Summary and Recommendations

Background

Until the 1980s, water resource management in agriculture in most OECD countries focused on the physical supply of water. Emphasis was on infrastructure "supply-side" *technical* solutions and harvesting the maximum amount from the resource. This technical-based path to water resource management is now being complemented with the accent on sustainable based water resource management and greater reliance on "demand-side" *economic* solutions. A turning point in this shift in the policy agenda was the *Dublin International Conference on Water* in 1992, where it was stressed that "managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources".

These developments have led to an emerging policy approach with emphasis on: meeting the diverse demands for water (economic, environmental and social); embracing participatory decision making and institutional structures; and encouraging a greater role for market-based allocation mechanisms. Nearly all OECD countries have policy strategies to address broad water management issues – water resources, quality and ecosystems – and in terms of the more specific objectives for managing water resources in agriculture they broadly share a strategic vision to:[1]

- Establish a long-term plan for the sustainable management of water resources in agriculture taking into account climate change and climate variability impacts, including the increased need for protection from flood and drought risks and alteration in the seasonality and timing of precipitation (rainfall and snow pack melt);
- Contribute to raising agricultural incomes and achieving broader social equity and rural development goals;
- Protect ecosystems on agricultural land or affected by farming activities;
- Balance consumptive water uses across the economy with environmental needs; and
- Improve water resource use efficiency, management and technologies on-farm and ensure the financing to maintain and upgrade the infrastructure supplying water to farms (and other users).

Evidence in this report indicates that agriculture's management of water resources has shown some signs of improvement but that more needs to be achieved, as revealed by the main trends in the use of water resources by agriculture across OECD countries since 1990 described below.

- ***Water use for agriculture*** and non-agricultural uses changed little between 1990-92 and 2002-04, although there has been considerable annual variability in water use in agriculture. The OECD trend in agriculture water use reflects significant growth in four countries (**Greece, Korea, New Zealand** and **Turkey**) mainly driven by an increase in the area irrigated (except **Korea**), but a substantial reduction in **Australia, Mexico** and most **European OECD countries**. For this latter group of countries the decrease in water use is due to a mix of factors varying between countries, but notably improvements in water use efficiency, drought, release of water to meet environmental needs, and, for OECD European countries contraction of the agricultural sector.

- Despite the near static demand for water by agriculture across OECD countries, there is growing ***pressure on water resources*** in some regions under water stress. This has arisen because of more intense competition between farmers and other water consumers, as well as diversion of more water for environmental purposes, such as in parts of California, **United States**, and in many **OECD European countries** surrounding the Mediterranean. Greater competition for water resources, however, can generate positive outcomes if it leads to more efficient resource allocation adjustments, generates environmental benefits, and fosters higher economic growth.

- ***Agriculture accounted for 44% of total water use overall*** in 2002-04, although for eight OECD countries where irrigated agriculture is important, the share is over 55%. Some of the water used by irrigated agriculture is reused by other downstream users or diverted to meet environmental needs, although there are also losses due to evapotranspiration; pollutant runoff from irrigated farming; and losses to groundwater sources which are no longer economic to pump.

- ***The area irrigated rose by 8%*** compared to a reduction of 3% in the total agricultural area between 1990-92 and 2002-04, although recently in a number of countries, the area irrigated has been decreasing, in part, reflecting an overall contraction of the agriculture sector.

- ***Irrigated agriculture*** provides a growing and major share of the value of farm production and exports for some OECD countries, and supports rural employment in a number of regions. As such irrigated agriculture accounts for most of agricultural water use, and will continue to play an important role in agricultural production growth in some countries.

- ***Improvements in physical water productivity*** by agriculture, through better management and uptake of more efficient technologies, such as drip irrigation and ***adoption*** of other water saving farm practices, has contributed to an increase in farm production. Overall the OECD average water application rate per hectare irrigated decreased by 7% between 1990-92 and 2002-04, while in most cases the volume of agricultural production increased.

- ***The adoption of drip irrigation, low-pressure sprinkler systems,*** and other water saving technologies and practices, are becoming more widespread. Water use efficiency in agriculture is also being improved through replacing earthen irrigation channels with concrete linings to reduce losses and upgrading flood irrigation systems (*e.g.* levelling of fields, neutron probes for soil moisture measurement, and scheduling of irrigation to plant needs).

- Agriculture ***abstracts*** an increasing share of its water from ***groundwater,*** and the sector's share in total groundwater utilisation, although data are limited, was above 30% in 12 OECD member countries in 2002. In some cases other sources of water are becoming significant, especially the use of recycled wastewater, mainly sewage, and desalinated seawater.

- Over-exploitation of water resources by agriculture in certain areas is damaging ***ecosystems*** by reducing water flows below minimum flow (stock) levels in rivers, lakes and wetlands, which is also detrimental to recreational, fishing and cultural uses of these ecosystems. Groundwater use for irrigation above recharge rates in some regions is also undermining the economic viability of farming in affected areas.
- ***Pollutant discharges*** from agriculture into water bodies have been declining in recent years in many OECD regions, but for nutrients and pesticides agriculture still remains a major source of pollution in most cases. However, information on the trends in pollution from irrigated land is patchy.
- Agriculture is at risk from the growing incidence and severity of ***floods and droughts*** in many OECD countries. This has been associated with both human alterations of the hydrological characteristics of watersheds and land-use policies that have encouraged ***urbanisation*** in areas at risk to flooding events, and also increasingly the trend toward greater climatic variability leading to higher financial costs both through loss of production and damage to farm infrastructure, and also costs for the wider economy in terms of damage to property and in some cases loss of life.
- The 2007 projections of the Intergovernmental Panel on Climate Change in relation to ***climate change, water and agriculture,*** supported by the conclusions of reports from many OECD government agencies, indicate that changes in water quantity and quality will affect food availability, stability, access and utilisation. Climate change is also expected to affect the functioning and operation of existing water infrastructure, including hydropower, structural flood defences, drainage and irrigation systems. Current water management practices might also not be robust enough to cope with the impacts of climate change and climate variability on water supply reliability, flood risk, agriculture, energy and ecosystems.

The developments outlined above suggest that a future challenge will be to ensure water resources used by agriculture are allocated among competing demands so as to: sustain the agricultural industry; produce food, fibre and energy efficiently; minimise pollution and support ecosystems; and meet social and cultural aspirations. Hence, the broad directions for a strategy that could shift ***agriculture's management of water resources onto a more sustainable path across OECD countries suggest the need to:***

- Recognise the complexity and diversity of managing water resources in agriculture;
- Strengthen institutions and property rights for water management in agriculture;
- Ensure charges for water supplied to agriculture at least reflect full supply costs;
- Improve policy integration between agriculture, water, energy and environment policies;
- Enhance agriculture's resilience to climate change and climate variability impacts; and,
- Address knowledge and information deficiencies to better guide water resource management.

Recognising the complexity and diversity of managing water resources in agriculture

The scope of the complexity and diversity of water resource management in agriculture can be summarised in terms of hydrology, and water sources, uses, economics and institutional structures.

- ***Hydrology:*** the mobility of water – in that it flows, leaches, evaporates, and has the opportunity to be reused – makes it distinctive as a commodity compared to land, for example. Moreover, agriculture can contribute positively to the hydrological cycle, for example, through groundwater recharge and water purification functions. But agriculture can also contribute to surface water and groundwater pollution and through excessive extraction may lead to the diversion of water from supporting ecosystems.

- ***Sources:*** agricultural water sources are varied and not, in general, as reliable as piped supply networks, depending on precipitation (rainfall and snowpack melt) and "stored" sources, mainly surface water (rivers and lakes) and groundwater (shallow/deep aquifers). For those regions where competition for scarce water resources is most intense, there is growing use of recycled water, mainly from processed drainage or sewage wastewater, and also desalination of seawater and saline groundwater, but these options currently provide only a small and highly localised supply of water for agriculture in some regions of the OECD.

- ***Uses:*** heterogeneity of water use in terms of space, quality and variability over time (seasonal and annual) present challenges in matching supply and demand. A given quantity of water is not the same as another available at a different location, point in time, quality and probability of occurrence. The heterogeneity extends to structuring legal and institutional arrangements. Commonly, irrigation systems are a mix of publicly, collectively owned or private systems, where farmers have their own access to groundwater and/or invest in on-farm dams, reservoirs and irrigation infrastructure. Depending on how these different systems are managed they can have varying consequences for the environment. It should also be emphasised that in periods of severe drought, the agricultural sector will frequently be the first sector to have to release water to meet other user needs, especially for domestic water consumers.

- ***Economics****:* private (extraction) and public good (stewardship) characteristics of water imply different allocation mechanisms. When water is used on a farm it is a private good, but when left *in situ*, such as a lake or wetland, it is a public good for which private markets are generally absent. Moreover, water is largely used by the private sector (farms, households, industry) but its ownership and delivery is normally in the public domain.

- ***Institutions:*** water resources are frequently managed through complex and multi-layered *institutional* and governance arrangements, often through national institutions and governance and, in some cases, cross national border structures. Water institutions are also embedded in sub-national regional and local governments (water user associations), while the governance of surface water and groundwater are commonly separated.

Strengthening institutions and property rights for water management in agriculture

The shift in policies with a greater accent on demand rather than supply management policies has brought reforms to the institutional and governance structure managing water resources. But the progress and path of water policy reforms has been mixed across OECD countries. Some countries have already undertaken major changes in their management of water resources or are in the early stages of reform programmes. For a few countries, however, where reform of water and agricultural policies could be beneficial to sustainable water resource management, progress has been limited.

Water policy reforms need to be developed as an integrated part of a broader reform framework: encompassing institutional changes to the way water services are delivered; defining water property (access) rights and entitlements; recovering costs for the delivery of water to agriculture; and providing a solid base for the financing of water delivery infrastructure so that the capital stock is not degraded. Also water policy reform processes should be seen in a longer-term perspective as an integral part of the policy functions of government. This is becoming more important as climate change impacts on agriculture are taking the industry into uncharted territory in terms of water available to farmers and its seasonal variability.

Simplification of institutional structures, rules governing water charges and trading arrangements for agricultural water use would improve transparency and accountability. There is frequently a plethora of institutions involved in managing, allocating and regulating water resources at all levels of government from local to national. These complexities can result in differing practices and regulations at the river basin level that create inefficiencies in allocation or trading of water resources to the highest value uses.

Progress has been made, however, towards decentralisation of institutional arrangements concerning water governance, from national to a water basin level, favouring greater local engagement and involvement of water users in resource management. However, some caution is necessary with the process of decentralisation. Basin level management, for example, may require national or international governance to avoid inequities in water allocation within a water basin and also ensure that the public good aspects of environmental, recreational and cultural uses and values of water are given sufficient recognition.

Developing ***stakeholder involvement*** is crucial to improve water and watershed management, but this takes time. Targeting communities, rather than individuals, may be a preferred solution to water governance issues. Shared irrigation systems (managed by private entities or farmers' associations), for example, may bring greater economic and environmental benefits than farmer owned systems, through sharing costs and responsibilities among members of the local community or water basin.

But ***transaction costs*** for co-operative stakeholder involvement can be high, especially in the initial phase of pilot programmes, which points to the need to translate these pilots to a broader adoption level or implementation at a larger scale so as to streamline the stakeholder engagement process. In this context, governments also need to monitor the equity and distributional effects of water reform policies on different stakeholders, and introduce appropriate safeguards and mechanisms to address these effects where they may be detrimental to both the farmer and wider community welfare.

Water property (access) rights in most OECD countries involve a complex set of rules, where water is often allocated in terms of *quantities* rather than *prices,* between users and for environmental needs. As pressures build up to reallocate water between users, this underlines the need for water access rights to become more flexible, and supporting institutions more robust to ensure an economically efficient and environmentally effective allocation of water. But it also emphasises the need to explore innovative water market solutions as allocative mechanisms. Where farmers and other users own water distribution infrastructure they may be more likely to accept an increase in water charges and higher rates of cost recovery for water delivered to their properties than when they do not own the infrastructure and increases in charges are imposed externally.

Water planning and management of water in agriculture requires funding. The specification of entitlements and the development of water markets are often pre-conditions to a well functioning planning and management system. The operation of irrigation schemes, management of entitlements within them, and the delivery and pricing of the water under those entitlements occur within frameworks administered by water resource agencies, often in the public domain, and which need to be adequately resourced. But to the extent that farmers are beneficiaries of public water delivery systems, then the marginal costs for these services should be reflected in their water charges. There should also be processes in place that can ensure efficiency in the management of public sector water delivery services.

Ensuring charges for water supplied to agriculture at least reflect full supply costs [2]

OECD analysis indicates that ***rates of cost recovery,*** mainly operation and maintenance costs, for irrigation water delivered to farmers are increasing across most OECD countries, due to a combination of (which varies in importance regionally): changes in public preferences regarding water allocation among competing uses, including meeting environmental needs; greater budgetary scrutiny by national and sub-national governments; high energy prices raising the pumping costs of an irrigation system; and increased awareness and impact of climate change and climate variability on precipitation (rainfall and snowpack) and the availability of water resources.

These issues will likely, in most cases, continue to encourage policy makers to ***increase water charges*** and explore other market-based incentives to improve cost recovery rates for water supplies and motivate further improvements in water use efficiency in agriculture. Inevitably farm-level costs will increase (although the share of water in total farm costs is in many cases not very significant), but innovative management and wise use of technology will enable farmers to adjust and generate greater value from limited water resources.

The conventional wisdom regarding ***full cost recovery*** through water tariffs (or charges), including for the agricultural sector, is that water tariffs should be sufficient to cover the full supply costs of water (including the operation and maintenance costs and the capital costs for renewing and extending the water system), and ultimately opportunity costs (scarcity value) and externality costs (economic and environmental). The principle of full cost recovery is evoked in a number of OECD countries water policy frameworks, but in reality, very few countries practice full cost recovery through water charges, even if this definition is limited to full supply costs.

In recognition of the difficulties for countries in moving toward full cost recovery, OECD has endorsed the concept of ***sustainable cost recovery*** which highlights the need to establish the water sector on a financially sustainable basis, finding the right mix between the ultimate revenues for the water sector, the so-called "3Ts": tariffs, taxes and transfers. Every country must find its own balance among these three basic sources of finance, but typically for OECD countries, with most of the agricultural sector (and domestic/industrial sectors) connected to a water infrastructure network, they largely rely on water tariffs to cover operation and maintenance costs for water supplies to agriculture.

The ***path to improved cost recovery*** may involve a phased approach, with tariffs increasing in stages to cover operation and maintenance costs, and thereafter depreciation of assets, new investment and, eventually – where relevant and possible – the externality and opportunity (resource) costs of water. Where tariffs are extremely low relative to full cost recovery or sustainable cost recovery, a gradual approach may not be sufficient and more drastic action may be called for. Increasing cost recovery rates through water tariffs also requires a comprehensive approach, which includes reforming tariff levels and structures and increasing bill collection rates, but also improving levels of service and establishing social protection measures where necessary.

There are still many farmers in some countries, and regions within countries, who benefit from policies that allow them to forego repaying capital expenditures for irrigation infrastructure, or to schedule repayment over many years with zero interest. But the number and proportion of such arrangements is beginning to decline with water policy reforms. Increasingly governments seem inclined to require marginal cost recovery for any future irrigation projects and to improve the rate of cost recovery, as much as possible, from existing projects. There is also an effort to shift from charging for irrigation water based on the *area* covered to the *volume* of water used in many countries, especially where water stress is a serious issue.

Water policies in many countries also need to address the imbalance between the current policy focus on surface water and pay greater attention to approaches that can address the ***overuse and pollution of groundwater*** and the full water cycle (*i.e.* connections between different water sources). Policies regarding on-farm water resources, mainly groundwater, usually involve licenses and other regulatory instruments, but because of high transaction costs to enforce compliance, the degradation and illegal pumping of groundwater remains a challenge. To achieve sustainable groundwater use more effort will be required to enforce regulatory measures and develop mechanisms for volumetric management and charging, which is also essential for the management of surface water, especially where water stress is a serious issue.

The ***costs of pumping groundwater*** can be expected to increase with the anticipated rise in energy prices and expected further decline in water table levels. OECD countries will likely increase their efforts to manage groundwater as scarcity increases and as the public becomes more concerned about the regional economic impacts of groundwater overdraft. But achieving marginal cost recovery for groundwater supplies is complex, as is the development of groundwater markets. The property rights issue is central in this respect.

Many irrigation areas in OECD countries face the ***problem of ageing infrastructures*** and a declining revenue base from which to fund maintenance and repair activities. The drive toward marginal cost recovery for storage and delivery services arising from water reform policies means that both water suppliers and irrigators are beginning to consider the strategic evaluation of infrastructure renewal to remain viable. This raises questions as to future sources of finance and asset management. Securing financial and investment assets may require water user groups to seek private-public partnerships to raise capital and develop skills in long term asset management for infrastructure renewal.

While higher water charges and water market formation can bring benefits in improving water use efficiency in agriculture, expectations that these approaches alone can adequately address economic, environmental and social issues related to water are often over-optimistic. This is because there remain many impediments to water market formation related to, for example, issues of equity, incomplete science, specific quantity-related property rights, high transaction costs in creating water markets, and the historical allocation of water.

The possibilities of ***using water markets and pricing*** as a policy tool to achieve environmental objectives in agriculture seem to be limited. In addressing these issues a different mix of policies may be appropriate, such as the use of well-targeted payments where farmers provide a clearly-defined and verifiable public good or service, such as wetland conservation areas. A few countries, however, are using water markets to meet consumptive (address the scarcity value of water) and environmental objectives. This includes, for example, purchasing water entitlements to rebalance water consumer and environmental needs, and public sector water purchases to supplement water supplies to wetlands. Trading of water entitlements can also provide a scarcity price in the market and lead to the highest value use of water resources.

Defining, securing and agreeing among stakeholders the quantity of water needed in a water basin to sustain environmental outcomes is a key issue for many OECD countries. This will necessitate enhancing the knowledge and monitoring of water flows and interconnections between surface and groundwater flows, and re-examining the concept of “minimum flows” as the sole measure to assess environmental needs in rivers and lakes. This is also linked to the need to improve methods for identifying natural water bodies and ecosystems that are considered to be under threat.

Improving policy integration between agriculture, water, energy and environment policies[3]

For many OECD countries policies across agriculture, water, energy and environment are formulated without sufficient consideration of their interrelationship in any comprehensive manner or their unintended consequences. Recognition (and practical implementation) of ***policy integration*** across different scales of decision-making – from the farm through to water catchment, national and international levels – is a gap in many countries. Policy coherence and integration also relates to broader national questions of which institutions make decisions to allocate water across sectors and for environmental needs.

More ***integrated and coherent policy approaches,*** however, are beginning to take shape. This is particularly evident with climate change as many countries have started to co-ordinate and integrate the previously separated policy domains of water policy, flood and drought control policies, and agri-environmental policies. For example, the restoration of land in flood plains by planting trees has helped to reduce impacts of floods, improved water quality, and led to co-benefits such as restoring biodiversity and sequestering greenhouse gases.

Agricultural and agri-environmental support policies across OECD countries provide an intricate mix of incentives and disincentives toward sustainable water resource management. The use of crop and livestock market price support provides incentives to intensify agricultural production. Additionally, support for farm inputs, especially water (lowering water charges and for on-farm irrigation infrastructure costs) and energy (for water pumping) misalign farmer incentives. This can aggravate water resource-use inefficiencies and lead to greater pollution and other environmental damage to water bodies, especially where water stress is a serious issue and the value of water is high.

Agricultural policy reforms across most OECD countries over the past 20 years, however, have led to an overall reduction in support levels (as measured by the OECD's Producer Support Estimate) and a decrease in the share of support most linked to commodity production and unconstrained use of inputs (such as water and energy). The shift to decoupled agricultural policy measures is likely to lead to a positive outcome for water resources and the environment, although the cause and effect relations here are complex.

Whether and to what extent the ***environment benefits*** from shifting to decoupled payments may depend, in part, on the use of the "saved" water. If it is used to expand irrigated land, or to shift to crops that are more water intensive, the environment will not necessarily benefit from efficiency improvements unless there is an incentive to do so (*e.g.* a regulation or market incentive). Again, the complicated set of water allocation institutions and property rights will drive this relationship. Moreover, some environmental policies have affected the supply of water for agriculture, by increasing quantities available for the environment. In sum the conclusions from current research suggests that in some countries the shift to decoupled payments has led to changes in the cropping mix on irrigated land toward less water demanding crops and/or a reduction of irrigation in areas where water stress is an issue.

Continued use of ***support for energy in agriculture,*** both directly through support for diesel and electricity use, and indirectly for feedstocks to produce biofuels and bioenergy, can increase pressure on water resources. This is most evident where support for energy, by reducing pumping costs, in some countries is leading to excessive extraction of groundwater. Removal of this form of support may contribute to more sustainable water use in agriculture.

The impact on water balances of supporting agricultural feedstocks to produce ***biofuels and bioenergy,*** however, is complex and remains unclear. It is a largely empirical question and needs to be assessed in a way that compares the effects of alternative uses of resources. However, research suggests that the quantity of water needed to produce each unit of energy from second generation biofuel feedstocks (*e.g.* lignocellulosic harvest residues and forestry) is much lower than the water required to produce ethanol from first generation feedstocks (such as from maize, sugar cane, and rapeseed), although this can vary according to the location and practices adopted to produce these different feedstocks.

Overall, ***isolating and quantifying the economic efficiency and environmental effectiveness of agricultural and agri-environmental support on water resources, is difficult,*** and further analysis on causation is needed. This is because farmers are usually responding to a very complex set of signals in making water management decisions, including institutional constraints (*e.g.* regulations on water allocations), or because the change in relative prices associated with reduced output-linked payments may cause farmers to switch to previously non-supported crops that are more water intensive than those that benefited from coupled support payments.

Enhancing agriculture's resilience to climate change and climate variability impacts

Farming systems and water resources are becoming increasingly vulnerable to climate change and climate variability, although there is significant regional variation within and across OECD countries. The most recent Intergovernmental Panel on Climate Change assessment (IPCC, 2008) and OECD government reports confirm that this trend is expected to continue.

Climate change projections make clear that changes in water availability, the timing and seasonality of precipitation, and warming, as well as the growing incidence and severity of floods and droughts, will require high levels of adaptive responses to address these issues so as to enhance the resilience of agricultural systems to produce enough food, fibre and fuel. However, it should be stressed that in some countries (that are constrained at present in terms of expanding agriculture) climate change may lead to benefits and positive opportunities for agriculture. Better understanding of climate variability and extension of risk management approaches in agriculture to existing climate variability, can help build a more solid foundation for addressing climate change in the future.

The ***increasing frequency and severity of drought and flood events*** is leading to higher budgetary costs for governments in supporting affected farmers and rural communities, and an increase in farmer insurance costs. The rising cost of flood and drought relief, for agriculture and society as a whole, is exacerbated in some cases by the fragmentation of responsibility and the lack of policy coherence in agricultural, environmental, land and water policies to address these problems.

Where farmers are guaranteed government support in times of flood and drought disasters this does not give farmers the right incentives to improve self-reliance and risk management for adverse events (moral hazard). Hence, greater policy attention and investment will be required in water control (for floods) and water retention (droughts) management. There is also a need for farm practices that can reduce economic losses and lead to better management of water flows and stocks on farmland, taking into account the impact on any water entitlements that are established.

Given the prospect for increasing ***flood events*** associated with climate change, farmland is likely to play an important role in mitigation and adaptation strategies for flood risk management. Policies that are able to combine flood risk management with other objectives, such as for nature conservation, the protection of natural resources and agricultural production, are likely to offer the best long term solutions. Even without the changes associated with climate change, the frequency of flood events has increased along with the damages. Human alterations of the hydrological characteristics of watersheds has increased runoff and narrowed channels. Land-use policies have also encouraged urbanisation in areas at risk to flooding events, and thus increased the economic cost associated with a given flood event.

Where land management practices are known to result in serious flood risk, there is a call for regulation and compliance with "good practice". In cases where farmers purposefully manage land to retain and store potential floodwater to reduce flood risk for the benefit of others, there can be scope for policies to reward them accordingly, although this may be highly localised. Integrating sustainable water resource management in agriculture within the broader context of regional land use planning is also important as a broader economy-wide mitigation strategy to address flood risks (*e.g.* the conversion of farmland to urban uses can raise flood costs as farmland has the potential to act as a flood sink).

The expectation is that ***drought events*** will occur more frequently in the future as a result of greater climate variability. So improving the resilience of agriculture to droughts will also be important, including by developing water storage capacity. It is essential in drought prone areas for agriculture to improve its water use efficiency (or even consider abandoning agriculture completely in more extreme cases), in part, to free water for other users and environmental purposes. This might be achieved through:

- Reducing leakages in delivery systems;
- Developing on-farm rain harvesting practices and systems, *e.g.* conservation tillage;
- Making greater use of recycled sewage and drainage water and desalinated water;
- Improving soil moisture measurement;
- Increasing adoption of efficient water application technologies, such as nanotechnologies;
- Encouraging greater adoption of drought-resistant cultivars; and,
- Recharging groundwater during times of low seasonal water demand.

In many cases these practices and technologies to make water savings are already known. However, it is the barriers to their adoption, such as a lack of farmer training, that are an important challenge for policy makers.

Addressing knowledge and information deficiencies to better guide water resource management

Improving the effectiveness and efficiency of policies to achieve societal goals related to water requires better information at many levels. This is especially important because water reforms are tending to become more decentralised and complex, while management of water in agriculture is highly diverse. Achieving cost recovery targets, developing water pricing and trading mechanisms, clarifying water entitlements and changing institutional arrangements, need to be underpinned by more and reliable information.

A substantial effort is underway in many OECD countries to address information deficiencies to better guide policy making, taking into account specific natural conditions and historical backgrounds. Encouraging examples are the monitoring of minimum water flow rates in rivers as part of environmental planning, and comprehensive river basin assessments being undertaken in a number of countries. However, considerable information and knowledge gaps still remain. In five areas improvements in knowledge, science and monitoring of water resources in agriculture could help to better inform policy makers, stakeholders and the wider public:

- ***Improving the knowledge of the interrelationships between agriculture and water availability,*** and between surface water and groundwater flows.
- ***Establishing robust databases on trends in water resource availability and use,*** including use by agriculture. This encompasses data on the sources of water used; improved calculations of the physical and economic efficiency of water use in agriculture; and a better understanding of the links between on-farm water use and off-farm environmental impacts.
- ***Increasing the quantity and quality of information on cost recovery rates*** for water supplied to agriculture, as considerable caution is required in using and comparing data on cost recovery rates and agricultural water charges, both within and between countries.
- ***Developing information systems and tools to better inform water management allocation decisions.*** This applies at the: strategic planning level, in order to optimise the planning of irrigation infrastructures, such as information systems to assist planning decisions in the face of increasing climatic variability; tactical level, to identify the optimal allocation of water for a given period (season, year); and at the operational decision making level, to optimise water distribution at the farm level. The latter also requires improvements in the tools to manage water systems, such as providing technical information and advice, and offering farmers educational programmes on best practices to adopt, especially as climate change impacts may require changes to current farm practices.
- ***Undertaking evaluation of the impacts of policies on environmental and economic outcomes in the context of agricultural water resource management.*** This would provide a contribution to broader based agri-environmental policy evaluation, such as the need to better understand the link between agricultural policies and water use efficiency. Aside from academic research of these linkages, there is little evaluation by governments of the environmental effectiveness and economic efficiency of agricultural water resource management policies. Quantifying the net costs and benefits of water resource use by agriculture in a sustainable development framework is a necessary component, and requires attention to the "soft" infrastructure – meters, stream gauging networks, hydrologic and scientific support, water reporting systems, farm surveys, and benchmarking of irrigation businesses.

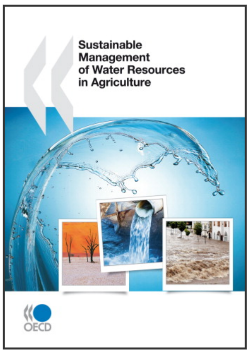
None of the information requirements described above are obtained cheaply or easily. But without better information policy reforms will be at a disadvantage and effective water policy decision making, planning and management could be impeded.

Notes

1. Agriculture and water quality linkages are not covered in this report, but will be the focus of a forthcoming (2011) OECD study.

2. Full water supply costs include operation and maintenance costs and capital costs, covering both renewal of existing water supply infrastructure and new capital investment costs for water supply infrastructure, see Figure 1.4.

3. It is beyond the scope of this report to provide a comprehensive analysis of the integration and linkages between agriculture, water, energy and environmental policies: for example, in the energy context the focus here is mainly on the water demand from growing energy crops and not the links between irrigation and hydro-electric power (dams).



From:

Sustainable Management of Water Resources in Agriculture

Access the complete publication at:

https://doi.org/10.1787/9789264083578-en

Please cite this chapter as:

OECD (2010), “Summary and Recommendations”, in *Sustainable Management of Water Resources in Agriculture*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/9789264083578-2-en

This work is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of OECD member countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org. Requests for permission to photocopy portions of this material for public or commercial use shall be addressed directly to the Copyright Clearance Center (CCC) at info@copyright.com or the Centre français d’exploitation du droit de copie (CFC) at contact@cfcopies.com.

OECD