The Economic Importance of Western Irrigated Agriculture
Family Farm Alliance Review, 2015

Water Resources-White Paper

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March 2015

Pacific Northwest Project
Water Resources-White Paper

DATE: March 20, 2015

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SUBJECT: The Economic Importance of Western Irrigated Agriculture,
Family Farm Alliance Review, 2015

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. This is the third edition and update for the White Paper. The information it conveys is becoming more crucial to the future of Western water management actions, with pervasive implications for the national economy.

It is specifically drafted to be *read by policy makers* seeking to better understand the direct economic impact of Western irrigated agriculture, and to acknowledge the growing chorus of voices bringing attention to food security and irrigated agriculture as an economic issue.

First, the White Paper summarizes basic economic information to irrigated agriculture and quantifies what many policy makers view as a critical indicator of economic performance—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 national/world food security issue is no longer confined to just basic scarcity problems, but is gaining much greater awareness toward emerging irrigated agriculture impacts to both advanced and developing nations. Here, we clarify further the broader link between food security and national economic prosperity.

Given the magnitude of the food security issue to economic wellbeing, the Irrigated Agriculture Indutry must make 21st Century water management a reality, and state and national policy makers must place irrigated agriculture on the high priority list.

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1.0 Summary Points.

- In 2012-13, the total production value (farm gate prices received) for the 17 states comprising the Western U.S. region was about $184 billion; with about ***$125-130 billion*** tied to irrigated agriculture.

- The total estimated irrigated acres for the Western U.S. states are about 40.4 million (production agriculture, including pasture/livestock feed and harvested crops).

- 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 in 2013, the annual direct household income derived from the Irrigated Agriculture Industry is estimated to be about $70 billion. Taking into account the total direct, indirect, and induced impacts, the total household income impacts are estimated to be about ***$172 billion annually.***

- The direct net benefits provided by irrigated agriculture represent the ***opportunity costs*** of economic tradeoffs made in water resource allocation decisions. Opportunity costs are the values (benefits) of what you give up to pursue some other alternative.

- But 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. These types of policy considerations should be at the forefront of future decision making for water resources.

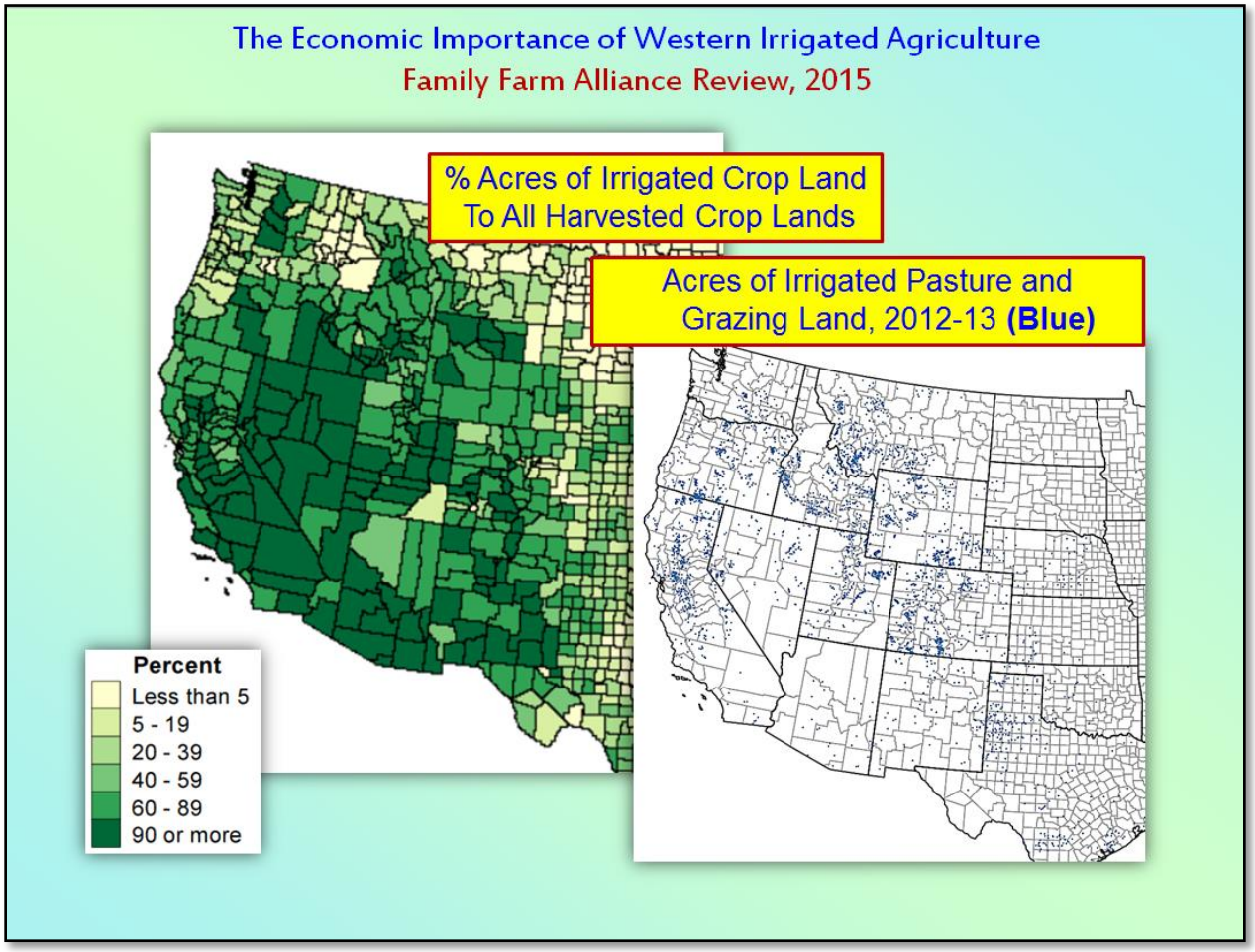
- Among the stabilizing factors for Western irrigated agriculture is the need to encourage water use efficiencies to promote further development of increased food supplies. This point is being misunderstood by many state/federal policy makers. New water use efficiencies, including conveyance and direct application technologies, should be applied expediently; and along with these technologies, water spreading should be aggressively pursued ***to allocate water for new irrigated agricultural production.***

- Given the magnitude of the food security issue to economic wellbeing, the Irrigated Agriculture Indutry must continue to make 21st Century water management a reality, and ***policy makers must place irrigated agriculture on the high priority list.***

2.0 The Distribution of Western Irrigated Agriculture.

One of the lesser appreciated qualities of Western U.S. irrigated agriculture is its vast dispersion and distribution across the region. Significant production agricultural activity can be found in almost all of the Western States. This is illustrated by Figures 1-3.

Figure 1. Agricultural Production in the Western U.S. By Area

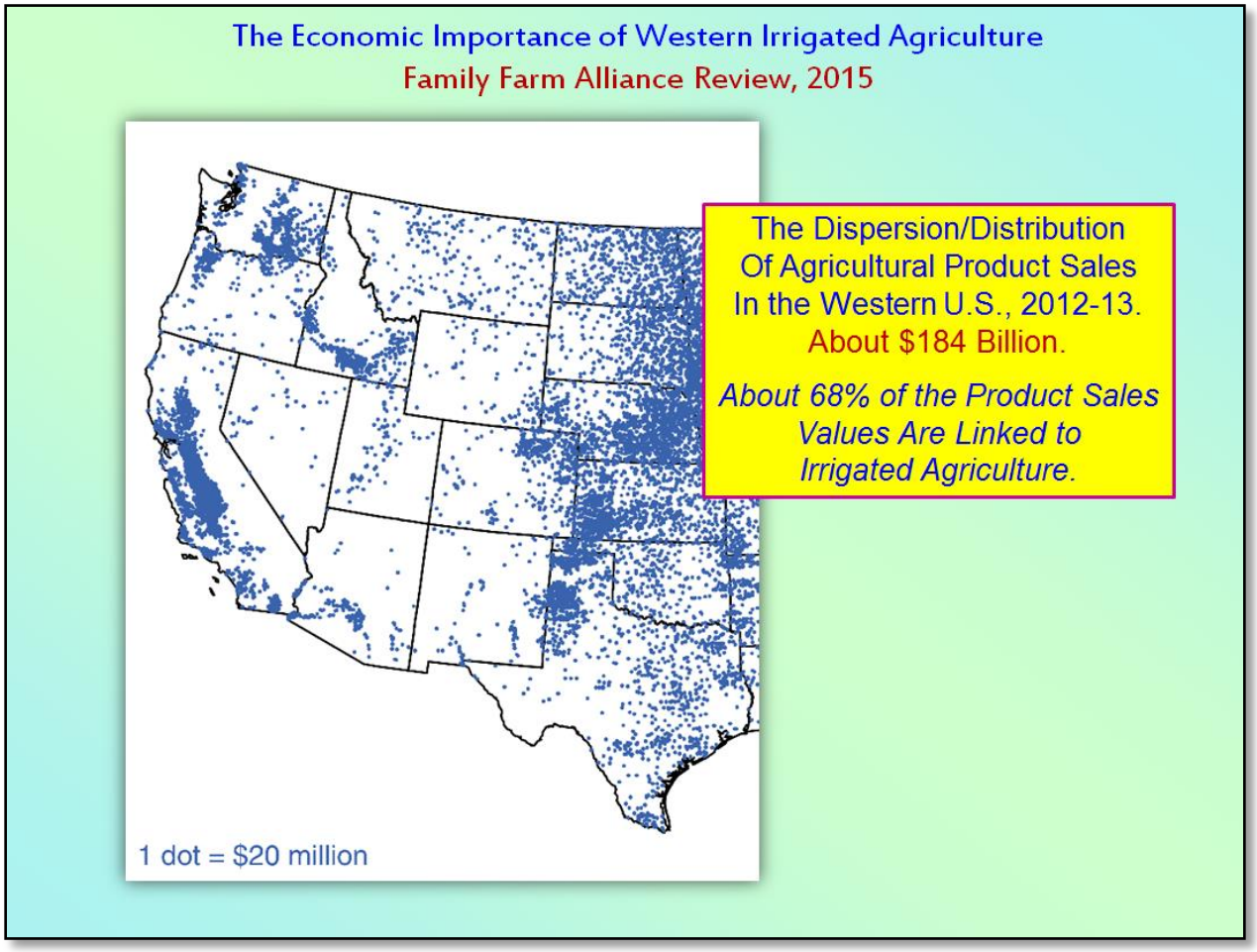


Source: ERS, USDA, Charts and Graphs/Data Sets, 2012; 2013 Estimate, Pacific NW Project. Total Irrigated Acres Provided by State in Appendix Table 1.

While states such as California, Idaho, Oregon, Washington, and Texas rely heavily on irrigation for most agricultural production, other states reliance for irrigation to service agricultural production is often absolute—such as in states like Arizonia, New Mexico, or Utah. Other states depend on supplemental irrigation to ensure that high-yield/quality crop production can be maintained. And as presented in Figure 1, most states' livestock feed and pasture requires either primary or supplemental irrigation.

Figure 2 offers a visual display of how the value of production agricultural is "spread" across the West. In total, the Western states create about $184 billion of farm-gate production value. Figure 3 provides a production value breakdown by state, separating harvested crops from livestock production.[1] Significantly, it is estimated here that about 68% of this production value relies on West-wide irrigation activity.

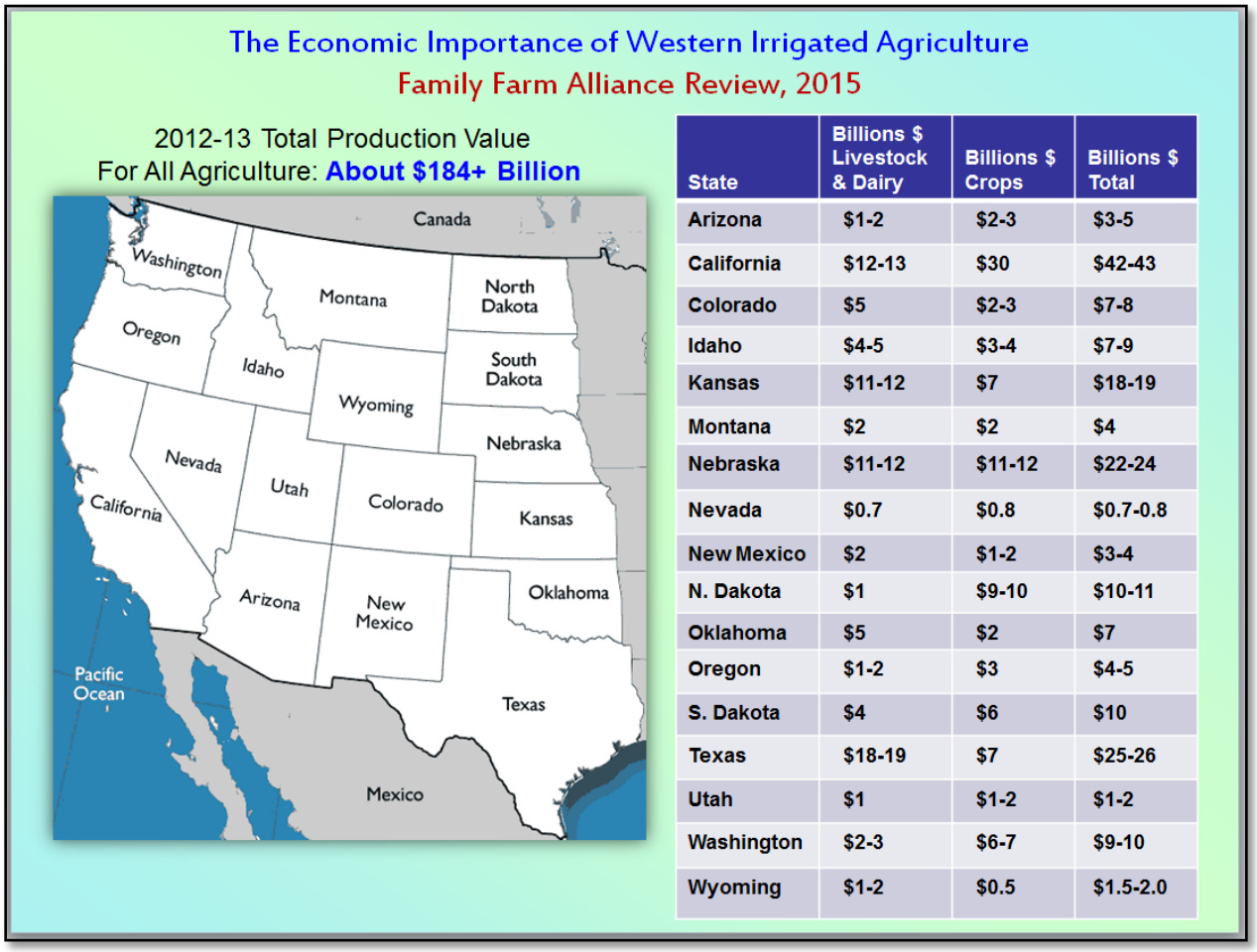
Figure 2. Agricultural Production Value in the Western U.S. By Area



Source: ERS, USDA, Charts and Graphs/Data Sets, 2012; 2013 Estimate, Pacific NW Project. Income Impact Estimates from Pacific NW Project.

[1] The relative changes to livestock and crop farm-gate production prices (value) between 2006-2015 are illustrated by Appendix Figure 1.

Figure 3. Agricultural Production Value in the Western U.S. By State



State	Billions $ Livestock & Dairy	Billions $ Crops	Billions $ Total
Arizona	$1-2	$2-3	$3-5
California	$12-13	$30	$42-43
Colorado	$5	$2-3	$7-8
Idaho	$4-5	$3-4	$7-9
Kansas	$11-12	$7	$18-19
Montana	$2	$2	$4
Nebraska	$11-12	$11-12	$22-24
Nevada	$0.7	$0.8	$0.7-0.8
New Mexico	$2	$1-2	$3-4
N. Dakota	$1	$9-10	$10-11
Oklahoma	$5	$2	$7
Oregon	$1-2	$3	$4-5
S. Dakota	$4	$6	$10
Texas	$18-19	$7	$25-26
Utah	$1	$1-2	$1-2
Washington	$2-3	$6-7	$9-10
Wyoming	$1-2	$0.5	$1.5-2.0

Source: NASS, USDA, Annual Bulletins and NASS Census Data for 2012 (2013, 2014).

3.0 The Economic Impact of Western Irrigated Agriculture.

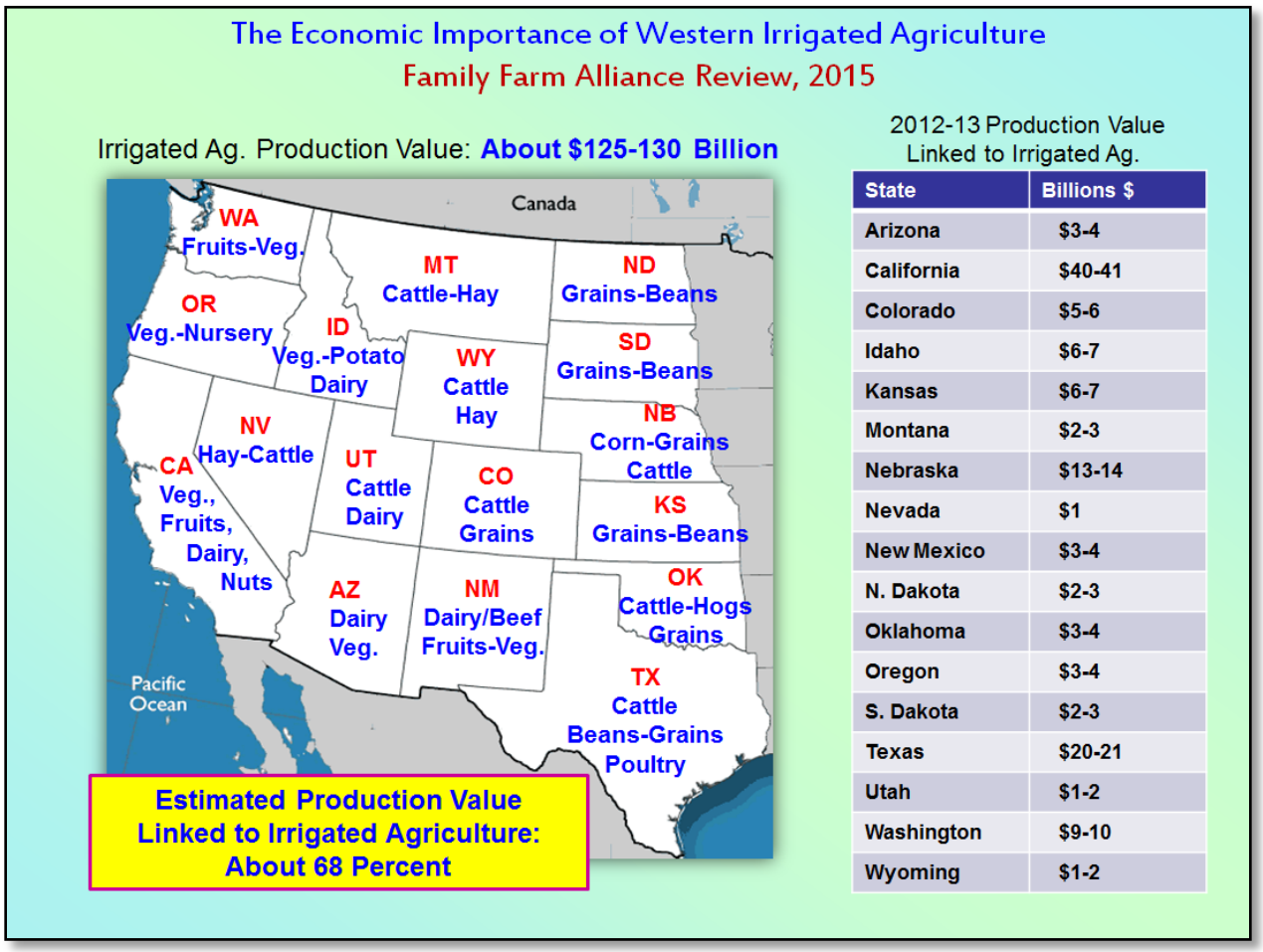
While economists are fond of bringing forth various metrics to interpret economic value and social wellbeing, perhaps the most readily understood measure of economic impact or performance is *household income.* For many, including policy makers and families, annual income is an undisputed determinant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

In Figures 4 and 5 (and Appendix Table 1), estimates for agricultural production value (farm gate prices received), 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 depict 2012-13 values, representing about $125-130 billion in production value linked to irrigated agriculture.

This production value leads to about $70 billion in direct household income, and about $172 billion in state household income, when applied to all the direct and secondary income impacts

from the combined agriculture production, agriculture service, and food processing sectors that comprise the Irrigated Agriculture Industry (see Appendix Tables 1 and 2).

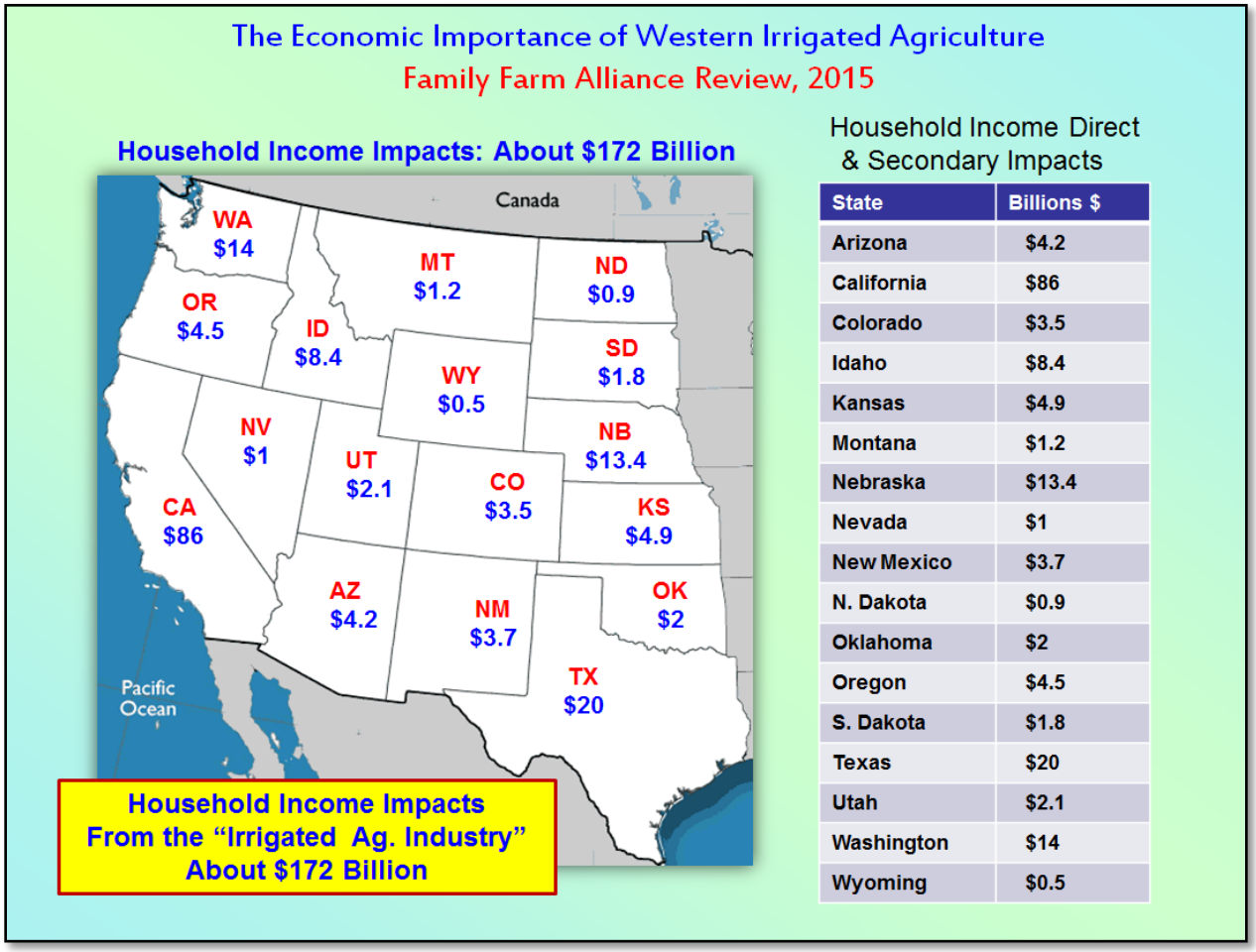
Figure 4. Agricultural Production Value Tied to Irrigated Ag. By State



State	Billions $
Arizona	$3-4
California	$40-41
Colorado	$5-6
Idaho	$6-7
Kansas	$6-7
Montana	$2-3
Nebraska	$13-14
Nevada	$1
New Mexico	$3-4
N. Dakota	$2-3
Oklahoma	$3-4
Oregon	$3-4
S. Dakota	$2-3
Texas	$20-21
Utah	$1-2
Washington	$9-10
Wyoming	$1-2

Source: Baseline Production Data from NASS, USDA, Annual Bulletins and NASS Census Data for 2012 (2013, 2014); and Irrigation Production Estimates from Appendix Tables 1 and 2, and Methodology Described in This White Paper.

Figure 5. Irrigated Agriculture Industry Household Income, By State



Household Income Direct & Secondary Impacts

State	Billions $
Arizona	$4.2
California	$86
Colorado	$3.5
Idaho	$8.4
Kansas	$4.9
Montana	$1.2
Nebraska	$13.4
Nevada	$1
New Mexico	$3.7
N. Dakota	$0.9
Oklahoma	$2
Oregon	$4.5
S. Dakota	$1.8
Texas	$20
Utah	$2.1
Washington	$14
Wyoming	$0.5

Source: Baseline Data from BEA, Annual Income Data for 2013; Appendix Tables 1 and 2, and Methodology Described in This White Paper.

Note: The "Irrigated Agriculture Industry" refers to the agricultural production, agricultural services, and food processing sectors of the Western U.S. state economies; and the above estimate includes secondary income impacts from other economic sectors supporting (serving) the Irrigated Agriculture Industry.

3.1 Agricultural and Irrigated Agriculture Production Values, and Income Impacts.

To summarize the production values and income impacts:

- In 2012-13, the total production (farm gate) value for the 17 states composing the Western U.S. region is about $184 billion. About 68% of this value is attributable to irrigation activity, $125-130 billion.

- The total estimated irrigated acres for the Western U.S. states are about 40.4 million (production agriculture of some form, including feed, pasture, and harvested crops).

- 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 $70 billion. Taking into account the total direct, indirect, and induced impacts, the total household income impacts are estimated to be about $172 billion annually.

3.2 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) data; 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 estimating an allocation of direct production to irrigated agriculture, and the use of input-output analyses to estimate the aggregated, industry sector secondary impacts. The resulting estimates likely fall with an acceptable error range.[2]

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

- By state, total agricultural production values (2012-2013) are obtained from the Agricultural Census-NASS data, and Economic Research Service annual data series. These data sources also breakdown crop/livestock production value contributions by commodities and specialty crops, by state.

- The NASS data sources have data (2008-2012) 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

[2] This White Paper represents the third time that the Pacific NW Project has estimated Western Irrigated Agriculture income impacts, as described herein. Consequently, greater confidence in the methodology has been obtained over time, including revised data assumptions and receipt of peer review comments; the numbers are perceived as providing decision-makers with a useful estimate for water resources management.

commodity and specialty crop, by state are 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 Appendix 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. Appendix Table 2 provides more detail about the multipliers used in this analysis.

- Although the direct and secondary linkages among the sectors are relatively stable over time, any future updates to this White Paper should include revised IMPLAN analyses for multiple states.

4.0 Economic Impacts vs. Efficiency vs. Opportunity 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 (National Economic Development account approach). This is viewed as an efficiency change.

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.

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.

5.0 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 tenet 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:

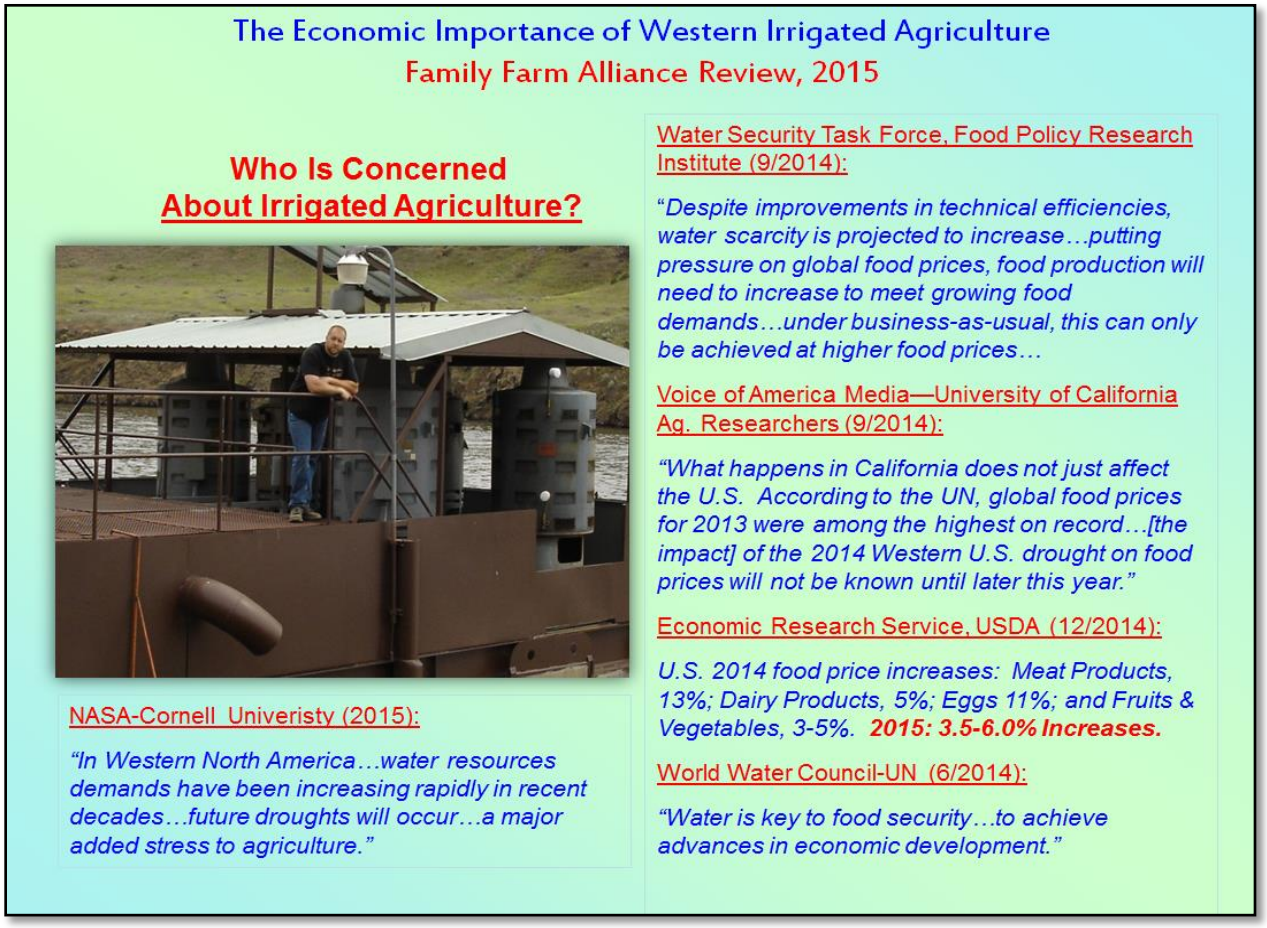
Some food security impacts are within the realm of silent opportunity costs, and they may need to be better appreciated in direct national economic terms, where impact is defined as:

- 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 (see Figure 6). Today, the World Bank, the Earth Policy Institute, the World Economic Forum, and the UN Food Policy Research Institute are almost alarmist in their projections of near-term food scarcity brought about by a lack of irrigation production in the developing 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.

Figure 6. Who Is Concerned About Irrigated Agriculture?



Source: See Primary References and Citations.

Perhaps to be expected given research assessing long-term climate change, based on multiple causes, NASA and academic researchers have predicted "unprecedented 21st Century drought risk in the Western U.S." likely to occur during the second-half of the century. Their prediction characterizes future droughts as outside of our historical norms and stressing irrigated agriculture production to a new extreme.

Interestingly, the more structural 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), the Boston Consulting Group (BCG), and the Food Policy Institute. What makes these reviews curiously relevant to the discussion here is that they ask questions about water availability for irrigated agriculture, including for the Western U.S., and the 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 (BCG) 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.

The Food Policy Institute ties aggressive water use efficiency to sustained economic growth and observes that even advanced industrial regions like the Western U.S. will need to deal with water scarcity. They refer to current water management practices as " business as usual," that will not be able to serve present or future water demands.

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.

During the 2012 to 2014 period, the USDA has tracked increases to U.S. food costs attributable to Midwest-Southwest drought conditions and a steady upward trend in demand. Several sectors--like meat products, eggs, and dairy—witnessed steep year-over-year price increases; while fresh fruits and vegetables witnessed "modest" annual changes ranging from about 2-5%. For 2015, the USDA perceives 3-6% price increases across sectors, and suggests that these increases would be only slightly above inflationary trends.

On an optimistic note, the agency further calculates that even under a high food cost scenario, retail food prices would not likely exceed 15%. But the introduction of worldwide, accelerated food demand, the prevalence of creeping reductions to irrigation water supply, and more excessive drought impacts may change the picture.

To what extent domestic and 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 (and others) could be weakened, in part, if Western irrigated agriculture is impaired.

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

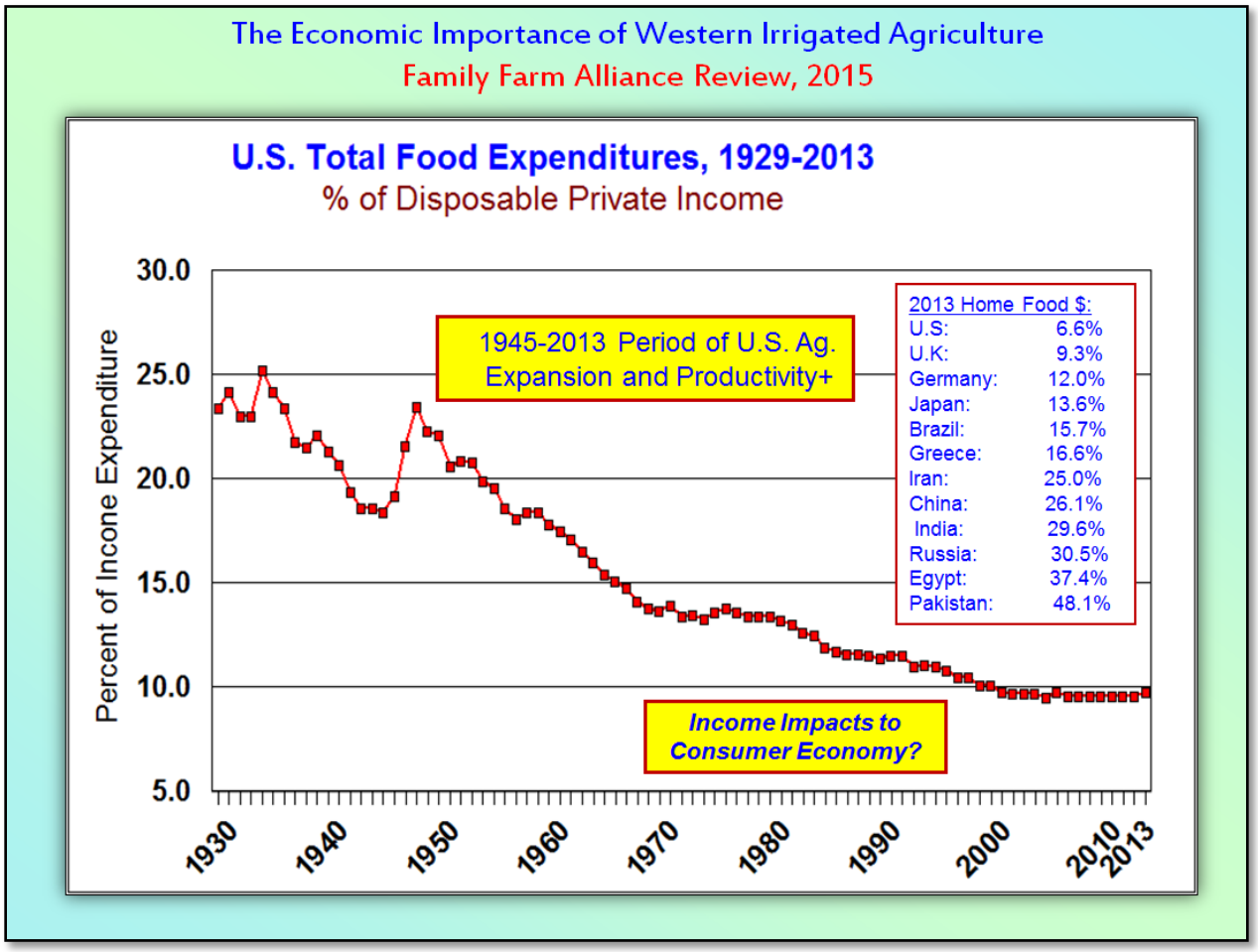
So how would the food security issue be most directly linked to general U.S. economic health? Declining costs of U.S. household food purchases affecting discretionary income, over time, have contributed dramatically to the national economy. A dominant portion of the U.S. consumer spending economy—estimated at about 70% 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 7. Since World War II, the percentage contribution of (disposable) household/personal income to food costs has dropped from about 25% to 8%--this includes both home and away from home expenditures.[3] No longer spending larger portions of income on food, U.S. households have been able to direct more dollars toward houses, automobiles, and an ever-growing array of consumer goods.

The U.S. food expenditures and economic wellbeing context can be contrasted to other developed and developing countries. 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. It also is perhaps non-coincidental that high food costs exist in many parts of the world where regional and inter-regional strife are prevalent, and perhaps growing.

[3] Estimated expenditures by Economic Research Service, USDA; does not include alcoholic beverages.

Figure 7. Percent of Food Expenditures to Disposable Private Income



Source: ERS, USDA, Food Expenditures Data Series, 2014.

5.2 Food Security Impacts—What Actions for the Western U.S.

If policy makers accept the interface between food security and economic wellbeing, then they should reconsider strategic actions and implications underlying water resources policy measures.

While not the analytical subject of this White Paper, at least five such actions are readily apparent:

- Those grappling with the food security impacts should include a focus on the economic structure of the current food production/processing/distribution sector linkages—and their support for regional for household income stability. The Irrigated Agriculture Industry is a mainstay economic force in the Western U.S.

- This economic structure is highly sensitive to an elaborate state/federal regulatory structure for food production, processing, and distribution that ensures sufficient, high-

quality food products. That regulatory structure needs to be overhauled to place a higher priority on irrigated agricultural production. In particular, where private sector capital is available, the regulatory community should move away administrative obstacles to irrigation enhancement.

- Food security considerations should respect 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.

- Among the stabilizing factors for Western irrigated agriculture is the need to accelerate an implementation of advanced water use efficiencies, to boost 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 "new" water allocated, for new irrigated agricultural production. Water use efficiencies should be tied to "water spreading," where additional irrigated acreage is developed.

Given the potential magnitude of the food security issue to economic wellbeing, the Irrigated Agriculture Indutry must continue to make 21st Century water management a reality, and state and national policy makers must place irrigated agriculture on the high priority list.

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Appendix Tables and Figure

Table 1. Western U.S. Irrigated Agricture Production Review, Estimated Value of Production Linked to Irrigated Agriculture (2012$).

State	Total Farmgate $ 2012 (State)	Est. Irrigated Acres (2012)	Total Land (Acres) in Irrigated Farms Irr./Non-Irrigated	% of All Farms with Some Irr. Land	% of Irr. Land for Farms with Irr. Land	Harvested Crop Land	Total All Land Farm Owned	Primary Farmgate Production Value Group Ranking within State First	Second	Third
Arizona	$3,732,113,000	880,613	2,580,504	30%	34%	890,130	26,249,195	Dairy and Veg.	Beef	Hay, Cotton, Nurs.
California	$42,627,472,000	7,861,964	16,039,761	69%	49%	8,007,461	25,364,695	Fruits, Nuts, Veg./Mel.	Milk-Dairy, Veg./Mel.	Beef, Hay, Nurs.
Colorado	$7,780,874,000	2,516,785	13,893,878	43%	18%	5,182,628	31,886,676	Cattle-Beef	Gr.Beans	Dairy-Hay-Veg.
Idaho	$7,801,446,000	3,365,292	7,704,751	64%	44%	4,504,676	11,760,109	Gr.-Beans-Peas	Dairy-Cattle	Veg.-Pot.
Kansas	$18,460,564,000	2,881,292	13,927,077	10%	21%	21,043,596	46,137,295	Cattle-Beef	Corn, Grains, Beans	Hay-Dairy-Hogs
Montana	$4,230,083,000	1,903,019	23,982,172	34%	8%	9,533,929	59,758,917	Gr.-Beans	Cattle-Beef	Hay
Nebraska	$23,068,756,000	8,296,573	25,189,921	34%	33%	18,812,755	45,331,783	Cattle-Beef	Gr.-Beans-Peas	Hay-Poultry
Nevada	$764,144,000	687,790	4,420,327	61%	16%	582,494	5,913,761	Hay	Beef-Cattle	Dairy
New Mexico	$4,106,000,000	680,318	13,362,070	49%	5%	1,009,683	43,238,049	Dairy	Cattle-Beef	Hay, Fruits, Gr. Veg.
North Dakota	$10,950,680,000	218,407	2,089,451	3%	10%	23,469,816	39,262,613	Wheat,Grains,Beans	Cattle-Beef	Hay
Oklahoma	$7,129,584,000	479,750	3,109,988	3%	15%	8,074,733	34,356,110	Cattle-Beef-Hogs-Pol.	Grains, Beans	Dairy-Hay
Oregon	$4,883,674,000	1,629,735	9,310,305	42%	18%	2,966,351	16,301,578	Cattle-Beef-Dairy	Nurs.-Gr.-Beans	Veg., Fruit, Hay
South Dakota	$10,170,227,000	378,678	3,316,308	5%	11%	16,392,000	43,257,079	Gr.-Beans-peas	Cattle-Beef	Hogs,Other Livest.
Texas	$25,375,581,000	4,489,163	21,492,404	7%	21%	16,458,332	130,153,438	Cattle-Beef	Gr.-Beans-Peas	Poultry-Nurs.-Hay
Utah	$1,816,147,000	1,104,257	5,791,872	67%	19%	1,054,369	10,974,396	Cattle-Beef	Milk and Dairy	Hogs-Hay-Nurs.
Washington	$9,120,749,000	1,633,571	6,323,980	40%	26%	4,342,904	14,748,107	Fruits, Dairy	Gr.- Beans-Veg.	Beef-Hay
Wyoming	$1,689,416,000	1,435,710	14,589,838	49%	10%	1,440,605	30,363,641	Cattle-Beef	Hay	Grains
Total:	$183,707,510,000	40,442,917	187,124,607	------	------	143,766,462	615,057,442	------	------	------

State	Total Farmgate $ 2012 (State)	Est. Irrigated Acres (2012)	Primary Farmgate Product Value % of Total Value*	Estimated Percent Value Linked to Irrigated Ag.**	Est. Farmgate Value Linked to to Irrigated Ag.
Arizona	$3,732,113,000	880,613	85%	95%	$3,545,507,350
California	$42,627,472,000	7,861,964	80%	95%	$40,496,098,400
Colorado	$7,780,874,000	2,516,785	90%	75%	$5,835,655,500
Idaho	$7,801,446,000	3,365,292	95%	85%	$6,631,229,100
Kansas	$18,460,564,000	2,881,292	97%	35%	$6,461,197,400
Montana	$4,230,083,000	1,903,019	90%	55%	$2,326,545,650
Nebraska	$23,068,756,000	8,296,573	95%	60%	$13,841,253,600
Nevada	$764,144,000	687,790	85%	95%	$725,936,800
New Mexico	$4,106,000,000	680,318	95%	95%	$3,900,700,000
North Dakota	$10,950,680,000	218,407	95%	20%	$2,190,136,000
Oklahoma	$7,129,584,000	479,750	95%	40%	$2,851,833,600
Oregon	$4,883,674,000	1,629,735	90%	65%	$3,174,388,100
South Dakota	$10,170,227,000	378,678	96%	20%	$2,034,045,400
Texas	$25,375,581,000	4,489,163	88%	80%	$20,300,464,800
Utah	$1,816,147,000	1,104,257	76%	80%	$1,452,917,600
Washington	$9,120,749,000	1,633,571	90%	85%	$7,752,636,650
Wyoming	$1,689,416,000	1,435,710	90%	60%	$1,013,649,600
Total:	$183,707,510,000	40,442,917	------	68%	$124,534,000,000

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

Note: Irrigated acres principally based on 2012 Census of Agriculture and production values from NASS Data by state. Total production values for 2012 are from NASS/USDA, Economic Research Service web sites, Annual Statistical Bulletin, by state, and related data (2013-2014)..

* The farm receipts percentages for the primary crops, by state, may be reviewed at http://www.ers.usda.gov/data-products/state-fact-sheets (2012-2013).

** 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 seriving 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 (2013$)

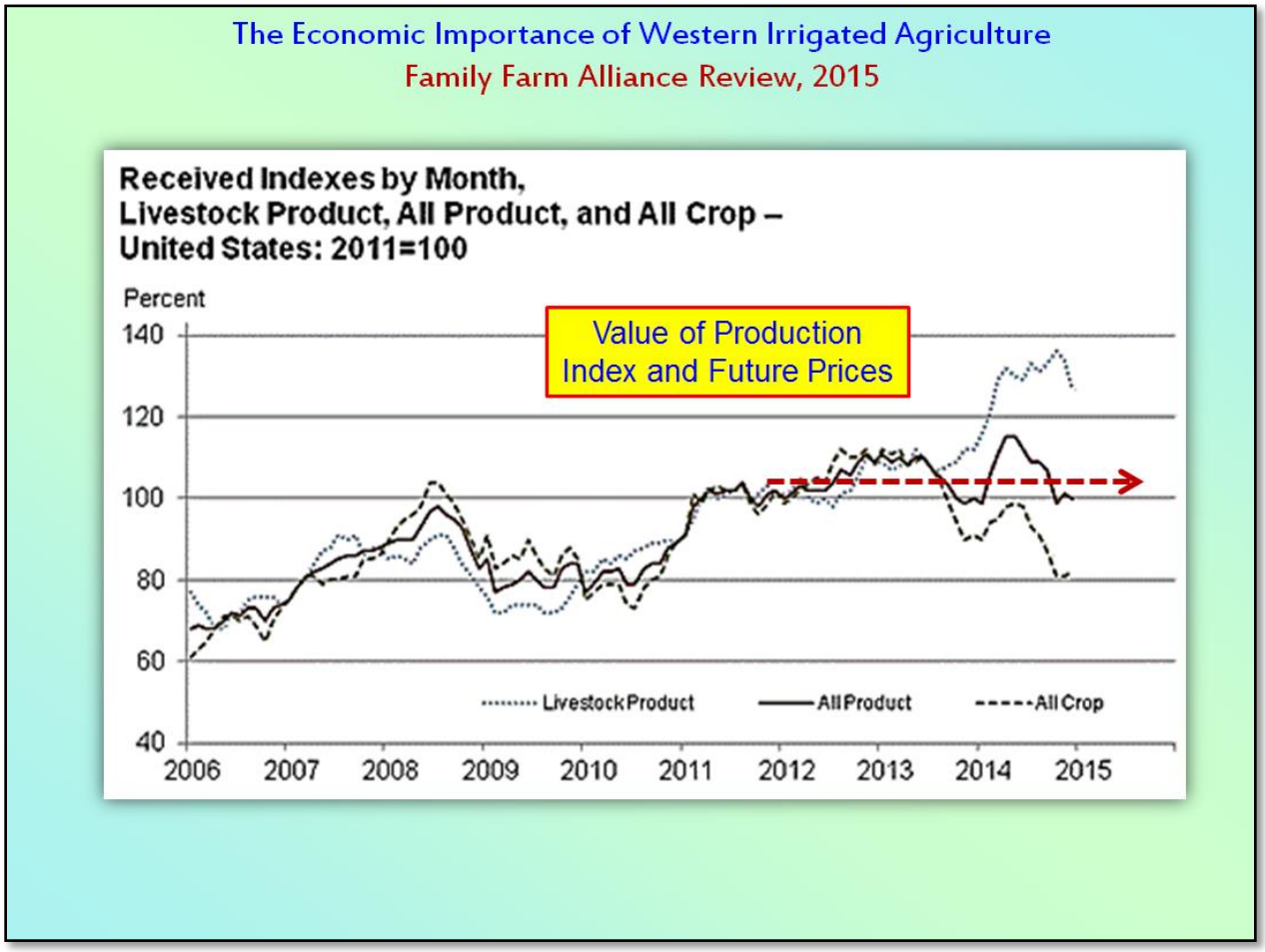
State	Estimated Annual Income, Estimate by Sector: Farm Production	Ag. Services	Food Processing	Total Income for All Agricultural Sectors	Est. % Linked to Irrigated Ag.	Est. Total Income For Irrigated Ag.	Statewide VA Multiplier**	Irrigated Ag. Est.Total Income
Arizona	$897,344,000	$386,142,000	$479,263,000	$1,762,749,000	95%	$1,674,611,550	2.5	$4,186,529,000
California*	$17,155,685,000	$6,197,596,000	$12,883,000,000	$36,236,281,000	95%	$34,424,466,950	2.5	$86,061,167,000
Colorado	$818,072,000	$180,142,000	$1,108,080,000	$2,106,294,000	75%	$1,579,720,500	2.2	$3,475,385,000
Idaho	$2,772,604,000	$240,536,000	$919,722,000	$3,932,862,000	85%	$3,342,932,700	2.5	$8,357,332,000
Kansas	$4,042,790,000	$458,580,000	$1,814,963,000	$6,316,333,000	35%	$2,210,716,550	2.2	$4,863,576,000
Montana	$817,733,000	$99,400,000	$114,091,000	$1,031,224,000	55%	$567,173,200	2.1	$1,191,064,000
Nebraska	$6,813,088,000	$232,682,000	$1,887,715,000	$8,933,485,000	60%	$5,360,091,000	2.5	$13,400,228,000
Nevada	$218,776,000	$23,959,000	$247,082,000	$489,817,000	95%	$465,326,150	2.1	$977,185,000
New Mexico	$1,408,377,000	$96,687,000	$267,254,000	$1,772,318,000	95%	$1,683,702,100	2.2	$3,704,145,000
North Dakota	$1,587,522,000	$124,930,000	$282,395,000	$1,994,847,000	20%	$398,969,400	2.1	$837,836,000
Oklahoma	$1,128,307,000	$197,671,000	$891,520,000	$2,217,498,000	40%	$886,999,200	2.2	$1,951,398,000
Oregon	$1,537,400,000	$332,703,000	$1,282,662,000	$3,152,765,000	65%	$2,049,297,250	2.2	$4,508,454,000
South Dakota	$3,611,453,000	$122,052,000	$443,857,000	$4,177,362,000	20%	$835,472,400	2.1	$1,754,492,000
Texas	$4,368,353,000	$1,052,777,000	$4,530,058,000	$9,951,188,000	80%	$7,960,950,400	2.5	$19,902,376,000
Utah	$349,233,000	$47,328,000	$878,209,000	$1,274,770,000	80%	$1,019,816,000	2.1	$2,141,614,000
Washington*	$3,303,533,000	$715,462,000	$2,555,409,000	$6,574,404,000	85%	$5,588,243,400	2.5	$13,970,609,000
Wyoming	$359,224,000	$34,860,000	$40,052,000	$434,136,000	60%	$260,481,600	2.0	$520,963,000
Total:	$51,189,494,000	$10,543,507,000	$30,625,332,000	$92,358,333,000	68%	$70,308,970,350		$171,804,353,000

Note: sources are included in Table 1; and U.S. Bureau of Economic Analysis, Personal Income by Major Source and Earnings by NAICS Industry, http://bea.gov (2013 data). 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 structual 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).

Appendix Figure 1. Value of Production Index and Forecast, 2006-2015



The above time series is from 2006 through January 2015. The red dash line represents Pacific NW Project's expectation of continued farm-gate prices for the future, near-term period.