REGIONAL WATER BOARD IMPACTS ON VEGETABLE PRODUCTION IN CALIFORNIA

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ABSTRACT

More than 300,000 ha of vegetable crops are produced annually in the coastal valleys of central California. In these valleys vegetable production dominates the landscape, and since most fields produce two or more crops per year the annual fertilizer input is very high. Not surprisingly, environmentally problematic levels of soluble phosphorus in surface waters, and nitrate-nitrogen (NO_3-N) in both surface- and groundwater, are common. The Central Coast Regional Water Quality Control Board (WQCB) is struggling to develop effective regulatory measures to improve water quality without damaging the viability and competitiveness of the commercial vegetable industry. To date, regulatory efforts have been tied to the discharge of irrigation tailwater or storm runoff from agricultural land. Beginning in 2004 the WQCB granted a waiver from the requirement to obtain a permit for such discharge to all growers who agreed to: a) attend an extensive water quality training course; b) develop a written farm water quality protection plan outlining practices to be undertaken to reduce nutrient losses; and c) participate in a watershed-scale water quality monitoring program. In the initial years of this program the majority of vegetable growers met these requirements, yet the monitoring data have shown little substantive improvement in water quality parameters related to nutrients. In 2010 the WQCB proposed additional requirements for a continuation of the waiver; those requirements include fertilizer use and farm nutrient balance reporting, and on-farm monitoring of surface and groundwater discharges.

INTRODUCTION

In California, as in many parts of the irrigated West, concern over water quality impairment resulting from agricultural operations has intensified governmental scrutiny of crop production practices. Commercial vegetable production, especially as practiced in the coastal valleys of central California, is of particular concern to regulatory agencies. In those coastal valleys vegetable production accounts for a large majority of irrigated acres. The moderate climate allows for year-around cropping, with 2-3 crops per year the norm. Leafy green vegetables (lettuce, celery, spinach and *Brassica* crops) dominate crop rotations, but significant quantities of several dozen other vegetables are also produced. Most of these crops are shallowly rooted and have exacting market standards for size, color and quality, providing incentives for high fertilization rates and frequent irrigation. The semi-arid climate (< 12 inches mean annual precipitation) provides minimal dilution of nutrients discharged in leachate or in irrigation tailwater. The resulting high soluble N and P concentrations in surface water, and high nitrate-nitrogen (NO_3-N) in groundwater, have spurred regulatory action to improve environmental water quality.

CURRENT SITUATION

The 'Clean Water Act', Federal legislation originally enacted in 1972, gave the U.S. Environmental Protection Agency (EPA) the authority to regulate both point- and non-point sources of pollution entering surface waters of the United States. The EPA requires states to develop a list of surface water bodies that are impaired, and to enumerate the pollutant(s) responsible for that impairment. That list, referred to as the 303(d) list after the section of the enabling legislation, is used to prioritize regulatory activity. Significant portions of the Salinas, Pajaro and Santa Maria River systems (the main watersheds in the coastal vegetable production areas) are listed as impaired for nutrient concentration. While soluble phosphorus levels are problematic throughout the region, the more immediate concern is NO_3-N concentration; in water bodies receiving significant runoff from vegetable fields NO_3-N is commonly 3-4 times the Federal drinking water standard of 10 PPM. Elevated NO_3-N is not strictly a concern for surface water; NO_3-N contamination of groundwater is pervasive in these valleys, and several municipalities have had to replace drinking water wells that have become contaminated.

The EPA delegates to the individual states broad authority to impose regulation of non-point sources of water pollution to improve impaired waters. In California, regional Water Quality Control Boards (WQCBs) develop and implement regulation of agricultural operations. As its primary mechanism of regulating agricultural industries, the central coast WQCB has chosen the use of conditional water discharge waivers. These waivers allow growers to discharge irrigation tailwater and storm runoff into surface waters of the state. In the absence of the waiver, growers would have to obtain water discharge permits similar to those required of factories and wastewater treatment plants. Meeting permit requirements would be economically and logistically impractical for growers, so their continued operation is dependent on meeting the requirements of the conditional waiver.

In 2004 the central coast WQCB set the following requirements for growers to obtain a conditional water discharge waiver:

- attend 15 hours of education on farm water quality protection
- develop a written farm water quality protection plan
- adopt management practices to protect water quality, and report those practices to the WQCB
- participate in a regional water quality monitoring program to document water quality trends

To meet the educational requirement University of California Cooperative Extension personnel developed a shortcourse designed to acquaint growers with the surface water quality challenges in the region, provide instruction in crop production and environmental conservation practices that can reduce off-farm movement of nutrients and other pollutants, and aid in the development of written farm water quality plans. By the end of 2007 more than 2,000 individuals had completed this shortcourse, among them growers responsible for the vast majority of coastal vegetable crop production.

In December, 2006, the WQCB surveyed holders of agricultural water discharge waivers to determine the extent of adoption of management practices that protect water quality; more than 250 vegetable growers responded, representing > 170,000 acres of production. Based on the grower responses, the vegetable industry appeared to be making significant strides toward water quality protection (Table 1). Large majorities of growers claimed to be using irrigation and nutrient management practices that should minimize nutrient loss to the environment. An additional factor not reflected in this survey was the rapid conversion of vegetable production

from sprinkler or furrow irrigation to drip irrigation. In theory, drip irrigation can be a valuable tool for water quality protection due to the high water distribution uniformity achievable, and the ability to deliver fertilizers efficiently and in sync with crop demand.

Despite the self-reported adoption of efficient management practices, and a substantial expansion in the use of drip irrigation, regional water quality monitoring has shown persistently high NO_3-N concentration in surface water, with little change across 5 years of monitoring. Surface water NO_3-N of 30-40 PPM has been common at monitoring sites at which drainage from vegetable crop fields (surface runoff or tile drain effluent) constituted a significant portion of the flow. Another sign that substantive changes were not taking place was the lack of reduction in fertilizer usage over these years. According to statistics collected by the California Department of Food and Agriculture, there was no trend toward lower N fertilizer sales in Monterey County, the heart of the coastal vegetable industry. While these fertilizer sales statistics are not broken down by crop type, the area under cultivation and the crop mix were quite stable over these years, with vegetable production representing more than 80% of fertilized, irrigated acres in all years.

FUTURE PROSPECTS

The current conditional discharge waive will expire in 2011. The WQCB has proposed stringent new requirements for waiver renewal, including:

- fertilizer use reporting
- farm-wide nutrient budget estimation
- on-farm monitoring of NO_3-N concentration in irrigation tailwater and water leaching from the root zone
- compliance dates to meet water quality standards in discharged water, ranging from 2015 for surface water to 2021 for leachate moving to groundwater

This marks a distinct shift of regulatory emphasis from grower education and adoption of nutrient management BMPs toward standards-based, timed compliance. Growers are understandably nervous about their ability to comply with these proposed requirements without making radical changes to their production practices. Their fears are well founded, since no combination of nutrient and irrigation BMPs will achieve consistent compliance with an NO_3-N standard for water discharged from fields in vegetable production.

Field monitoring of irrigation tailwater in this region has shown that its NO_3-N concentration is typically no more than 3-5 PPM greater than the well from which it was pumped. However, a substantial percentage of irrigation wells in this region exceed 10 PPM NO_3-N, meaning that many growers would be required to treat tailwater before it left the farm. Conservation techniques like filter strips and vegetated ditches have had little effect on soluble nutrient levels under local field conditions. Denitrification schemes may have some potential, but they would be difficult to manage, both technically and economically. The bottom line is that a combination of dramatically reduced tailwater volume (achieved through more efficient irrigation) and impoundment and reuse of any unavoidable tailwater will be the most practical path to surface water quality compliance.

The more intractable problem is meeting the 10 PPM NO_3-N standard in water leaching from the root zone, whether it is conveyed back to surface waters through tile drain systems, or moves toward groundwater. Leaching is unavoidable, because a degree of non-uniformity is inherent in any irrigation system, and because some leaching is required for salinity control. Given the relative mass of soil water to soil solids, leachate NO_3-N will generally be 3-5 times

higher than that of soil, expressed on a dry weight basis. Root zone soil NO_3-N of an adequately fertilized vegetable field is commonly above 10 PPM, meaning that leachate would be perpetually out of compliance. A change of emphasis by the WQCB away from a concentration-based regulatory approach to one considering environmental N loading would recognize the inherent impossibility of meeting a 10 PPM NO_3-N standard with every discharge from a fertilized field. However, a standard based on N loading would still severely challenge the vegetable industry. The relatively low rainfall in these coastal watersheds provides limited dilution of agricultural drainage; it is unlikely that double cropping shallowly rooted vegetables can be done on a landscape scale without exceeding N loading limits.

That is not to say that improvement in environmental water quality is impossible; there is ample evidence that a significant reduction in N loading is possible through improved fertilization and irrigation practices. Lettuce, grown on more than 150,000 coastal acres, typically contains approximately 120 lb N/acre in above-ground biomass (Breschini and Hartz, 2002b). A 2004-05 survey of > 70 lettuce fields showed that seasonal N application averaged 165 lb/acre, varying from 25-390 lb/acre (Hartz et al., 2007). While some variability was undoubtedly justified based on field-specific conditions, these statistics indicate a lack of understanding of crop nutrient requirements, and efficient fertilization practices, on the part of many growers. The situation with irrigation management is similar. In nine drip-irrigated celery fields monitored by Breschini and Hartz (2002a) growers applied from 85-400% of seasonal reference evapotranspiration. These studies demonstrated that some growers are highly efficient at nutrient and irrigation management, but they are in the minority. Convincing growers on the other end of the spectrum to emulate their more efficient neighbors would result in significant water quality improvement.

SUMMARY

It is clear that water quality regulation in the Central Coast region of California will increasingly disrupt commercial vegetable production, imposing economic costs and restrictions on production practices. This may be a harbinger of what will happen in other areas of concentrated horticultural production. Horticultural producers will have to improve their fertility and irrigation practices, but this may not be adequate to meet water NO_3-N standards.

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Table 1. Extent of adoption of nutrient and irrigation management practices thought to minimize water pollution potential from vegetable production.

	% of vegetable acres	
Management practice	Practice implemented	Implementation planned within 3 years
Crop nutrient budgets established and used	80	7
Nitrate content of irrigation water factored into fertilization rate	81	6
Soil residual nitrate tested and factored into fertilization rate	84	6
Plant tissue analysis used to aid fertilization decisions	61	10
Field personnel given nutrient management training	67	5
Irrigation system optimized to soil water infiltration rate	87	4
Irrigators receive training on system management and maintenance	88	6

Source: Central Coast Region Water Quality Control Board survey, 2006

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