGVID,AZ	1997	0.9915966	0	18	0	20	50	3	4	10776	129	1577	2765	5266	897	140	0	95
111	NGVID,AZ	1998	0.9734513	0	18	0	20	50	3	4	10185	176	1404	2318	5199	907	180	0	112
112	NGVID,AZ	1999	1.009009	0	18	0	20	50	3	4	9777	196	1201	1257	5236	1749	138	0	89.5
113	NGVID,AZ	2000	1	0	18	0	20	50	3	4	10362	131.77	1706.23	1742.46	5613.03	1005.42	162.65	0	89
114	NGVID,AZ	2001	0.8166667	0	18	0	20	50	3	4	10663	166.25	1490.05	1715.11	5418.71	1807.37	65.5	0	94
115	NGVID,AZ	2002	0.9159664	0	18	0	20	50	3	4	10344	146.08	1990.11	2346.96	4614.64	1194.98	51.35	0	99
116	NGVID,AZ	2003	0.8467742	0	18	0	20	50	3	4	10817.4	108.51	1993.69	2130.59	5203.87	1316.1	64.63	0	100
117	NGVID,AZ	2004	0.8030303	0	18	0	20	50	3	4	11439.5	140.15	2121.55	1871.39	6055.4	1184.49	66.54	0	89.5

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
118	NGVID,AZ	2005	0.8785715	0	18	0	20	50	3	4	11067.3	56.89	2161.03	1772.15	5564.33	1472.06	40.79	0	99.5
119	NGVID,AZ	2006	0.8648649	0	18	0	20	50	3	4	11317.8	210.14	1687.72	1716.62	6003.3	1673.49	26.53	0	124
120	NGVID,AZ	2007	0.9625	0	18	0	20	50	3	4	10855.2	151.62	1279.71	2034.62	5547.05	1776.82	65.4	0	130
121	PVID,CA	1996	0.8434783	0	8	0	22	54	3	4	97933	47828	15279	15736	8501	8706	1883	0	79
122	PVID,CA	1997	0.9915966	0	8	0	22	54	3	4	92583	59580	12827	3951	10168	4583	1474	0	95
123	PVID,CA	1998	0.9734513	0	8	0	22	54	3	4	91233	58052	14348	6835	4193	5083	2723	0	112
124	PVID,CA	1999	1.009009	0	8	0	22	54	3	4	96876	58372	14082	1803	13765	6051	2803	0	89.5
125	PVID,CA	2000	1	0	8	0	22	54	3	4	95085	52184	16263.3	6943.42	11496.7	5517.94	2679.29	0	89
126	PVID,CA	2001	0.8166667	0	8	0	22	54	3	4	94644	51971.6	18676.4	3850.93	9975.56	7514.95	2654.24	0	94
127	PVID,CA	2002	0.9159664	0	8	0	22	54	3	4	92492	57062.5	11240.4	6860.84	7733.31	6916.36	2678.36	0	99
128	PVID,CA	2003	0.8467742	0.1747011	8	0	22	54	3	4	87225.2	49475.4	15957.2	6189.17	6713.27	6546.53	2343.63	17109	100
129	PVID,CA	2004	0.8030303	0.0564263	8	0	22	54	3	4	91639.5	46089.9	22694.7	9428.23	6304.36	4699.86	2422.55	5526	89.5
130	PVID,CA	2005	0.8785715	0.2325467	8	0	22	54	3	4	75065.3	47763.7	17201.4	2423.58	1673.8	3969.55	2033.3	22774	99.5
131	PVID,CA	2006	0.8648649	0.2038945	8	0	22	54	3	4	69388.7	44186.8	13508.1	1342.5	2908.72	5302.11	2140.51	19968	124
132	PVID,CA	2007	0.9625	0.1499903	8	0	22	54	3	4	75909.1	46064.6	17947	1736.05	3393.48	4605.19	2162.82	14689	130
133	StGMR,AZ	1996	0.8434783	0	29	0	12	61	3	3	2901	484	196	784	818	555	63	0	79
134	StGMR,AZ	1997	0.9915966	0	29	0	12	61	3	3	2427	789	95	617	627	287	10	0	95
135	StGMR,AZ	1998	0.9734513	0	29	0	12	61	3	3	2452	667	622	83	938	69	72	0	112
136	StGMR,AZ	1999	1.009009	0	29	0	12	61	3	3	3203	19	552	248	1567	713	104	0	89.5
137	StGMR,AZ	2000	1	0	29	0	12	61	3	3	3223	0	735.41	507.02	1518.31	333.75	128.55	0	89
138	StGMR,AZ	2001	0.8166667	0	29	0	12	61	3	3	2984	21.12	814.35	231.28	1311.78	442.4	162.67	0	94
139	StGMR,AZ	2002	0.9159664	0	29	0	12	61	3	3	3192	3.35	751.05	423.94	1376.21	445.59	191.82	0	99
140	StGMR,AZ	2003	0.8467742	0	29	0	12	61	3	3	3153.04	4.05	792.06	560.48	1457.45	139.26	199.74	0	100
141	StGMR,AZ	2004	0.8030303	0	29	0	12	61	3	3	3166.97	0	758.67	607.47	1400.9	200	199.93	0	89.5
142	StGMR,AZ	2005	0.8785715	0	29	0	12	61	3	3	1853.93	11.38	865.72	262.2	110.36	414.09	190.18	0	99.5
143	StGMR,AZ	2006	0.8648649	0	29	0	12	61	3	3	2591.83	178.43	712.17	347.46	959.84	259.49	134.44	0	124
144	StGMR,AZ	2007	0.9625	0	29	0	12	61	3	3	2703.83	0	409.43	637.25	1176.84	346.71	133.6	0	130
145	UBIDD,AZ	1996	0.8434783	0	99	0	6	91	2	1	2389	883	19	65	319	115	987	0	79
146	UBIDD,AZ	1997	0.9915966	0	99	0	6	91	2	1	2349	930	17	140	225	132	906	0	95
147	UBIDD,AZ	1998	0.9734513	0	99	0	6	91	2	1	2454	867	0	184	358	278	767	0	112
148	UBIDD,AZ	1999	1.009009	0	99	0	6	91	2	1	2054	876	0	4	226	225	723	0	89.5
149	UBIDD,AZ	2000	1	0	99	0	6	91	2	1	2080	650.23	4.35	72.04	407.12	242.13	703.63	0	89
150	UBIDD,AZ	2001	0.8166667	0	99	0	6	91	2	1	1882	700.41	25.92	16.38	312.63	174.6	651.96	0	94
151	UBIDD,AZ	2002	0.9159664	0	99	0	6	91	2	1	1703	648.99	0	29.09	126.97	223.63	673.96	0	99
152	UBIDD,AZ	2003	0.8467742	0	99	0	6	91	2	1	1674.29	561.79	0	45.86	249.21	161.76	655.67	0	100
153	UBIDD,AZ	2004	0.8030303	0	99	0	6	91	2	1	1996.2	398.54	22.9	83.22	549.64	349.77	592.13	0	89.5
154	UBIDD,AZ	2005	0.8785715	0	99	0	6	91	2	1	2659.16	66.56	66.33	33.01	1187.12	760.24	545.9	0	99.5
155	UBIDD,AZ	2006	0.8648649	0	99	0	6	91	2	1	2010.12	423.7	87.22	67.86	491.82	417.71	521.81	0	124
156	UBIDD,AZ	2007	0.9625	0	99	0	6	91	2	1	1943.02	504.21	10.62	74.59	365.16	511.28	477.16	0	130

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
157	WMIDD,AZ	1996	0.8434783	0	125	0	14	54	3	3	83699	13749	16500	17374	25751	8254	2071	0	79
158	WMIDD,AZ	1997	0.9915966	0	125	0	14	54	3	3	84690	15796	17898	15053	24925	9086	1932	0	95
159	WMIDD,AZ	1998	0.9734513	0	125	0	14	54	3	3	85230	15548	15191	16310	27619	8681	1881	0	112
160	WMIDD,AZ	1999	1.009009	0	125	0	14	54	3	3	86199	14406	15083	13784	30930	10273	1723	0	89.5
161	WMIDD,AZ	2000	1	0	125	0	14	54	3	3	86512	13596	16067	15824	29454	9478	2093	0	89
162	WMIDD,AZ	2001	0.8166667	0	125	0	14	54	3	3	86512	13596	16067	15824	29454	9478	2093	0	94
163	WMIDD,AZ	2002	0.9159664	0	125	0	14	54	3	3	88443	15822	10690	15802	33097	11974	1058	0	99
164	WMIDD,AZ	2003	0.8467742	0	125	0	14	54	3	3	91936	16623	13058	16402	32248	13134	471	0	100
165	WMIDD,AZ	2004	0.8030303	0	125	0	14	54	3	3	90486.7	13318.7	13316.7	14521	35376.9	12489.4	1463.99	0	89.5
166	WMIDD,AZ	2005	0.8785715	0	125	0	14	54	3	3	99762.9	8775.58	14800.4	11135.3	46922.2	17237.3	892.14	0	99.5
167	WMIDD,AZ	2006	0.8648649	0	125	0	14	54	3	3	84287.1	14115	10962.4	11432.9	34216.4	12968.4	591.88	0	124
168	WMIDD,AZ	2007	0.9625	0	125	0	14	54	3	3	89961.1	13034.5	9395.93	14761	36036.8	15998.3	734.59	0	130
169	YID,AZ	1996	0.8434783	0	30	0	18	43	3	3	17971	595	987	5759	8798	1184	648	0	79
170	YID,AZ	1997	0.9915966	0	30	0	18	43	3	3	16686	541	1362	5566	8134	967	117	0	95
171	YID,AZ	1998	0.9734513	0	30	0	18	43	3	3	17159	623	1477	5135	8899	797	227	0	112
172	YID,AZ	1999	1.009009	0	30	0	18	43	3	3	18557	420	1459	3422	10241	2307	708	0	89.5
173	YID,AZ	2000	1	0	30	0	18	43	3	3	18201	427.51	1506.81	3999.95	10500.6	1349.58	416.36	0	89
174	YID,AZ	2001	0.8166667	0	30	0	18	43	3	3	17570	689.43	1356.31	3740.85	9436.97	1903.49	443.13	0	94
175	YID,AZ	2002	0.9159664	0	30	0	18	43	3	3	18259	501.98	1245.87	4000.13	9545.29	2476.36	489.37	0	99
176	YID,AZ	2003	0.8467742	0	30	0	18	43	3	3	18018.3	524.21	1817.25	4315.61	9232.47	1717.4	411.31	0	100
177	YID,AZ	2004	0.8030303	0	30	0	18	43	3	3	17362.4	484.6	1856.82	3885.18	9079.57	1803.14	253.09	0	89.5
178	YID,AZ	2005	0.8785715	0	30	0	18	43	3	3	18519.3	224.84	1852.8	4504.71	8734.61	2440.35	761.95	0	99.5
179	YID,AZ	2006	0.8648649	0	30	0	18	43	3	3	17295	707.79	1719.98	3325.24	8763.94	2471.15	306.88	0	124
180	YID,AZ	2007	0.9625	0	30	0	18	43	3	3	18716.7	365.23	1092.38	3752.14	10082.4	3365.69	58.85	0	130
181	YMIDD,AZ	1996	0.8434783	0	107	0	3	96	2	1	17219	3134	39	416	980	335	12315	0	79
182	YMIDD,AZ	1997	0.9915966	0	107	0	3	96	2	1	17150	3367	96	540	316	192	12639	0	95
183	YMIDD,AZ	1998	0.9734513	0	107	0	3	96	2	1	17308	4584	32	327	769	550	11044	0	112
184	YMIDD,AZ	1999	1.009009	0	107	0	3	96	2	1	18241	6291	22	199	684	969	10077	0	89.5
185	YMIDD,AZ	2000	1	0	107	0	3	96	2	1	18243	5328.04	5.12	263.68	1826.61	903.49	9916.35	0	89
186	YMIDD,AZ	2001	0.8166667	0	107	0	3	96	2	1	17338	6634.36	11.68	130.96	507.95	349.26	9703.46	0	94
187	YMIDD,AZ	2002	0.9159664	0	107	0	3	96	2	1	17156	6594.06	17.31	396.85	441.35	372.95	9333.7	0	99
188	YMIDD,AZ	2003	0.8467742	0	107	0	3	96	2	1	17205.2	6153.25	0	154.38	1284.99	702.44	8910.12	0	100
189	YMIDD,AZ	2004	0.8030303	0	107	0	3	96	2	1	17066.9	5294.91	35.34	302.65	2111.95	1014.39	8307.68	0	89.5
190	YMIDD,AZ	2005	0.8785715	0	107	0	3	96	2	1	21047.4	2395.54	367.3	631.39	5977.6	3503.67	8171.86	0	99.5
191	YMIDD,AZ	2006	0.8648649	0	107	0	3	96	2	1	17652.6	2903.62	77.87	426.12	3579.59	2463.31	8202.08	0	124
192	YMIDD,AZ	2007	0.9625	0	107	0	3	96	2	1	16600.6	3339.52	87.94	251.84	2706.6	2013.73	8200.94	0	130
193	YVID,AZ	1996	0.8434783	0	15	0	40	26	3	6	73752	1491	5920	24648	34329	3516	3847	0	79
194	YVID,AZ	1997	0.9915966	0	15	0	40	26	3	6	76276	2579	8419	19593	36347	4575	4763	0	95
195	YVID,AZ	1998	0.9734513	0	15	0	40	26	3	6	75023	1458	6607	15325	40286	8123	3225	0	112

row#	district	year	npr_fruitnut	prop_fallow	Elevation	IndianRes	clay	sand	drnge	hydrgrp	q_totagac	q_alfalfa	q_cotton	q_grains	q_vegmel	q_grasses	q_fruitnut	FllwPrgm	p1_alfalfa
196	YVID,AZ	1999	1.009009	0	15	0	40	26	3	6	86283	602	3252	17849	49853	12286	2439	0	89.5
197	YVID,AZ	2000	1	0	15	0	40	26	3	6	75054	445.7	4106.59	22158.4	39422.3	6709.6	2211.22	0	89
198	YVID,AZ	2001	0.8166667	0	15	0	40	26	3	6	75007	570.68	3844.4	19391.7	40325.7	8955.95	1918.18	0	94
199	YVID,AZ	2002	0.9159664	0	15	0	40	26	3	6	69909	813.13	4080.09	19944.8	33433.3	9476.78	2161.07	0	99
200	YVID,AZ	2003	0.8467742	0	15	0	40	26	3	6	81140.3	429.38	3209.92	21995	44202	8781.84	2522.15	0	100
201	YVID,AZ	2004	0.8030303	0	15	0	40	26	3	6	79190.7	366.16	4587.07	18211.3	43345.1	11141.5	1539.62	0	89.5
202	YVID,AZ	2005	0.8785715	0	15	0	40	26	3	6	77457.5	164.77	6000.07	16976.6	41199.5	11610.5	1506.06	0	99.5
203	YVID,AZ	2006	0.8648649	0	15	0	40	26	3	6	77796.2	912.46	4573.82	15460.7	44909.7	10953.4	986.18	0	124
204	YVID,AZ	2007	0.9625	0	15	0	40	26	3	6	78585	263.15	2999.89	16787.6	43640.4	13883.4	1010.61	0	130

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
1	CRIR,AZ	1996	0.729	123	121	74.5	97	115	713839	476338	664044	82470	361079	0.6672905	9.358754	6.245008
2	CRIR,AZ	1997	0.697	132	111	74.5	118	119	631658	392723	713839	82470	324249	0.6217336	8.083878	5.026018
3	CRIR,AZ	1998	0.647	119	118	88.5	110	113	591924	351668	631658	82470	325326	0.5941101	7.177446	4.264193
4	CRIR,AZ	1999	0.547	110	123	78.5	112	111	599509	343165	591924	82470	312993	0.5724101	7.736299	4.428336
5	CRIR,AZ	2000	0.439	101	110	74.5	115	115	628251	392306	599509	82470	333708	0.6244415	8.433465	5.266206
6	CRIR,AZ	2001	0.397	93	121	87.5	98	120	585920	342348	628251	82470	338909	0.5842914	7.900755	4.616343
7	CRIR,AZ	2002	0.284	100	133	91.5	109	119	614444	384860	585920	82470	361333	0.6263549	8.081068	5.061616
8	CRIR,AZ	2003	0.463	111	137	93.5	105	124	606298	392177	614444	82470	335719	0.6468387	8.048535	5.206104
9	CRIR,AZ	2004	0.664	118	137	85.5	106	132	585534	359801	606298	82470	321253	0.6144835	7.891769	4.849362
10	CRIR,AZ	2005	0.444	110	126	95	123	140	577870	360896	585534	82470	325428	0.624528	7.898784	4.933012
11	CRIR,AZ	2006	0.516	110	130	118	128	148	614769	384905	577870	82470	355324	0.626097	8.466926	5.301116
12	CRIR,AZ	2007	0.499	131	136	130	154	160	612632	396597	614769	82470	340138	0.6473658	8.771726	5.678515
13	CVIDD,AZ	1996	0.729	123	121	74.5	97	115	29223		29210	4363	13983		7.477738	
14	CVIDD,AZ	1997	0.697	132	111	74.5	118	119	30883		29223	4363	14177		8.065553	
15	CVIDD,AZ	1998	0.647	119	118	88.5	110	113	28952		30883	4363	16104		6.635801	
16	CVIDD,AZ	1999	0.547	110	123	78.5	112	111	26920		28952	4363	15077		7.250202	
17	CVIDD,AZ	2000	0.439	101	110	74.5	115	115	30085		26920	4363	14629		7.755865	
18	CVIDD,AZ	2001	0.397	93	121	87.5	98	120	26302		30085	4363	14289		6.718263	
19	CVIDD,AZ	2002	0.284	100	133	91.5	109	119	27069		26302	4363	14279		7.249331	
20	CVIDD,AZ	2003	0.463	111	137	93.5	105	124	27069		27069	4363	14095		7.202785	
21	CVIDD,AZ	2004	0.664	118	137	85.5	106	132	27070		27069	4363	14064		7.096605	
22	CVIDD,AZ	2005	0.444	110	126	95	123	140	13424		27070	4363	12322		3.675915	
23	CVIDD,AZ	2006	0.516	110	130	118	128	148	13625		13424	4363	13176		3.975293	
24	CVIDD,AZ	2007	0.499	131	136	130	154	160	13620		13625	4363	14028		3.715839	
25	FMIR,AZ	1996	0.729	123	121	74.5	97	115	68035		65152	9446	41084		7.685845	
26	FMIR,AZ	1997	0.697	132	111	74.5	118	119	69967		68035.1	9446	33853		8.205348	
27	FMIR,AZ	1998	0.647	119	118	88.5	110	113	61888		69967	9446	35623		6.551768	
28	FMIR,AZ	1999	0.547	110	123	78.5	112	111	80252		61888	9446	36589		8.872526	
29	FMIR,AZ	2000	0.439	101	110	74.5	115	115	65883		80252	9446	37841		8.075876	
30	FMIR,AZ	2001	0.397	93	121	87.5	98	120	63451		65883	9446	37043		6.984919	
31	FMIR,AZ	2002	0.284	100	133	91.5	109	119	61982		63451	9446	39292		7.112105	
32	FMIR,AZ	2003	0.463	111	137	93.5	105	124	57458		61982	9446	37719		6.493457	
33	FMIR,AZ	2004	0.664	118	137	85.5	106	132	69109		57458	9446	38031		7.71286	
34	FMIR,AZ	2005	0.444	110	126	95	123	140	72364		69109	9446	37041		8.181299	
35	FMIR,AZ	2006	0.516	110	130	118	128	148	64110		72364	9446	42189		7.432423	
36	FMIR,AZ	2007	0.499	131	136	130	154	160	73747		64110	9446	40267		8.316146	
37	FMIR,CA	1996	0.729	123	121	74.5	97	115	30189		21364	3847.87	17497		8.307375	
38	FMIR,CA	1997	0.697	132	111	74.5	118	119	27241		30189	3847.87	14858		7.677847	
39	FMIR,CA	1998	0.647	119	118	88.5	110	113	26276		27241	3847.87	14424		7.441518	

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
40	FMIR,CA	1999	0.547	110	123	78.5	112	111	21109		26276	3847.87	14786		6.318168	
41	FMIR,CA	2000	0.439	101	110	74.5	115	115	23303		21109	3847.87	13287		7.252723	
42	FMIR,CA	2001	0.397	93	121	87.5	98	120	18512		23303	3847.87	12992		5.535885	
43	FMIR,CA	2002	0.284	100	133	91.5	109	119	16494		18512	3847.87	11010		6.326812	
44	FMIR,CA	2003	0.463	111	137	93.5	105	124	16481		16494	3847.87	12948		4.283149	
45	FMIR,CA	2004	0.664	118	137	85.5	106	132	16019		16481	3847.87	12842		4.685028	
46	FMIR,CA	2005	0.444	110	126	95	123	140	16307		16019	3847.87	13580		4.951117	
47	FMIR,CA	2006	0.516	110	130	118	128	148	18827		16307	3847.87	14937		5.997904	
48	FMIR,CA	2007	0.499	131	136	130	154	160	21323		18827	3847.87	15151		6.584201	
49	FYIRBU,CA	1996	0.729	123	121	74.5	97	115	56412	55726	52843	12366	26559	0.9878395	5.333459	5.268602
50	FYIRBU,CA	1997	0.697	132	111	74.5	118	119	53179	52744	56412	12366	24360	0.9918201	4.780135	4.741034
51	FYIRBU,CA	1998	0.647	119	118	88.5	110	113	49812	49564	53179	12366	21378	0.9950213	4.887362	4.86303
52	FYIRBU,CA	1999	0.547	110	123	78.5	112	111	48800	48620	49812	12366	25030	0.9963115	3.946304	3.931748
53	FYIRBU,CA	2000	0.439	101	110	74.5	115	115	50334	50076	48800	12366	22088	0.9948742	4.90537	4.880226
54	FYIRBU,CA	2001	0.397	93	121	87.5	98	120	46180	45678	50334	12366	22403	0.9891295	4.445942	4.397613
55	FYIRBU,CA	2002	0.284	100	133	91.5	109	119	47221	46811	46180	12366	23931	0.9913175	4.593929	4.554042
56	FYIRBU,CA	2003	0.463	111	137	93.5	105	124	46977	46494	47221	12366	22754	0.9897184	4.89759	4.847235
57	FYIRBU,CA	2004	0.664	118	137	85.5	106	132	37457	37084	46977	12366	24181	0.9900419	3.239721	3.207459
58	FYIRBU,CA	2005	0.444	110	126	95	123	140	38537	38018	37457	12366	13829	0.9865324	4.89971	4.833722
59	FYIRBU,CA	2006	0.516	110	130	118	128	148	40757	40346	38537	12366	21897	0.9899158	4.10239	4.061021
60	FYIRBU,CA	2007	0.499	131	136	130	154	160	43454	43010	40757	12366	24425	0.9897823	4.010703	3.969723
61	FYIRIU,CA	1996	0.729	123	121	74.5	97	115	33196	32521	38939	12037.01	20836	0.9796662	2.831457	2.773883
62	FYIRIU,CA	1997	0.697	132	111	74.5	118	119	31008	30575	33196	12037.01	17022	0.9860359	2.884197	2.843921
63	FYIRIU,CA	1998	0.647	119	118	88.5	110	113	31386	31163	31008	12037.01	14187	0.9928949	3.10353	3.081479
64	FYIRIU,CA	1999	0.547	110	123	78.5	112	111	31350	31182	31386	12037.01	16059	0.9946411	2.829422	2.81426
65	FYIRIU,CA	2000	0.439	101	110	74.5	115	115	29785	29582	31350	12037.01	16024	0.9931845	2.893152	2.873434
66	FYIRIU,CA	2001	0.397	93	121	87.5	98	120	40992	40239	29785	12037.01	14953	0.9816306	3.940402	3.868019
67	FYIRIU,CA	2002	0.284	100	133	91.5	109	119	47084	46387	40992	12037.01	17037	0.9851967	4.934395	4.86135
68	FYIRIU,CA	2003	0.463	111	137	93.5	105	124	46352	45547	47084	12037.01	16825	0.9826329	4.258877	4.184913
69	FYIRIU,CA	2004	0.664	118	137	85.5	106	132	46259	45531	46352	12037.01	17794	0.9842625	4.002786	3.939792
70	FYIRIU,CA	2005	0.444	110	126	95	123	140	44803	43817	46259	12037.01	19569	0.9779925	3.722104	3.64019
71	FYIRIU,CA	2006	0.516	110	130	118	128	148	38187	37571	44803	12037.01	15859	0.9838688	3.704048	3.644298
72	FYIRIU,CA	2007	0.499	131	136	130	154	160	45290	44508	38187	12037.01	19586	0.9827335	4.194299	4.121878
73	IID,CA	1996	0.729	123	121	74.5	97	115	3275453	2329952	3.20E+06	556262		0.7113374	5.950079	4.232513
74	IID,CA	1997	0.697	132	111	74.5	118	119	3235259	2263551	3.30E+06	556262		0.6996505	5.831681	4.080138
75	IID,CA	1998	0.647	119	118	88.5	110	113	3148164	2211061	3.20E+06	556262		0.7023336	5.659499	3.974856
76	IID,CA	1999	0.547	110	123	78.5	112	111	3122480	2200001	3.10E+06	556262		0.7045686	5.877565	4.141148
77	IID,CA	2000	0.439	101	110	74.5	115	115	2977456	2048679	3.10E+06	556262		0.6880635	5.663168	3.896619
78	IID,CA	2001	0.397	93	121	87.5	98	120	3190927	2228775	3.00E+06	556262		0.6984726	6.114679	4.270936

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
79	IID,CA	2002	0.284	100	133	91.5	109	119	3230352	2269213	3.20E+06	556262		0.7024663	6.353445	4.463081
80	IID,CA	2003	0.463	111	137	93.5	105	124	3066361	2162778	3.20E+06	556262		0.7053239	5.71791	4.032979
81	IID,CA	2004	0.664	118	137	85.5	106	132	2822794	1912406	3.10E+06	556262	1711737	0.6774868	5.368089	3.636809
82	IID,CA	2005	0.444	110	126	95	123	140	2860526	1921179	2.80E+06	556262	1707998	0.6716173	5.822798	3.910692
83	IID,CA	2006	0.516	110	130	118	128	148	2994325	2071412	2.90E+06	556262	1889373	0.6917793	5.935256	4.105887
84	IID,CA	2007	0.499	131	136	130	154	160	2952526	2019550	3.00E+06	556262	1730300	0.6840075	5.5537	3.798773
85	MVIDD,AZ	1996	0.729	123	121	74.5	97	115	45793		38398	5320	25941		8.622293	
86	MVIDD,AZ	1997	0.697	132	111	74.5	118	119	42600		45793	5320	22255		8.007519	
87	MVIDD,AZ	1998	0.647	119	118	88.5	110	113	31668		42600	5320	20455		6.082981	
88	MVIDD,AZ	1999	0.547	110	123	78.5	112	111	34981		31668	5320	21066		6.911875	
89	MVIDD,AZ	2000	0.439	101	110	74.5	115	115	37432		34981	5320	22980		7.651676	
90	MVIDD,AZ	2001	0.397	93	121	87.5	98	120	36869		37432	5320	22007		7.23347	
91	MVIDD,AZ	2002	0.284	100	133	91.5	109	119	35770		36869	5320	22588		7.317922	
92	MVIDD,AZ	2003	0.463	111	137	93.5	105	124	36456		35770	5320	21429		7.314005	
93	MVIDD,AZ	2004	0.664	118	137	85.5	106	132	36771		36456	5320	21053		7.364496	
94	MVIDD,AZ	2005	0.444	110	126	95	123	140	32326		36771	5320	21520		6.625062	
95	MVIDD,AZ	2006	0.516	110	130	118	128	148	36181		32326	5320	23275		7.907258	
96	MVIDD,AZ	2007	0.499	131	136	130	154	160	35470		36181	5320	26317		7.046731	
97	NCIR,AZ	1996	0.729	123	121	74.5	97	115	1368		1469	572.85	881		2.651163	
98	NCIR,AZ	1997	0.697	132	111	74.5	118	119	2023		1368	572.85	1072		6.075075	
99	NCIR,AZ	1998	0.647	119	118	88.5	110	113	4537		2023	572.85	833		9.906114	
100	NCIR,AZ	1999	0.547	110	123	78.5	112	111	4897		4537	572.85	641		11.1549	
101	NCIR,AZ	2000	0.439	101	110	74.5	115	115	4286		4897	572.85	531		13.39375	
102	NCIR,AZ	2001	0.397	93	121	87.5	98	120	6273		4286	572.85	639		13.84768	
103	NCIR,AZ	2002	0.284	100	133	91.5	109	119	3593		6273	572.85	707		8.9825	
104	NCIR,AZ	2003	0.463	111	137	93.5	105	124	3824		3593	572.85	674		6.675395	
105	NCIR,AZ	2004	0.664	118	137	85.5	106	132	3861		3824	572.85	654		8.797193	
106	NCIR,AZ	2005	0.444	110	126	95	123	140	3641		3861	572.85	654		7.69556	
107	NCIR,AZ	2006	0.516	110	130	118	128	148	5267		3641	572.85	848		9.896655	
108	NCIR,AZ	2007	0.499	131	136	130	154	160	3445		5267	572.85	973		6.627039	
109	NGVID,AZ	1996	0.729	123	121	74.5	97	115	48573	20646	45674	11439.52	20063	0.4250509	4.742068	2.01562
110	NGVID,AZ	1997	0.697	132	111	74.5	118	119	49843	20599	48573	11439.52	18721	0.4132777	4.625371	1.911563
111	NGVID,AZ	1998	0.647	119	118	88.5	110	113	45611	19532	49843	11439.52	16058	0.42823	4.478252	1.917722
112	NGVID,AZ	1999	0.547	110	123	78.5	112	111	43976	18567	45611	11439.52	18066	0.4222076	4.497903	1.899049
113	NGVID,AZ	2000	0.439	101	110	74.5	115	115	48965	21060	43976	11439.52	17999	0.4301031	4.725439	2.032426
114	NGVID,AZ	2001	0.397	93	121	87.5	98	120	46150	19276	48965	11439.52	19130	0.4176815	4.32805	1.807746
115	NGVID,AZ	2002	0.284	100	133	91.5	109	119	48441	18417	46150	11439.52	20919	0.3801945	4.683005	1.780452
116	NGVID,AZ	2003	0.463	111	137	93.5	105	124	45191	18009	48441	11439.52	20045	0.3985085	4.177625	1.664819
117	NGVID,AZ	2004	0.664	118	137	85.5	106	132	43793	16173	45191	11439.52	20447	0.3693056	3.82822	1.413783

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
118	NGVID,AZ	2005	0.444	110	126	95	123	140	44827	18550	43793	11439.52	19834	0.4138131	4.050419	1.676116
119	NGVID,AZ	2006	0.516	110	130	118	128	148	45661	18750	44827	11439.52	22004	0.4106349	4.034441	1.656682
120	NGVID,AZ	2007	0.499	131	136	130	154	160	47528	19922	45661	11439.52	21383	0.4191634	4.378355	1.835246
121	PVID,CA	1996	0.729	123	121	74.5	97	115	953010	493572	861800	97933	348912	0.5179085	9.731245	5.039895
122	PVID,CA	1997	0.697	132	111	74.5	118	119	917520	421851	953010	97933	398036	0.4597731	9.910243	4.556463
123	PVID,CA	1998	0.647	119	118	88.5	110	113	918910	427113	917520	97933	372772	0.464804	10.07212	4.681562
124	PVID,CA	1999	0.547	110	123	78.5	112	111	938870	468888	918910	97933	391697	0.4994174	9.691462	4.840084
125	PVID,CA	2000	0.439	101	110	74.5	115	115	982760	511947	938870	97933	395349	0.5209278	10.33559	5.384099
126	PVID,CA	2001	0.397	93	121	87.5	98	120	944740	492634	982760	97933	395142	0.5214493	9.982038	5.205127
127	PVID,CA	2002	0.284	100	133	91.5	109	119	998610	540786	944740	97933	416365	0.5415387	10.79672	5.846841
128	PVID,CA	2003	0.463	111	137	93.5	105	124	917360	431021	998610	97933	367813	0.4698493	10.51714	4.941473
129	PVID,CA	2004	0.664	118	137	85.5	106	132	969040	466965	917360	97933	357831	0.4818841	10.57448	5.095672
130	PVID,CA	2005	0.444	110	126	95	123	140	800460	369764	969040	97933	323048	0.4619394	10.66351	4.925895
131	PVID,CA	2006	0.516	110	130	118	128	148	851320	402571	800460	97933	320830	0.4728786	12.26885	5.801678
132	PVID,CA	2007	0.499	131	136	130	154	160	917090	426705	851320	97933	347880	0.4652815	12.08142	5.621262
133	StGMR,AZ	1996	0.729	123	121	74.5	97	115	6725	6553	4736	3223	8349	0.9744238	2.318166	2.258876
134	StGMR,AZ	1997	0.697	132	111	74.5	118	119	8004	7961	6725	3223	7223	0.9946277	3.297899	3.280181
135	StGMR,AZ	1998	0.647	119	118	88.5	110	113	11824	11702	8004	3223	6379	0.989682	4.822186	4.772431
136	StGMR,AZ	1999	0.547	110	123	78.5	112	111	15020	14628	11824	3223	6084	0.9739015	4.689354	4.566968
137	StGMR,AZ	2000	0.439	101	110	74.5	115	115	11467	10798	15020	3223	6026	0.9416587	3.557865	3.350295
138	StGMR,AZ	2001	0.397	93	121	87.5	98	120	12953	12474	11467	3223	6081	0.9630201	4.340818	4.180295
139	StGMR,AZ	2002	0.284	100	133	91.5	109	119	12080	11433	12953	3223	6966	0.9464404	3.784461	3.581767
140	StGMR,AZ	2003	0.463	111	137	93.5	105	124	11349	10897	12080	3223	5923	0.9601727	3.599383	3.45603
141	StGMR,AZ	2004	0.664	118	137	85.5	106	132	10677	9820	11349	3223	6132	0.919734	3.371361	3.100756
142	StGMR,AZ	2005	0.444	110	126	95	123	140	8539	7987	10677	3223	5572	0.9353554	4.605891	4.308145
143	StGMR,AZ	2006	0.516	110	130	118	128	148	9330	8930	8539	3223	6468	0.9571276	3.599773	3.445442
144	StGMR,AZ	2007	0.499	131	136	130	154	160	9455	8896	9330	3223	5425	0.9408779	3.496891	3.290148
145	UBIDD,AZ	1996	0.729	123	121	74.5	97	115	31344	25231	32173	2659.16	10343	0.8049706	13.12013	10.56132
146	UBIDD,AZ	1997	0.697	132	111	74.5	118	119	25996	21282	31344	2659.16	9455	0.8186644	11.06684	9.060025
147	UBIDD,AZ	1998	0.647	119	118	88.5	110	113	27370	20969	25996	2659.16	8873	0.7661308	11.15322	8.544825
148	UBIDD,AZ	1999	0.547	110	123	78.5	112	111	30157	22414	27370	2659.16	8122	0.7432437	14.68208	10.91237
149	UBIDD,AZ	2000	0.439	101	110	74.5	115	115	30394	21565	30157	2659.16	7550	0.709515	14.6125	10.36779
150	UBIDD,AZ	2001	0.397	93	121	87.5	98	120	26422	15980	30394	2659.16	6834	0.604799	14.03932	8.490967
151	UBIDD,AZ	2002	0.284	100	133	91.5	109	119	24873	14314	26422	2659.16	7323	0.5754834	14.6054	8.405168
152	UBIDD,AZ	2003	0.463	111	137	93.5	105	124	25794	12466	24873	2659.16	6334	0.4832907	15.40593	7.445544
153	UBIDD,AZ	2004	0.664	118	137	85.5	106	132	23718	14312	25794	2659.16	5974	0.6034235	11.88158	7.169622
154	UBIDD,AZ	2005	0.444	110	126	95	123	140	23944	13997	23718	2659.16	5871	0.5845723	9.004348	5.263692
155	UBIDD,AZ	2006	0.516	110	130	118	128	148	27529	13174	23944	2659.16	6866	0.4785499	13.6952	6.553838
156	UBIDD,AZ	2007	0.499	131	136	130	154	160	29438	12625	27529	2659.16	7219	0.4288675	15.15064	6.497617

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
157	WMIDD,AZ	1996	0.729	123	121	74.5	97	115	415131	274421	388701	99762.93		0.6610467	4.959808	3.278665
158	WMIDD,AZ	1997	0.697	132	111	74.5	118	119	415190	312514	415131	99762.93		0.7527012	4.902468	3.690093
159	WMIDD,AZ	1998	0.647	119	118	88.5	110	113	400029	290355	415190	99762.93		0.7258349	4.693523	3.406723
160	WMIDD,AZ	1999	0.547	110	123	78.5	112	111	382902	266730	400029	99762.93		0.6966012	4.44207	3.094352
161	WMIDD,AZ	2000	0.439	101	110	74.5	115	115	418784	275747	382902	99762.93		0.6584468	4.840762	3.187384
162	WMIDD,AZ	2001	0.397	93	121	87.5	98	120	406725	276682	418784	99762.93		0.680268	4.701371	3.198192
163	WMIDD,AZ	2002	0.284	100	133	91.5	109	119	439585	285755	406725	99762.93		0.6500563	4.970263	3.230951
164	WMIDD,AZ	2003	0.463	111	137	93.5	105	124	414909	272739	439585	99762.93		0.6573465	4.51302	2.966618
165	WMIDD,AZ	2004	0.664	118	137	85.5	106	132	407699	256574	414909	99762.93	207201	0.6293221	4.505624	2.835489
166	WMIDD,AZ	2005	0.444	110	126	95	123	140	372370	236323	407699	99762.93	198886	0.6346456	3.732549	2.368846
167	WMIDD,AZ	2006	0.516	110	130	118	128	148	401996	274927	372370	99762.93	194209	0.6839048	4.769363	3.261791
168	WMIDD,AZ	2007	0.499	131	136	130	154	160	420160	272778	401996	99762.93	208189	0.6492241	4.670463	3.032177
169	YID,AZ	1996	0.729	123	121	74.5	97	115	66311	52073	63904	18716.65	35891	0.7852845	3.689889	2.897613
170	YID,AZ	1997	0.697	132	111	74.5	118	119	63044	50875	66311	18716.65	29999	0.8069761	3.778257	3.048963
171	YID,AZ	1998	0.647	119	118	88.5	110	113	61736	50736	63044	18716.65	26706	0.8218219	3.597879	2.956816
172	YID,AZ	1999	0.547	110	123	78.5	112	111	64022	50590	61736	18716.65	32116	0.7901971	3.450019	2.726195
173	YID,AZ	2000	0.439	101	110	74.5	115	115	70482	52729	64022	18716.65	29805	0.7481201	3.872425	2.897039
174	YID,AZ	2001	0.397	93	121	87.5	98	120	63298	49171	70482	18716.65	30189	0.7768176	3.602618	2.798577
175	YID,AZ	2002	0.284	100	133	91.5	109	119	68413	52631	63298	18716.65	34684	0.7693129	3.74681	2.882469
176	YID,AZ	2003	0.463	111	137	93.5	105	124	67313	48372	68413	18716.65	31464	0.718613	3.735823	2.684611
177	YID,AZ	2004	0.664	118	137	85.5	106	132	68628	44885	67313	18716.65	30176	0.6540334	3.952679	2.585184
178	YID,AZ	2005	0.444	110	126	95	123	140	65098	47377	68628	18716.65	32030	0.7277796	3.515151	2.558256
179	YID,AZ	2006	0.516	110	130	118	128	148	65484	49806	65098	18716.65	34308	0.7605827	3.786301	2.879795
180	YID,AZ	2007	0.499	131	136	130	154	160	67422	49220	65484	18716.65	35385	0.7300287	3.602247	2.629744
181	YMIDD,AZ	1996	0.729	123	121	74.5	97	115	240916	203787	239250	21047.36	73567	0.845884	13.99132	11.83503
182	YMIDD,AZ	1997	0.697	132	111	74.5	118	119	215234	188356	240916	21047.36	68731	0.875122	12.55009	10.98286
183	YMIDD,AZ	1998	0.647	119	118	88.5	110	113	216226	179134	215234	21047.36	67017	0.8284572	12.49284	10.34978
184	YMIDD,AZ	1999	0.547	110	123	78.5	112	111	226001	179690	216226	21047.36	71263	0.795085	12.38973	9.850885
185	YMIDD,AZ	2000	0.439	101	110	74.5	115	115	233862	179139	226001	21047.36	69041	0.766003	12.81927	9.819602
186	YMIDD,AZ	2001	0.397	93	121	87.5	98	120	212968	150636	233862	21047.36	67406	0.7073175	12.28331	8.688199
187	YMIDD,AZ	2002	0.284	100	133	91.5	109	119	225532	159168	212968	21047.36	74327	0.7057446	13.14596	9.277687
188	YMIDD,AZ	2003	0.463	111	137	93.5	105	124	199059	120854	225532	21047.36	68152	0.6071265	11.56971	7.02428
189	YMIDD,AZ	2004	0.664	118	137	85.5	106	132	180680	122549	199059	21047.36	61192	0.6782655	10.58656	7.180499
190	YMIDD,AZ	2005	0.444	110	126	95	123	140	198276	136695	180680	21047.36	57158	0.6894178	9.420469	6.494639
191	YMIDD,AZ	2006	0.516	110	130	118	128	148	190449	107247	198276	21047.36	60254	0.5631272	10.78873	6.075426
192	YMIDD,AZ	2007	0.499	131	136	130	154	160	206469	107347	190449	21047.36	61629	0.5199183	12.43746	6.466465
193	YVID,AZ	1996	0.729	123	121	74.5	97	115	352220	231122	338864	86283	159920	0.6561865	4.775735	3.133773
194	YVID,AZ	1997	0.697	132	111	74.5	118	119	345285	222706	352220	86283	145236	0.6449918	4.526784	2.919739
195	YVID,AZ	1998	0.647	119	118	88.5	110	113	350874	221057	345285	86283	130354	0.6300182	4.676886	2.946523

row#	district	year	p1_cotton	p1_grains	p1_vegmel	p1_grasses	p1_fruitnut	proditems	div	cons	t1_div	max_totagac	AG_ET	cons_div	div_acre	cons_acre
196	YVID,AZ	1999	0.547	110	123	78.5	112	111	370920	237588	350874	86283	142826	0.640537	4.298877	2.75359
197	YVID,AZ	2000	0.439	101	110	74.5	115	115	317612	178526	370920	86283	125147	0.5620883	4.23178	2.378634
198	YVID,AZ	2001	0.397	93	121	87.5	98	120	371309	230675	317612	86283	120065	0.6212481	4.950325	3.07538
199	YVID,AZ	2002	0.284	100	133	91.5	109	119	372671	241227	371309	86283	133786	0.6472921	5.330801	3.450586
200	YVID,AZ	2003	0.463	111	137	93.5	105	124	353362	218022	372671	86283	130789	0.6169934	4.354952	2.686976
201	YVID,AZ	2004	0.664	118	137	85.5	106	132	347749	229612	353362	86283	130016	0.6602808	4.391287	2.899483
202	YVID,AZ	2005	0.444	110	126	95	123	140	344433	234890	347749	86283	125544	0.6819614	4.446735	3.032501
203	YVID,AZ	2006	0.516	110	130	118	128	148	354510	250537	344433	86283	136282	0.7067135	4.556905	3.220426
204	YVID,AZ	2007	0.499	131	136	130	154	160	347911	249159	354510	86283	142759	0.7161573	4.427196	3.170568

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
1	CRIR,AZ	1996	0	662402	1.077652	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
2	CRIR,AZ	1997	0	662402	0.9535871	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
3	CRIR,AZ	1998	0	662402	0.8936024	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
4	CRIR,AZ	1999	0	662402	0.9050531	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
5	CRIR,AZ	2000	0	662402	0.9484437	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
6	CRIR,AZ	2001	0	662402	0.8845384	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
7	CRIR,AZ	2002	0	662402	0.9275998	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
8	CRIR,AZ	2003	0	662402	0.9153022	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
9	CRIR,AZ	2004	0	662402	0.8839557	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
10	CRIR,AZ	2005	0	662402	0.8723857	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
11	CRIR,AZ	2006	0	662402	0.9280905	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
12	CRIR,AZ	2007	0	662402	0.9248644	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
13	CVIDD,AZ	1996	0	31120	0.9390424	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
14	CVIDD,AZ	1997	0	31120	0.9923843	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
15	CVIDD,AZ	1998	0	31120	0.9303342	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
16	CVIDD,AZ	1999	0	31120	0.8650386	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
17	CVIDD,AZ	2000	0	31120	0.9667416	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
18	CVIDD,AZ	2001	0	31120	0.84518	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
19	CVIDD,AZ	2002	0	31120	0.8698265	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
20	CVIDD,AZ	2003	0	31120	0.8698265	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
21	CVIDD,AZ	2004	0	31120	0.8698586	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
22	CVIDD,AZ	2005	0	15626	0.859081	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
23	CVIDD,AZ	2006	0	15626	0.8719442	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
24	CVIDD,AZ	2007	0	15566	0.874984	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
25	FMIR,AZ	1996	0	103535	0.6571217	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
26	FMIR,AZ	1997	0	103535	0.6757811	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
27	FMIR,AZ	1998	0	103535	0.5977495	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
28	FMIR,AZ	1999	0	103535	0.7751195	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
29	FMIR,AZ	2000	0	103535	0.6363356	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
30	FMIR,AZ	2001	0	103535	0.6128459	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
31	FMIR,AZ	2002	0	103535	0.5986574	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
32	FMIR,AZ	2003	0	103535	0.5549621	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
33	FMIR,AZ	2004	0	103535	0.6674941	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
34	FMIR,AZ	2005	0	103535	0.6989327	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
35	FMIR,AZ	2006	0	103535	0.6192109	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
36	FMIR,AZ	2007	0	103535	0.7122905	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
37	FMIR,CA	1996	0	16720	1.805562	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
38	FMIR,CA	1997	0	16720	1.629246	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
39	FMIR,CA	1998	0	16720	1.571531	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
40	FMIR,CA	1999	0	16720	1.2625	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
41	FMIR,CA	2000	0	16720	1.39372	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
42	FMIR,CA	2001	0	16720	1.107177	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
43	FMIR,CA	2002	0	16720	0.9864833	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
44	FMIR,CA	2003	0	16720	0.9857057	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
45	FMIR,CA	2004	0	16720	0.9580742	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
46	FMIR,CA	2005	0	16720	0.9752991	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
47	FMIR,CA	2006	0	16720	1.126017	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
48	FMIR,CA	2007	0	16720	1.275299	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
49	FYIRBU,CA	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
50	FYIRBU,CA	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
51	FYIRBU,CA	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
52	FYIRBU,CA	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
53	FYIRBU,CA	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
54	FYIRBU,CA	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
55	FYIRBU,CA	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
56	FYIRBU,CA	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
57	FYIRBU,CA	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
58	FYIRBU,CA	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
59	FYIRBU,CA	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
60	FYIRBU,CA	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
61	FYIRIU,CA	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
62	FYIRIU,CA	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
63	FYIRIU,CA	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
64	FYIRIU,CA	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
65	FYIRIU,CA	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
66	FYIRIU,CA	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
67	FYIRIU,CA	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
68	FYIRIU,CA	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
69	FYIRIU,CA	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
70	FYIRIU,CA	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
71	FYIRIU,CA	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
72	FYIRIU,CA	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
73	IID,CA	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
74	IID,CA	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
75	IID,CA	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
76	IID,CA	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
77	IID,CA	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
78	IID,CA	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
79	IID,CA	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
80	IID,CA	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
81	IID,CA	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
82	IID,CA	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
83	IID,CA	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
84	IID,CA	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
85	MVIDD,AZ	1996	0	41000	1.116902	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
86	MVIDD,AZ	1997	0	41000	1.039024	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
87	MVIDD,AZ	1998	0	41000	0.7723902	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
88	MVIDD,AZ	1999	0	41000	0.8531951	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
89	MVIDD,AZ	2000	0	41000	0.9129756	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
90	MVIDD,AZ	2001	0	41000	0.8992439	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
91	MVIDD,AZ	2002	0	41000	0.872439	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
92	MVIDD,AZ	2003	0	41000	0.8891707	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
93	MVIDD,AZ	2004	0	41000	0.8968537	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
94	MVIDD,AZ	2005	0	41000	0.788439	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
95	MVIDD,AZ	2006	0	41000	0.8824634	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
96	MVIDD,AZ	2007	0	41000	0.865122	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
97	NCIR,AZ	1996	0	10817	0.1264676	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
98	NCIR,AZ	1997	0	10817	0.1870204	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
99	NCIR,AZ	1998	0	10817	0.4194324	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
100	NCIR,AZ	1999	0	10817	0.4527133	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
101	NCIR,AZ	2000	0	10817	0.3962282	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
102	NCIR,AZ	2001	0	10817	0.5799205	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
103	NCIR,AZ	2002	0	10817	0.3321624	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
104	NCIR,AZ	2003	0	10817	0.3535176	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
105	NCIR,AZ	2004	0	10817	0.3569382	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
106	NCIR,AZ	2005	0	10817	0.3365998	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
107	NCIR,AZ	2006	0	10817	0.4869187	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
108	NCIR,AZ	2007	0	10817	0.3184802	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
109	NGVID,AZ	1996	0	49000	0.9912857	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
110	NGVID,AZ	1997	0	49000	1.017204	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
111	NGVID,AZ	1998	0	49000	0.9308367	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
112	NGVID,AZ	1999	0	49000	0.8974694	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
113	NGVID,AZ	2000	0	49000	0.9992857	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
114	NGVID,AZ	2001	0	49000	0.9418367	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
115	NGVID,AZ	2002	0	49000	0.9885918	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
116	NGVID,AZ	2003	0	49000	0.9222653	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
117	NGVID,AZ	2004	0	49000	0.8937347	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
118	NGVID,AZ	2005	0	49000	0.9148368	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
119	NGVID,AZ	2006	0	49000	0.9318572	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
120	NGVID,AZ	2007	0	49000	0.9699592	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
121	PVID,CA	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
122	PVID,CA	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
123	PVID,CA	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
124	PVID,CA	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
125	PVID,CA	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
126	PVID,CA	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
127	PVID,CA	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
128	PVID,CA	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
129	PVID,CA	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
130	PVID,CA	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
131	PVID,CA	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
132	PVID,CA	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
133	StGMR,AZ	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
134	StGMR,AZ	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
135	StGMR,AZ	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
136	StGMR,AZ	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
137	StGMR,AZ	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
138	StGMR,AZ	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
139	StGMR,AZ	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
140	StGMR,AZ	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
141	StGMR,AZ	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
142	StGMR,AZ	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
143	StGMR,AZ	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
144	StGMR,AZ	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
145	UBIDD,AZ	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
146	UBIDD,AZ	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
147	UBIDD,AZ	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
148	UBIDD,AZ	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
149	UBIDD,AZ	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
150	UBIDD,AZ	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
151	UBIDD,AZ	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
152	UBIDD,AZ	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
153	UBIDD,AZ	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
154	UBIDD,AZ	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
155	UBIDD,AZ	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
156	UBIDD,AZ	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
157	WMIDD,AZ	1996	278000	0	0.9871259	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
158	WMIDD,AZ	1997	278000	0	1.124151	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
159	WMIDD,AZ	1998	278000	0	1.044442	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
160	WMIDD,AZ	1999	278000	0	0.9594604	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
161	WMIDD,AZ	2000	278000	0	0.9918957	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
162	WMIDD,AZ	2001	278000	0	0.995259	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
163	WMIDD,AZ	2002	278000	0	1.027896	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
164	WMIDD,AZ	2003	278000	0	0.9810755	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
165	WMIDD,AZ	2004	278000	0	0.922928	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
166	WMIDD,AZ	2005	278000	0	0.8500828	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
167	WMIDD,AZ	2006	278000	0	0.988946	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
168	WMIDD,AZ	2007	278000	0	0.9812158	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
169	YID,AZ	1996	67278	0	0.7739974	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
170	YID,AZ	1997	67278	0	0.7561907	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
171	YID,AZ	1998	67278	0	0.7541247	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
172	YID,AZ	1999	67278	0	0.7519546	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
173	YID,AZ	2000	67278	0	0.783748	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
174	YID,AZ	2001	67278	0	0.730863	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
175	YID,AZ	2002	67278	0	0.7822914	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
176	YID,AZ	2003	67278	0	0.7189869	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
177	YID,AZ	2004	67278	0	0.6671572	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
178	YID,AZ	2005	67278	0	0.7041975	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
179	YID,AZ	2006	67278	0	0.7403014	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
180	YID,AZ	2007	67278	0	0.7315913	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	1
181	YMIDD,AZ	1996	141519	0	1.439997	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
182	YMIDD,AZ	1997	141519	0	1.330959	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
183	YMIDD,AZ	1998	141519	0	1.265795	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
184	YMIDD,AZ	1999	141519	0	1.269724	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
185	YMIDD,AZ	2000	141519	0	1.26583	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
186	YMIDD,AZ	2001	141519	0	1.064422	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
187	YMIDD,AZ	2002	141519	0	1.124711	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
188	YMIDD,AZ	2003	141519	0	0.8539772	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
189	YMIDD,AZ	2004	141519	0	0.8659544	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
190	YMIDD,AZ	2005	141519	0	0.9659127	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
191	YMIDD,AZ	2006	141519	0	0.7578276	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
192	YMIDD,AZ	2007	141519	0	0.7585342	5.268333	3.310833	2.244167	1.720833	3.835833	3.27	3
193	YVID,AZ	1996	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
194	YVID,AZ	1997	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
195	YVID,AZ	1998	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2

row#	district	year	cons_ceiling	div_ceiling	prop_ceiling	alfalfa_ET	cotton_ET	grains_ET	vegmel_ET	grasses_ET	fruitnut_ET	regime
196	YVID,AZ	1999	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
197	YVID,AZ	2000	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
198	YVID,AZ	2001	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
199	YVID,AZ	2002	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
200	YVID,AZ	2003	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
201	YVID,AZ	2004	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
202	YVID,AZ	2005	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
203	YVID,AZ	2006	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2
204	YVID,AZ	2007	0	0		5.268333	3.310833	2.244167	1.720833	3.835833	3.27	2