

The Economic Importance of Western Irrigated Agriculture Impacts, Water Values, and Strategic Policy Questions



Water Resources-White Paper

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Irrigation Association



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Pacific Northwest Project Water Resources-White Paper

DATE: August 27, 2013

TO: Mr. Dan Keppen, Executive Director
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FROM: Darryll Olsen, Ph.D.,
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SUBJECT: Water Resources-White Paper:
The Economic Importance of Western Irrigated Agriculture,
Impacts, Water Values, and Strategic Policy Question

The Pacific Northwest Project, working with the Family Farm Alliance (FFA), has prepared this White Paper, for discussion with state/federal policy makers and their staffs. It is specifically drafted to be *read by policy makers* seeking to better understand the economic impact of Western irrigated agriculture, and to address strategic policy questions about water resources economics raised by senior staff from the Office of Water, U. S. Environmental Protection Agency (EPA Washington D.C., Office, September 2012 Workshop).

First, the White Paper summarizes basic economic information current to irrigated agriculture and quantifies what many policy makers view as a critical indicator of economic significance—irrigated agriculture’s impact to annual household income in the Western U.S. The full magnitude of the *Irrigated Agriculture Industry’s* contribution to the economy is rarely, if ever, quantified in terms of total household income for the Western region.

Second, the White Paper responds to three questions posed by EPA staff:

1. Water’s contribution to the U.S. economy—what is its significance?
2. What are the capabilities and methods to analyze this contribution?
3. What water resources issue would you present to federal policy makers?

This White Paper is not intended to be the “definitive word” on the above subjects, but the economic impact section provides a carefully developed estimate for the Irrigated Agriculture Industry’s contribution to regional/U.S. income. And an economic perspective toward irrigation water supply and food security implications is clarified. The Paper conveys that greater recognition should be given to Western irrigated agriculture’s direct contribution to the U.S. economy, and that water policy actions are integral to the broader economy’s well-being.

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The Economic Importance of Western Irrigated Agriculture, Impacts, Water Values, and Strategic Policy Questions

1.0 Summary Points.

- In 2011, the total production (farm gate) value for the 17 states comprising the Western U.S. region is about \$171 billion; about **\$117 billion** tied to irrigated agriculture.
- The total estimated irrigated acres for the Western U.S. states are about 42 million (production agriculture of some form, including pasture and harvested crops).
- Within the larger economy, the **“Irrigated Agriculture Industry”** predominantly consists of three major sectors: agricultural production, agricultural services, and the food processing (sectors). These sectors are the “economic engine” of irrigated agriculture.
- For the Western U.S. region, the annual direct household income derived from the Irrigated Agriculture Industry is estimated to be about \$64 billion. Taking into account the total direct, indirect, and induced impacts, the total household income impacts are estimated to be about **\$156 billion annually**.
- There likely will be more emphasis on reviewing the direct net water value for irrigated agriculture projects. For water market values, the range is about \$1,500 to 3,000/acre-ft. (irrigation water purposes).
- The direct net benefits provided by irrigated agriculture represent the **opportunity costs** of economic tradeoffs made in water resources allocation decisions. Opportunity costs are the values (benefits) of what you give up to pursue some other alternative.
- There are other potential costs for decision makers to consider, when taking into account broader economic implications from Western irrigated agriculture. These could be termed externality benefits or, if foregone, the **“silent opportunity costs”** inherent to changes to Western irrigated agriculture indirectly tied to the **consumer spending economy**.
- **Food security impacts** should include an understanding of the direct and indirect linkages to the economy derived from a low-cost food supply, making available large blocks of disposable income to the consumer spending economy, as well as the availability of high-quality food sources provided by Western irrigated agriculture. Are these types of policy considerations even being integrated into current decision making for water resources projects?
- Among the stabilization factors for Western irrigated agriculture is the need to encourage water use efficiencies to promote the development of increased food supplies. This particular point is largely being ignored by state/federal policy makers—new water use efficiencies (of all types) should be encouraged, and water allocated, for new irrigated agricultural production.

2.0 The Economic Impact of Western Irrigated Agriculture.

While economists are fond of bringing forth various metrics to interpret economic value and social wellbeing, perhaps the most readily understood measure of economic impact or importance is *household income*. For many, including policy makers and families, annual income is an undisputed determinant of wealth and financial stability.

In Tables 1 and 2, estimates for agricultural production (farm gate) value, by state and irrigated acres, are provided; and these building block figures are further integrated into estimates of statewide household income derived from the “Irrigated Agriculture Industry.” The estimates here are 2011 values, an estimate that coincides well with what may be described as a new “plateau period” for agricultural production revenues, per the post 2010 period (see Figure 1).

2.1 To summarize the production values and income impacts:

- In 2011, the total production (farm gate) value for the 17 states composing the Western U.S. region is about \$171 billion.
- The total acres for all types of non-irrigated, and irrigated farmland, is about 618 million acres. Of this land amount, about 191 million acres are composed of farms with some land in irrigated agriculture (crop and pasture).
- The total estimated irrigated acres for the Western U.S. states are about 42 million (production agriculture of some form, including pasture and harvested crops).
- Within the larger economy, the “Irrigated Agriculture Industry” predominantly consists of three major sectors: agricultural production, agricultural services, and the food processing (sectors). These sectors are the “economic engine” of irrigated agriculture.
- For the Western U.S. region, the annual direct household income derived from the Irrigated Agriculture Industry is estimated to be about \$64 billion. Taking into account the total direct, indirect, and induced impacts, the total household income impacts are estimated to be about \$156 billion annually.

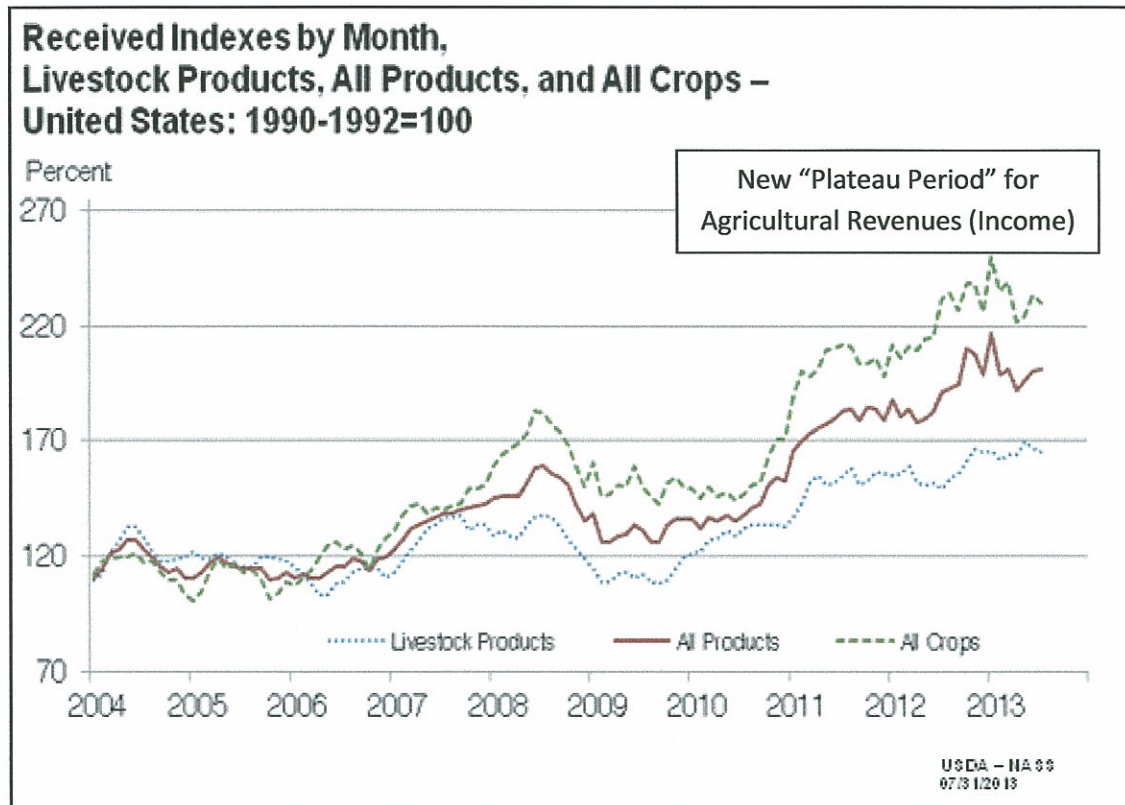
2.2 Analysis Methodology for Western Irrigated Agriculture Income Impacts.

There exist ample data and modeling experience to analyze the impacts of Western Irrigated Agriculture to the national (or state) economy. The basic approach used here is to focus on income impacts relying on: 1) Agricultural Census-NASS (and Economic Research Service); 2) U.S. BEA data sets for income by place of work and economic sector; and 3) state and IMPLAN model multipliers for the Irrigated Agriculture Industry (agricultural production, agricultural services, and food processing sectors).

While several descriptive, irrigation/agricultural economic statics are cited, the full magnitude of the Irrigated Agriculture Industry’s contribution to the economy is rarely, if ever, quantified in terms of *total household income for the Western region*. This estimate requires an allocation of

direct production to irrigated agriculture, and the use of input-output analyses to estimate the aggregated, industry sector secondary impacts.

Figure 1. U.S. Agriculture Revenues (Farm Prices Received)



Source: NASS, USDA, 2013, Under "Charts and Maps, Economics," web site.

In summary, the steps used to calculate income derived from the irrigated agriculture sector as described below:

- By state, total agricultural production values (2007-2011) are obtained from the Agricultural Census-NASS data, and Economic Research Service annual data series. These data sources also breakdown crop production value contributions by commodities and specialty crops, by state.
- The above data sources have data (2007-2008) for irrigated acres by state and the farms, with and without irrigated acreage. This includes farms with some reliance on irrigation within the farm (such as pasture ground for beef/livestock).
- Using the above data and other state-level sources (including personal communications with state agricultural offices and producers), estimates of production value by commodity and specialty crop, by state can be prepared, that are allocated to irrigated

lands (both direct and indirect production). This allocation includes harvested crops and vegetables, and beef and dairy production (dependent on irrigated feed production).

- The estimated production value percentages linked to irrigated agriculture, by commodity within in each state, must take into account dry-land versus irrigation production, and for beef/livestock, areas where no irrigation is used. There are no direct irrigation-production data from which to make precise estimates, so the best estimates are qualitative or judgment based, taking into account the available empirical data, and state growing and production conditions.

For example, almost all crops and beef/livestock production are dependent on irrigation in states like New Mexico or California, whereas non-irrigation production is substantial in states like Kansas or Nebraska (although the percentage of supplemental irrigation acreage is substantial in Nebraska). The estimated irrigation-production percentage allocation for each state is displayed in Table 1.

- An estimate (percent) of production value allocated to irrigated agriculture then can be applied to household income created by the agriculture production, agricultural services, and food processing sectors. This percentage allocation is applied to these combined sectors (combined income) to derive an estimated allocation of direct statewide household income.
- Economic sector linkages among the agricultural production, agricultural services, and food processing sectors are relatively direct (and uniform); as such, the application of the production value estimates to direct household income among the sectors is considered a reasonable estimate (assumption), as well. In particular, higher levels of income derived from irrigated agriculture (versus non-irrigated agriculture) are expected, and the impacts to agricultural services and food processing are usually higher.
- Using input-output model (IMPLAN) multipliers for selected states, income and value added multipliers are calculated for the combined economic sectors of the Irrigated Agriculture Industry. The multipliers are then applied to the direct income estimates. Extensive review of the multipliers used here have been made over several years, and the approach for the aggregated sectors has been discussed directly with the INPLAN modelers and others conversant with I/O applications. Table 2 provides more detail about the multipliers.

3.0 Economic Impacts vs. Efficiency, Direct Net Benefits and Costs.

Economists deal with economic impacts for different reasons than relying on direct net benefit estimates (or costs) when evaluating specific water resources actions. Impact values are generally expressed as localized income/employment changes or relatively isolated among a few economic sectors (Regional Economic Development account approach). Direct net benefits represent a true change to overall net economic production (or efficiency); and are real, quantitative changes to social well-being.

The reason for the emphasis on direct net values in economic analyses is to better capture marginal changes to real economic production, as they affect the national economy (the National Economic Development account), or even a state level economy. Water project or program expenditures made at the national or state level are usually done so to increase the net social welfare benefits for those entire jurisdictions—not just local entities or counties.

3.1 Calculating Direct Net Water Values for Irrigated Agriculture.

As U.S. and international demand increases for irrigated agriculture products, there likely will be more emphasis on reviewing the direct net water value for irrigated agriculture projects, and assessing the economic trade-offs underlying policy decisions.

Such emphasis means that greater scrutiny will be placed on using direct net water values for irrigated agriculture, for estimating benefits and costs under B/C and cost-effectiveness analysis. The current direct net benefit estimates are derived from multiple sources:

- Agricultural production/enterprise budgets—never initially designed for estimating direct net value or being applied within B/C analyses for water projects. These are usually expressed as annual values but can be converted to capitalized values:
 - ✓ About \$300-800/acre; water application rates have to be considered.
- Capitalized land values—where the value of dry land is excluded from market real estate transactions, land with and without irrigation:
 - ✓ In the Odessa Subarea region within Washington State, the values are the \$1,300-1,500/acre-ft. range.
- Water market values—such as Western U.S. and Columbia River water market transactions:
 - ✓ The range is about \$1,500 to 3,000/acre-ft. for irrigation values.

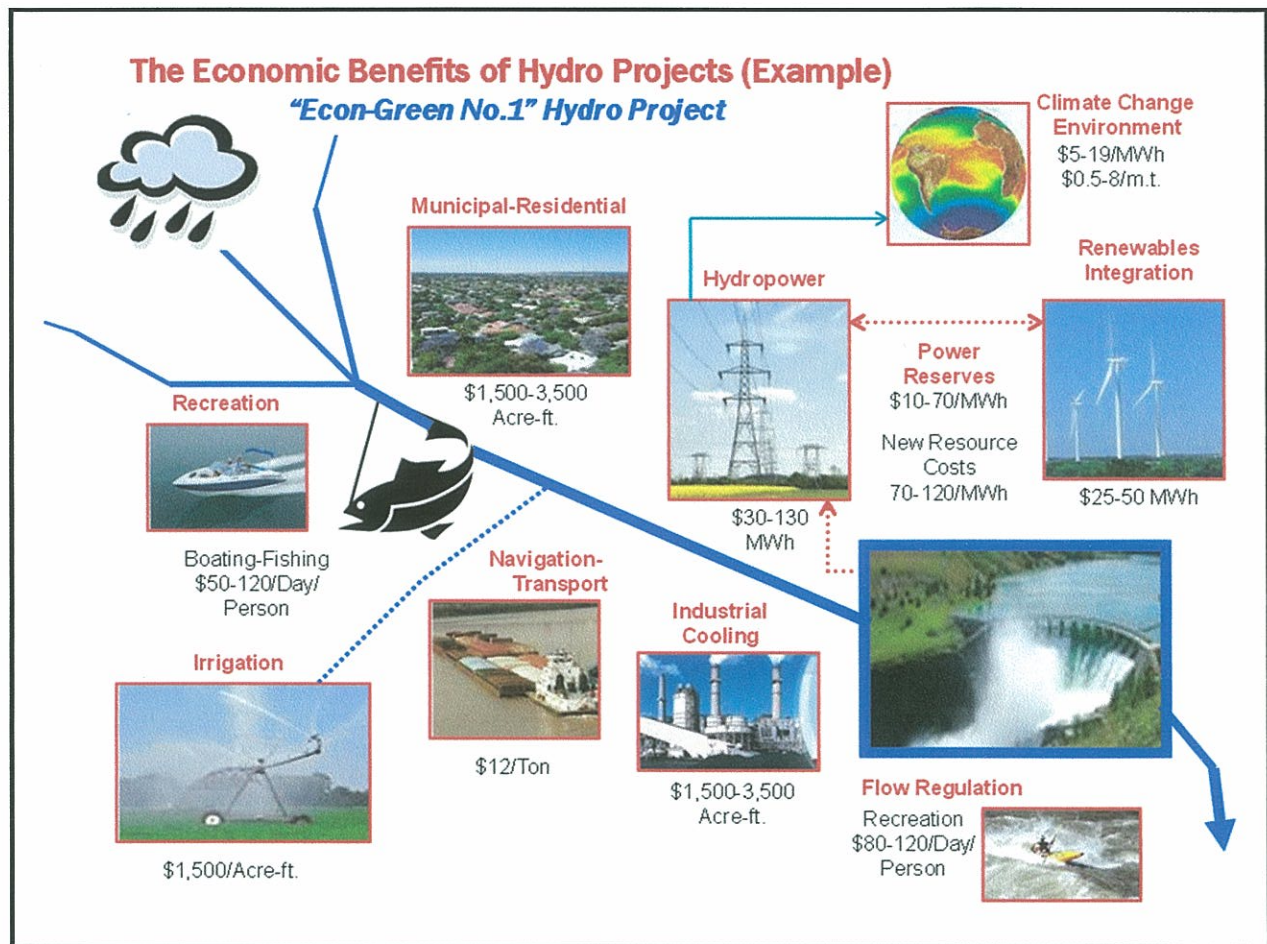
3.2 Direct Net Value and Opportunity Costs for Multiple Water Resources Sectors.

Direct net value estimates for several water resources sectors have been (are) calculated for various planning and water project development decisions. This is done for both federal and state decision making forums. A concise review of these water values is illustrated in Figure 2 below, the economic values associated with a “generic,” Western U.S. hydro project. Water values are quantified for several purposes, including irrigation, municipal-industrial supply, recreation, power generation, navigation, and other demands.

The direct net benefits provided by water resources projects also represent the *opportunity costs* of selecting one type of water development over another—the economic tradeoffs that are made in water resources allocation decisions. Opportunity costs are equivalent to foregone benefits, and are usually measured by economists in direct net value terms.

For example, if we reallocate water away from irrigated agriculture or away from hydropower production, to some type of other environmental resources (fish, wildlife, other), then the opportunity cost is the value of the irrigated agriculture or power benefits. Opportunity costs are the values (benefits) of what you give up to pursue some other alternative.

Figure 2. Measures of Direct Net Economic Value for Water



Source: GEI Consultants and Pacific Northwest Project, 2010.

There also are environmental benefits (wetlands, wildlife habitat) often associated with many irrigation projects that must be considered as potential opportunity costs, in water reallocation.

Oddly enough, although “opportunity costs” are well understood in economic theory, this fundamental economic principle is commonly violated every day at all levels of resource decision making—at the household, local government, state, and national, and international levels.

4.0 The “Silent Opportunity Costs” of Water Resources Management.

Opportunity Costs-Further Consideration:

In resource economics, all economic thought is but a footnote to the basic tenant of opportunity cost. The real value of an action is not the action per se, but the value of the thing or action you give-up. These opportunity costs can be direct or indirect in nature.

Indirectly, there are other economic linkages related to “opportunity cost” for policy makers to consider, when taking into account the broader economic implications of Western irrigated agriculture. This can be termed the “*silent opportunity costs*” inherent to changes to Western irrigated agriculture that are reflected as changes to other sectors the economy—and perhaps not readily perceived as related. If foregone through policy decisions, these benefits become opportunity costs that exist within tertiary links within the economy.

While this type of impact may fall within the technical nomenclature as either a “tertiary economic benefit,” or as an “externality benefit,” of water management actions, the terminology preferred here is “silent opportunity cost.” This better expresses to policy makers that there are economic tradeoffs associated with water management actions that may not be “making noise,” but are in fact a form of opportunity cost—when “lost” to certain policy measures.

Opportunity Costs and Food Security Issues:

Some food security impacts are within the realm of silent opportunity costs, and they may need to be better appreciated in direct national economic terms, where impact is defined as:

- Food Security Impacts—associated with the direct and indirect linkages to the economy derived from a low-cost food supply, making available large blocks of disposable income to the consumer spending economy; and the availability of high-quality food sources provided by Western irrigated agriculture.

Begin to reflect on this observation, or supposition, relative to the discussion below.

Over the past decade, several economic development agencies and non-governmental organizations (NGOs) have raised concerns about water and food supply, mostly targeted toward third-world nations or developing nations. Today, the World Bank, the Earth Policy Institute, and the World Economic Forum are alarmist in their projections of near-term food scarcity brought about by a lack of irrigation production in the third world, and other places. The World Economic Forum ranks adequate water supply for food production among the top global risks—a risk viewed as likely to occur and with resulting global impacts.

Interestingly, the more direct economic implications of food security also are beginning to draw greater attention by some international consultancies (as well as others). Among recent examples are policy reviews offered by researchers with the Washington Advisors, the World Watch Institute (WWI), and the Boston Consulting Group (BCG). What makes these reviews

curiously relevant to the discussion here is that they include questions about water availability to Western irrigated agriculture, and potential U.S. and world economic impacts.

As observed by a former consultant with Washington Advisors, one water issue is very pointedly directed toward irrigation water policy in California. The conflict is tightly framed as the use of water to subsidize U.S. food costs versus water for general urban growth—and problems with water use inefficiencies that can carry with them environmental impacts. It is implied that higher food costs are inevitable, relative to changes in California water policy and irrigated agriculture production.

For the World Watch Institute (WWI), the competition for Western U.S. water supplies will increase, and that will place pressure on meeting both U.S. and international food demands. Their concern can be broadly characterized as a future where global water scarcity for food production will lead to higher food prices, everywhere; and food shortages in third world nations. The WWI strongly calls for greater efficiencies in irrigation production, but does not suggest we need less irrigated lands. Irrigation water use efficiencies will be needed to “feed the world” and avoid escalating food costs.

The Boston Consulting Group review celebrates the newfound wealth of Asia and other world regions, but cautions that new food demands (and food quality demands) can lead to highly inflated food prices in the U.S., a situation exacerbated by limited water supplies. Here again, there is considerable focus on water supply constraints, and the BCG’s conclusion for the U.S. is that “scarce water means costlier food.” Their policy emphasis touches upon an adequate U.S. water supply for irrigated agriculture.

So, what will the future bring? Currently, there is a marked trend in both increasing food imports to and exports from the U.S.—the food trade business is growing. The exports include food and food products supplied by Western irrigated agriculture. Expect more demand for U.S. agricultural products well beyond beans and grains.

And to date, the USDA has not documented dramatic increases to U.S. food costs affected by the Midwest-Southwest 2012 drought conditions—although food costs are expected to increase by about 2-2.5% annually in 2013 and the following years. The agency further suggests that even under a high food cost scenario, retail food prices would not likely exceed 15%. But the introduction of worldwide, accelerated food demand and the prevalence of creeping reductions to irrigation water supply (as well as drought impacts) may change the picture.

To what extent international food demand and domestic water supply factors will influence U.S. food costs is unknown. But these factors are definitely gaining more attention, and policy makers are being asked to take pause and recognize that the U.S. economy could be weakened, in part, if Western irrigated agriculture is impaired.

4.1 The Economics of Food Security, Contributions to Disposable Income.

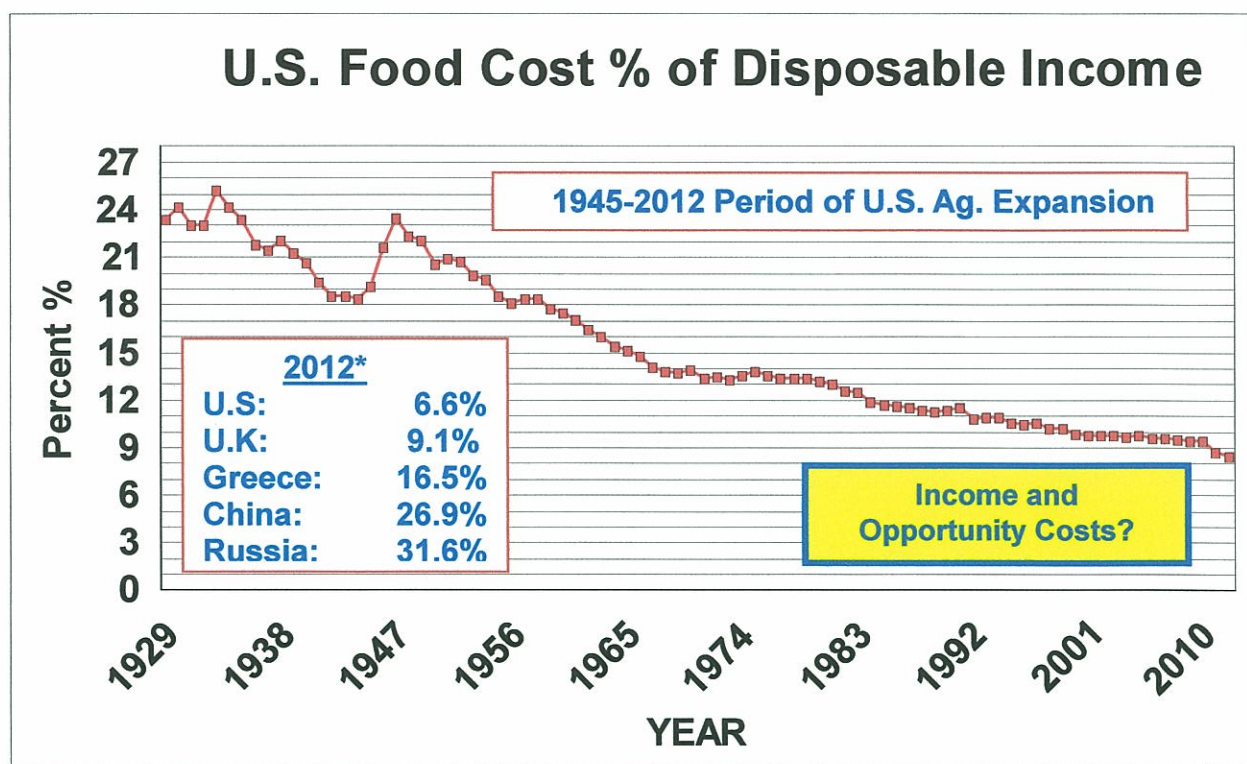
So how would the food security issue be most directly linked to general U.S. economic health? Declining costs of U.S. household food purchases affecting discretionary income, over time,

have contributed dramatically to the national economy. A dominant portion of the U.S. consumer spending economy—estimated at about two-thirds of the overall economy--is driven by an availability of cheap food, allowing more household income to be devoted to consumer goods and services.

No data set more clearly displays the impact of a low-cost food supply to the consumer spending economy than the food cost relationship to U.S. disposable income offered in Figure 3. Since World War II, the percentage contribution of (disposable) household income to food costs has dropped from about 25% to 7%. No longer spending larger portions of income on food, households have been able to direct more spending on houses, automobiles, and an ever-growing array of consumer goods.

As reported by the Economic Research Service, USDA, the food costs for U.S. residents are the lowest in the world—less than one-third that of Eastern Europe or Asia, and considerable less than that in Western Europe and other developed nations.

Figure 3. U.S. Food Costs and Disposable Income, 1928-2012.



Source: ERS, USDA, Food Expenditures Data Series. Chart Displays Percent of Income Spent on Food, Alcoholic Beverages, Consumed at Home, 2013.

*Food Expenditures Only for 2012 by Country.

4.2 Food Security Impacts.

If policy makers accept the interface between food security and the dispersion of economic impacts through the broader economy, then they should reconsider the strategic implications underlying water resources policy measures. A long list could be prepared for water resources policy actions, well beyond the scope of this Paper, but for primary consideration, a renewed emphasis could be directed toward the following items:

- Food security impacts should include a focus on the economic logistics of the current food production/processing/distribution sector linkages—a functional schematic of the logistics path among economic sectors and how such sectors can be affected.
- This economics schematic also should illustrate an elaborate regulatory structure for production, processing, and distribution that ensures high-quality food products. This is unique to areas with highly developed irrigated agriculture and large middle class populations (such as North America). How does this regulatory structure enhance or detract from an ability to increase irrigation production?
- Food security should equally address food quality availability and the increasing demand for high-quality irrigated agriculture products. This means extending quality food supplies to more segments of the population, as well as export markets. How does the market economy cope with this question or what types of food substitutes/trade are at play?
- To what extent should U.S. water resources policy meaningfully consider national food security issues, world food supply and international trade, and U.S. technological development? Are there even any of these types of policy considerations being integrated into current decision making for water resources projects?
- Among the stabilization factors for Western irrigated agriculture is the need to encourage water use efficiencies to promote the development of increased food supplies. This particular point is largely being ignored by state/federal policy makers—new water use efficiencies (of all types) should be encouraged, and water allocated, for new irrigated agricultural production.

5.0 Steps to Improve Water Resources (Economic) Significance to Decision Making for Western Irrigated Agriculture.

There are a set of “first principles” that should be advanced in economic evaluations for all water resources projects, and specifically for irrigated agriculture. These principles take account the discussion above on regional and direct economic impacts and the tertiary nature of economic benefits (opportunity costs) to the broader U.S. economy,

- Take into account regional/state economic impacts and equity impacts. Fully quantify the magnitude of the Irrigated Agriculture Industry.

- Prepare objective analyses, recognizing opportunity costs and quantifying them. Always prepare benefit-cost analysis or analyses that reveal all foregone benefits. Consider tertiary impacts embedded throughout multiple economic sectors.
- Integrate more fully economic benefits and costs for all water distribution and application efficiencies, and the use of the water delivery efficiencies for the expansion of agricultural production, in economic analyses. Quantify how efficiencies compare to other water supply alternatives for irrigated agriculture.
- As noted above, production efficiencies and expansion should be a part of the food security equation. Bring the question of U.S. food security into the economic analysis of irrigation projects—make sure the issue is recognized by decision makers.
- For the U.S., food security can be, and should be, better understood in terms of implications to the consumer spending economy. Recognize that there are “silent opportunity costs,” or foregone benefit impacts surrounding decisions affecting Western irrigated agriculture and the U.S. economy. This specific economic variable now requires more careful thought and incorporation in water resources decision making.

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Table 1. Western U.S. Irrigated Agriculture Production Review, Estimated Value of Production Linked to Irrigated Agriculture (2011\$)

State	Total Farmgate \$ 2011 (State)	Est. Irrigated Acres (2008)	Total Farm Acres Including Irr. Land	% of Farms with Some Irr. Land	% of Irr. Land for Farms with Irr. Land	Harvested Crop Land	Total All Land in Farms	Primary Farmgate Production Value Group Ranking within State		
								First	Second	Third
Arizona	\$4,372,000,000	876,158	2,692,407	33%	33%	832,406	26,117,899	Dairy	Veg., Beef	Cotton, Gr. H., Nurs.
California	\$43,544,000,000	8,016,159	16,231,930	66%	49%	7,633,173	25,364,695	Dairy	Fruits, Nuts, Veg./Mel.	Beef, Nursery, Hay
Colorado	\$7,076,000,000	2,867,957	14,237,479	43%	20%	5,888,926	31,604,911	Cattle-Beef	Corn, Dairy	Wheat, Hay
Idaho	\$7,328,000,000	3,299,889	7,365,264	64%	45%	4,225,786	11,497,383	Milk and Dairy	Cattle-Beef-Veg./Pot.	Grains, Hay
Kansas	\$15,856,000,000	2,762,748	12,750,857	9%	22%	19,886,655	46,345,827	Cattle-Beef	Corn, Grains, Beans	Hay
Montana	\$3,542,000,000	2,013,167	23,982,172	35%	8%	9,163,867	61,388,462	Wheat	Cattle-Beef	Hay
Nebraska	\$21,815,000,000	8,558,559	26,065,265	36%	33%	18,169,876	45,480,358	Cattle-Beef, Corn	Grains, Beans	Wheat
Nevada	\$680,000,000	691,030	4,671,396	66%	15%	504,311	5,865,392	Cattle-Beef	Hay	Milk and Dairy, Veg.
New Mexico	\$4,106,000,000	830,048	13,362,070	49%	6%	1,009,683	43,238,049	Cattle-Beef	Dairy	Hay, Fruits, Cotton
North Dakota	\$7,337,000,000	236,138	2,149,466	3%	11%	22,035,717	39,674,586	Wheat Grains, Corn	Cattle-Beef	Hay and Other
Oklahoma	\$7,056,000,000	534,768	3,228,907	4%	17%	7,650,080	35,087,269	Cattle-Beef-Hogs-Pol.	Grains, Beans	Dairy
Oregon	\$4,624,000,000	1,845,194	10,025,047	44%	18%	3,037,261	16,399,647	Nursery, Gr. H.	Cattle-Beef-Dairy	Veg., Fruit, Hay
South Dakota	\$9,410,000,000	373,842	3,443,596	5%	11%	15,278,709	43,666,403	Corn	Cattle-Beef	Wheat, Beans
Texas	\$22,681,000,000	5,010,416	23,281,801	8%	22%	19,174,301	130,398,753	Cattle-Beef	Cotton, Dairy, Pol.	Gr. H./Nursery
Utah	\$1,607,000,000	1,134,144	5,456,056	75%	21%	964,702	11,094,700	Milk and Dairy	Cattle-Beef	Hogs, Hay, Gr. H.
Washington	\$8,666,000,000	1,735,917	6,656,406	40%	26%	4,894,634	14,972,789	Fruits, Wheat	Grains, Beans, Veg.	Dairy/Beef
Wyoming	\$1,450,000,000	1,550,723	15,845,482	52%	10%	1,536,240	30,169,526	Cattle-Beef	Hay	Other
Total:	\$171,150,000,000	42,336,857	191,445,601	-----	-----	141,886,327	618,366,649			

State	Total Farmgate \$ 2011 (State)	Est. Irrigated Acres (2008)	Primary Farmgate Product Value % of Total Value*	Estimated Percent Value Linked to Irrigated Ag.**	Est. Farmgate Value Linked to Irrigated Ag.
Arizona	\$4,372,000,000	876,158	73%	93%	\$4,065,960,000
California	\$43,544,000,000	8,016,159	80%	92%	\$40,060,480,000
Colorado	\$7,076,000,000	2,867,957	87%	73%	\$5,165,480,000
Idaho	\$7,328,000,000	3,299,889	95%	85%	\$6,228,800,000
Kansas	\$15,856,000,000	2,762,748	91%	35%	\$5,549,600,000
Montana	\$3,542,000,000	2,013,167	60%	52%	\$1,841,840,000
Nebraska	\$21,815,000,000	8,558,559	90%	54%	\$11,780,100,000
Nevada	\$680,000,000	691,030	92%	95%	\$646,000,000
New Mexico	\$4,106,000,000	830,048	89%	95%	\$3,900,700,000
North Dakota	\$7,337,000,000	236,138	79%	28%	\$2,054,360,000
Oklahoma	\$7,056,000,000	534,768	87%	52%	\$3,669,120,000
Oregon	\$4,624,000,000	1,845,194	85%	65%	\$3,005,600,000
South Dakota	\$9,410,000,000	373,842	88%	30%	\$2,823,000,000
Texas	\$22,681,000,000	5,010,416	81%	75%	\$17,010,750,000
Utah	\$1,607,000,000	1,134,144	77%	76%	\$1,221,320,000
Washington	\$8,666,000,000	1,735,917	89%	80%	\$6,932,800,000
Wyoming	\$1,450,000,000	1,550,723	85%	55%	\$797,500,000
Total:	\$171,150,000,000	42,336,857	-----	68%	\$116,753,410,000

Observation: 68% of all Agricultural Production Value in the Western U.S. States Is Linked to Irrigated Agriculture.

Note: Irrigated acres principally based on 2007 Census of Agriculture and production values from NASS Data by state. Total production values for 2011 are from NASS/USDA, Economic Research Service web sites, Annual Statistical Bulletin, by state. The 2011 production values are slightly higher based on selected state records; 2007 Census data is used where data are limited. The 2008 irrigated acres data provided by the 2008 Farm and Ranch Irrigation Survey differ slightly from the 2007 Agricultural Census report.

* The farm receipts percentages for the primary crops, by state, may be reviewed at <http://www.ers.usda.gov/data-products/state-fact-sheets>. Where data are limited, the 2007 Census Report contains similar data for ranking of market value by commodity, by state.

** Estimate by Pacific Northwest Project. Estimated production value linked to irrigated agriculture reviewed on a product-by-product basis for each state, taking into account irrigated land percentages and commodity and specialty crop type. Cattle and dairy production are (proportionally) included as part of irrigated agriculture production, taking into account irrigated land crops/pasture serving the cattle and dairy industry. Estimates also include discussion with some agricultural agency staff and direct agricultural industry producers.

Table 2. Western U.S. Household Income by Irrigated Agricultural Sector (2011\$)

State	Estimated Annual Income, Estimate by Sector:			Total Income for All Agricultural Sectors	Est. % Linked to Irrigated Ag.	Est. Total Income For Irrigated Ag.	Statewide VA Multiplier**	Irrigated Ag. Est. Total Income
	Farm Production	Ag. Services	Food Processing					
Arizona	\$1,084,076,000	\$410,000,000	\$442,356,000	\$1,936,432,000	93%	\$1,800,881,760	2.5	\$4,502,000,000
California*	\$15,705,158,000	\$5,907,500,000	\$12,252,722,000	\$33,865,380,000	92%	\$31,156,149,600	2.5	\$77,890,000,000
Colorado	\$1,259,000,000	\$175,000,000	\$1,012,673,000	\$2,446,673,000	73%	\$1,786,071,290	2.2	\$3,929,000,000
Idaho	\$2,150,132,000	\$222,600,000	\$815,030,000	\$3,187,762,000	85%	\$2,709,597,700	2.5	\$6,773,000,000
Kansas	\$3,683,811,000	\$398,397,000	\$1,660,042,000	\$5,742,250,000	35%	\$2,009,787,500	2.2	\$4,421,000,000
Montana	\$621,387,000	\$75,000,000	\$109,496,000	\$805,883,000	52%	\$419,059,160	2.1	\$880,000,000
Nebraska	\$5,943,350,000	\$223,200,000	\$1,770,945,000	\$7,937,495,000	54%	\$4,286,247,300	2.5	\$10,716,000,000
Nevada	\$194,639,000	\$23,413,000	\$213,402,000	\$431,454,000	95%	\$409,881,300	2.1	\$861,000,000
New Mexico	\$1,242,029,000	\$93,794,000	\$239,749,000	\$1,575,572,000	95%	\$1,496,793,400	2.2	\$3,293,000,000
North Dakota	\$3,163,675,000	\$126,000,000	\$266,191,000	\$3,555,866,000	28%	\$995,642,480	2.1	\$2,090,000,000
Oklahoma	\$881,480,000	\$201,600,000	\$865,989,000	\$1,949,069,000	52%	\$1,013,515,880	2.2	\$2,229,000,000
Oregon	\$1,391,999,000	\$244,000,000	\$1,129,854,000	\$2,765,853,000	65%	\$1,797,804,450	2.2	\$3,955,000,000
South Dakota	\$4,829,327,000	\$132,000,000	\$383,693,000	\$5,345,020,000	30%	\$1,603,506,000	2.1	\$3,367,000,000
Texas	\$3,935,339,000	\$789,566,000	\$4,417,293,000	\$9,142,198,000	75%	\$6,856,648,500	2.5	\$17,142,000,000
Utah	\$266,260,000	\$42,300,000	\$771,545,000	\$1,080,105,000	76%	\$820,879,800	2.1	\$1,724,000,000
Washington*	\$3,162,499,000	\$517,528,000	\$2,172,565,000	\$5,852,592,000	80%	\$4,682,073,600	2.5	\$11,705,000,000
Wyoming	\$248,708,000	\$36,000,000	\$27,327,000	\$312,035,000	55%	\$171,619,250	2.0	\$343,000,000
Total:	\$49,762,869,000	\$9,617,898,000	\$28,550,872,000	\$87,931,639,000	68%	\$64,016,158,970		\$155,820,000,000

Note: sources are included in Table 1 and text; and U.S. Bureau of Economic Analysis, Personal Income by Major Source and Earnings by NAICS Industry, <http://bea.gov>. Irrigated Agriculture Industry multipliers are based on multi-year IMPLAN model analyses and review of multi-year state and IMPLAN multipliers for 1987, 1997, 2000, 2004, 2006, 2009, and 2010 (for multiple states). The above multipliers are based on IMPLAN modeling for the aggregated agricultural production, agricultural services, and food processing sectors (the agricultural industry), and for individual sector multipliers. The multipliers are, in effect, "weighted" taking into account the differences in total income produced by each sector. For example, the separate sector multipliers for agricultural production and agricultural services are lower (1.5-2.0) than the multipliers for the food processing sectors (about 2.5-4.0). The most recent multipliers have been for Washington (2010) and Utah (2007). The magnitude of the above multipliers is adjusted to take into consideration the size/type of the state production levels, with higher levels of production/diversification and product processing requiring more demand from other sectors (thus higher multipliers).

* Includes 80% of the income value from the beverage manufacturing sector (BEA aggregated sector data) to account for large volume direct winery/brewing production within the state.

** The review has considered both income and value added (VA) multiplier use, recognizing a structural difference between the two as developed by IMPLAN. Nevertheless, the VA multiplier is applied here, in an attempt to reflect the full income impacts associated with labor income, all forms of proprietary income, land income, and taxes that contribute to additional statewide income. In the case of Washington State, the 2009 income and VA multipliers range from about 2.5 to 3.0, for the Irrigated Agriculture Sector (combined agricultural production, agricultural services, and food processing sectors).