UK-China Sustainable Agriculture Innovation Network

Policy Brief No. 14 July 2016

Mitigation of diffuse water pollution from agriculture in England and China, and the scope for policy transfer

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Key Messages

- To mitigate diffuse water pollution from agriculture (DWPA) in China, the right mix of complementary policy approaches is needed (Figure1 and list below).
- The public agricultural extension service is relatively well resourced and is the primary means available to mitigate DWPA. The extension service needs re-orientation and re-skilling to help farmers maintain and increase agricultural productivity whilst balancing this with environmental protection. A new ethos of input use efficiency and environmental stewardship of natural resources is needed, based on 2-way knowledge exchange with farmers.

Four policies to achieve this are:

1. **A 'reference level' of enforceable regulation for all large commercial farms** is needed. This can be transposed from existing laws with appropriate variation by farming system and region. Intensive livestock units have the greatest potential to cause significant pollution and take first priority. Resources for monitoring and enforcement of regulation are limited, but as land transfer and farm consolidation continue in accord with local needs, regulations for use of manure and chemical fertiliser in arable systems can be developed for large farms.
2. For small farms monitoring and enforcement of regulations is difficult. Simple, locally well-adapted guidelines are needed. Adoption by farmers must be achieved through **an accredited advisory and voluntary approach developed by the public agricultural extension service** and its wider agricultural knowledge and innovation systems partners.
3. **Targeted incentive payment schemes** should be used strategically to protect water resources from DWPA in key locations. For example, payments for retirement, or low intensity use, of vulnerable land adjacent to watercourses or in aquifer recharge zones used for water supply.
4. To support these approaches more **applied research is needed to build an accessible and comprehensive knowledgebase**. This should span, for example, from methods for public participation, through design of regulation and incentive payments, to design and costing of farm best management practices and estimation of modelling coefficients empirically derived for conditions in China.

- None of these approaches are completely absent from China and attempts at international policy transfer or 'lesson-drawing' must consider what can be better developed rather than what could commence. Innovation in farmer participation, advice provision, design of incentive schemes, data sharing and applied research are leading examples.

The importance and focus of this briefing paper

Water pollution from agriculture is a threat to water security (Vorosmarty et al., 2010). In England, the water quality and ecology of water bodies is slowly improving (Gov.UK, 2016a). In China water pollution remains severe with more than 61% of groundwater and 28% of surface waters in the main river basins classified as unfit for human use or contact (China Water Risk, 2015). Agriculture is a major cause and the source for 57% of nitrogen and 69% of phosphorus water pollution (MEP, 2010). There is an urgent need for an improved policy framework. This briefing defines a generic policy framework, evaluates policies for mitigation of DWPA in England and China, and assesses the potential for international lesson drawing.

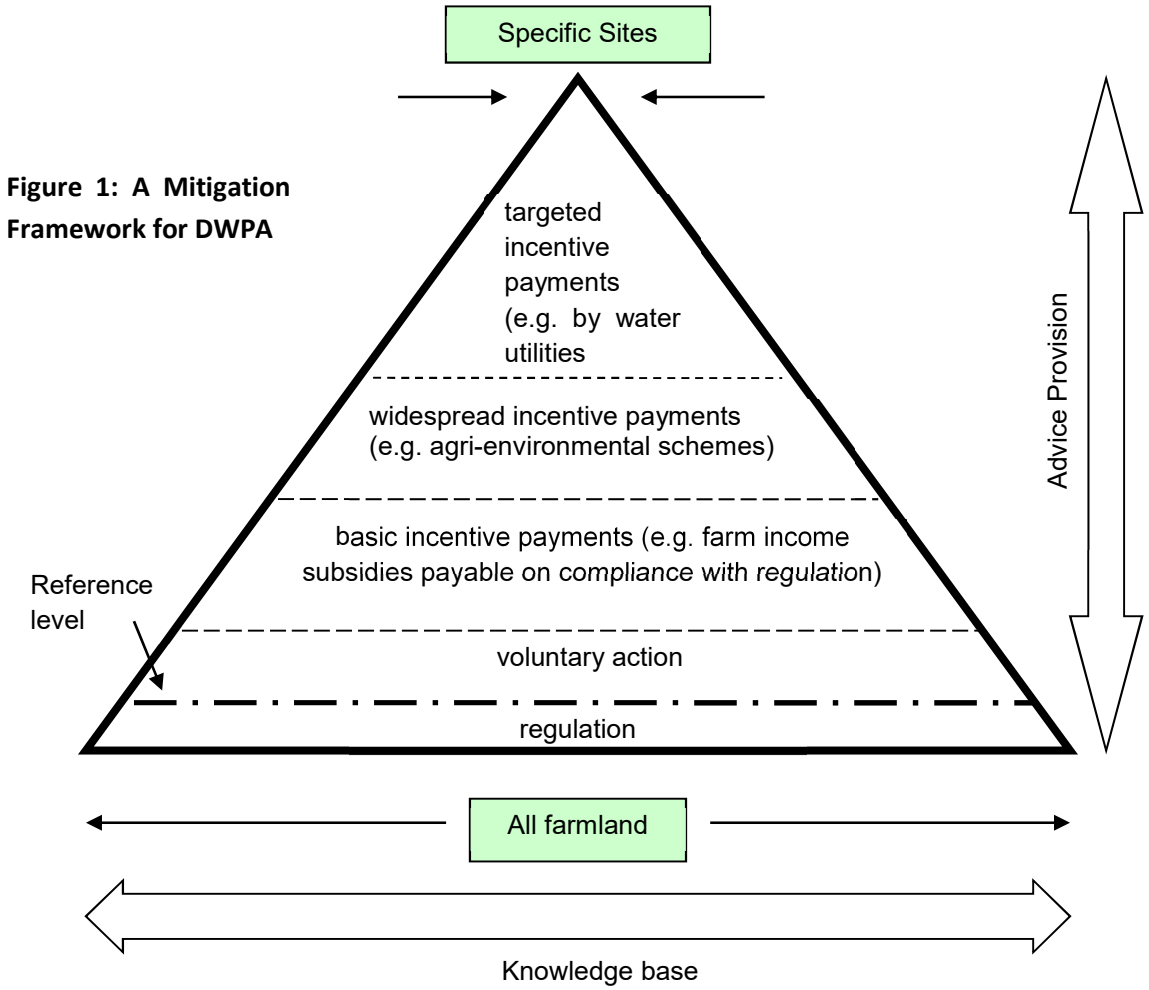

Figure 1: A Mitigation Framework for DWPA

Source: adapted from Baldock and Beaufoy, 1992.

A mitigation framework for DWPA

DWPA is a difficult challenge for public policy. Bio-physical uncertainties and the temporal and spatial characteristics of DWPA render a solely regulatory approach costly if not impractical (OECD, 2012). Also, although farming can cause negative environmental impacts it produces food and fibre, and can be managed to produce other beneficial ecosystem services. Thus government must determine how the costs of mitigating pollution from agriculture are to be shared. Experience shows that a mixed policy approach is required in which regulation of farming practice is complemented by economic incentives and advice provision to promote voluntary action. Such a mix can outperform a single instrument such as a pollution tax (OECD, 2012), but must be supported by sufficient scientific evidence. Including this knowledge base, the mix can be termed the 'mitigation framework for diffuse water pollution from agriculture' (Figure 1).

In Figure 1 regulations are applied widely to establish a 'reference level' of farming practice (Scheele, 1999) that divides environmental standards that farmers are expected to meet at their own cost from higher

standards for which society is willing to provide remuneration (or at least compensation for income foregone). Meeting the 'reference level' is thus a 'compliance condition' to receive such remuneration (Weersink and Livernois, 1996). Clearly the regulations must be practical and enforceable. Voluntary action and incentive schemes can then be overlaid to achieve higher environmental standards, but with an increasing degree of spatial targeting. Voluntary action can be altruistic, but more often farmers adopt practices that offer time or cost savings as well as environmental benefits. Provision of advice can facilitate compliance with regulation as well as adoption of voluntary and incentivised measures. The national knowledge base is similarly an essential supporting resource, providing policy makers and farm advisors with information on how to target DWPA mitigation measures, outcomes, costs and farmer responses. Other policies are possible – e.g. water quality trading schemes and pollution taxes - but the costs and difficulties of measuring DWPA tend to exclude them. A tax on the inputs that cause emissions is feasible but must overcome inelastic demand for inputs such as fertilizer and farmer resistance. Not shown in Figure 1 is the need to remove or reduce the effect of policies that raise farmgate prices or subsidise polluting inputs, as these may drive intensification whilst neglecting variation in landscapes, farming systems and environmental capacity to mitigate and absorb pollution (OECD, 2012).

The mitigation framework for DWPA in England

Figure 1 corresponds to policies in England in 2016. Numerous and detailed regulations cover the storage, handling and application of pesticides, inorganic fertilisers and manures, and management of soils. Farm inspections are carried out to ensure compliance with standards, although the cost effectiveness of these has been criticised (NAO, 2012). Government agencies have advised farmers and supported farmer-led voluntary initiatives for environmental protection. Voluntary action by farmers is also motivated by the advice and technical assistance provided by NGOs. Foremost in this are registered charities, including rivers trusts, wildlife trusts and other farm advisory groups that source funding from governmental (UK and EU) and private sources. There has been success in development of practices that are more efficient and protect water. For example, fencing of streams, clean and dirty water separation in farmyards, re-location of feeders and tracks, and precision use of fertilizers and chemicals. Many farmers/farm managers are also highly trained and experienced, particularly for larger commercial operations, and capable of innovating cost saving and environmentally beneficial practices.

Agricultural knowledge and information systems (AKIS) in England are highly diverse and decentralised, spanning inclusively from farmers to government funded research stations, with 80 or more sources of advice to land managers (Prager and Thompson, 2014, p.8). The Fertiliser Advisers Certification & Training Scheme (FACTS) of the Agricultural Industries Confederation (AIC) is notable. This sets standards, provides training and accredits advisers who provide nutrient management advice. Over 2500 advisers have voluntarily gained the qualification, demonstrating farmer demand for high quality advice to optimise crop nutrition whilst protecting soil, water, air and biodiversity.

The Basic Payments Scheme (BPS) under the EU Common Agricultural Policy has provided support to farm incomes. To receive this farmers have had to comply with 'reference' standards for public, animal and plant health, animal welfare, the environment, climate change, and good agricultural condition of land. This 'cross-compliance' condition has included some basic measures to protect water. The Countryside Stewardship scheme has then more selectively incentivized farmers to further provide environmental goods, including further water protection. In a few examples the private sector has also incentivised water resource protection. The leading examples are payments and capital grants from water companies for farm measures that enhance water retention in uplands and reduce DWPA in drinking water source areas.

The national knowledgebase informs the design and implementation of this policy mix. The effectiveness of DWPA mitigation measures at a field scale is documented for different farm types (Cuttle, et al., 2016). Knowledge of catchment scale responses is weaker and more uncertain. On-going research through 'demonstration test catchments' is addressing this (McGonigle, et al., 2014), and novel spatial environmental science and modelling approaches are being used to assess pollution risks, pressures and mitigation strategies at a catchment scale (Holden, et al., 2016). Guidance and case studies have also been compiled to assist development of PES-based schemes (e.g. Smith et al., 2013).

The Mitigation Framework for DWPA in China

China lacks farm-level regulation for mitigation of DWPA comparable to that in England. This is inevitable given the number and size of farms and their role in economic development, but the proportion of land farmed in larger units is rapidly increasing, and central government is strengthening laws, monitoring and enforcement to address environmental degradation. However, 'top-down' regulatory intent is often 'decoupled' from ability for implementation and enforcement at lower level; reinforced by a continuing 'growth-first' mentality amongst local authorities (Smith and Siciliano, 2015). Most areas lack well-adapted standards for: livestock waste treatment, storage and disposal; utilization of manures; carrying capacity of land; and need for riparian buffer zones. Enforcement of regulation that does exist is inconsistent across regions and penalties are usually insufficient to ensure compliance.

To date, 'eco-compensation' programmes have focused on provision of watershed ecosystem services from land use change in upper catchments. Payments are made to farmers who take land out of crop production to reduce deforestation, soil erosion and rural poverty rather than DWPA *per se*. More DWPA focused is the Paddy Land-to-Dry Land (PLDL) programme that aims to protect water quality and quantity for the Miyun reservoir that serves Beijing. Farmers are paid to convert from flooded rice to dryland cropping to reduce water consumption and fertilizer and sediment runoff (Zheng et al., 2013). Eco-compensation programmes have shown success, but targeting, design, environmental outcomes and sustainability have sometimes been poor, and programme cost effectiveness has been questioned (Zhen and Zhang, 2011).

The scope for voluntary action by farmers to mitigate DWPA in China is limited in many arable and horticultural systems by farm and plot size, income levels, prevailing knowledge, attitudes and practices (in part age and gender related), and increasingly by labour constraints (Smith and Siciliano, 2015). There is more scope in large intensive livestock and arable farms and these are growing in number. Great potential to improve the efficiency of farming practice whilst maintaining productivity and reducing risk to the environment does exist. For example, management of soils, manures, chemical fertilizer and irrigation could all be improved to more closely match crop requirements and reduce risk of losses to air and water (e.g. Chen et al., 2014). This emphasises agricultural knowledge and innovation systems (AKIS) and their ability to change farmer behaviour through advice, training and access to technologies. Large in terms of staffing and number of township stations the public agricultural extension service (PAES) is the leading resource available to government for mitigation of DWPA. However, many observers are critical of its performance. They note: low responsiveness to community and farmer needs; insufficient information provision and use of information technology in remote areas; functional specialisation and 'silo-working' at Ministerial, provincial, municipal and county levels (though at township level a single station usually implements all extension activities); and lack of coordination and scientific consensus with universities and research institutes. The latter need to be faced with applied questions and problems delivered from the farmers in order to carry out and communicate the most relevant research (Rahn, 2013); yet incentives for researchers favour journal publications over knowledge transfer to farmers; whilst the Ministries of Education, Environmental Protection and Agriculture lack alignment of strategies and policies.

Farmers are passive recipients of recommendations with little formalized opportunity to feedback priorities and needs. Efficiency in input use and environmental protection remain low priorities in rural areas and the PAES remains strongly focused on productivity, lacking strategies to balance this with environmental protection. For example for DWPA, without relevant regulation and publicly available data for ground and surface water quality, there are no 'reference levels' against which to set advice and training, or evaluate achievement. Similarly, relevant research is fragmented, lacks coordination and is not being compiled in the form of an accessible knowledge base for use by the PAES and wider AKIS. At local level the education level of extension agents is relatively low and they lack well-adapted 'messages' for mitigation of DWPA.

The potential for international lesson drawing

China has at least some experience of all of the elements of the mitigation framework in Figure 1, and lesson drawing and potential policy transfer can focus on what can be better developed. Table 1 assesses constraints to this. The generic aim of practical and enforceable farm level regulation that establishes a 'reference level' of good practice in relation to DWPA across varied farming systems can be drawn from Figure 1 and international examples, but the actual regulatory regime to be developed must be unique to Chinese conditions. In particular, scale and income level may limit the compliance-related costs that can be imposed on small farm units. Other constraints to better farm regulation are communication, data sharing and coordination gaps across agencies, the diversity of China's physical geography and farming systems, and resources for monitoring and enforcement. In particular, constraints to publication and sharing of data are barriers to improvement in agency cooperation. The strengths and weaknesses of data sets, including meta-data and sampling methods, are rarely shared; and experts may remain unaware of data available beyond their own organisation. Applied research is needed to build an improved, accessible and shared knowledgebase.

The PLDL programme is indicative that demand for 'eco-compensation' schemes to protect drinking water supplies may grow, at least among municipalities. However, wide application of something like the Countryside Stewardship scheme in England may be constrained by a lack of ideological consensus. Key tenets of Figure 1 – e.g. the 'polluter pays principle', a 'reference level' for farming practice and targeting of incentive payments – may not yet be shared and accepted by a majority of stakeholders in China. Incentive schemes need to be well adapted to Chinese conditions, locally varied (Zheng et al., 2013) and innovative in their institutional arrangements. Lessons from international experience can certainly help inform this. For example, on methods to ensure cost effectiveness such as spatial risk mapping and modelling to identify land within a catchment with the most potential to buffer water resources from DWPA, and on design of payment regimes that ensure long-term land use change and limit reversion to previous practice.

Table 1 suggests that there are fewer constraints to drawing lessons from international experience to improve the effectiveness of advice provision and voluntary action in mitigation of DWPA. The PAES is relatively well resourced and has a clear and hierarchical institutional structure. There is potential to reform its priorities, ethos and modes of working to promote environmental protection alongside productivity in farming. It also has the potential to coordinate and quality assure other actors' activities within the increasingly diverse AKIS developing in China. However, the trust held by farmers in the PAES needs improvement and lessons can be learnt from adviser training and accreditation schemes such as FACTS in England. China also lacks the NGOs, and their partnerships with government agencies, that have played a key role in advice provision for mitigation of DWPA in England. There is further scope for lesson drawing to inform efforts to improve the knowledgebase for mitigation of DWPA in China. In England, information resources in the form of manuals and databases, experience of public participation, the demonstration test catchment programme and catchment modelling methods all provide examples to inform efforts in China seeking to apply its growing research outputs in coherent support of environmental protection policy.

Table 1: Assessment of constraints to international lesson drawing for mitigation of DWPA in China

	Policy approaches		
Constraints to lesson drawing	**Regulation**	**Incentive payments**	**Advice provision/ voluntary action**
Policy demand	*Growing demand*	*Low but protection of water supply to become a driver.*	*Lacks articulation from the top-down; weak from the bottom-up.*
Policy resistance	*Low*	*Low*	*Low to moderate*
Path dependency	*Low*	*Moderate*	*Low to moderate*
Existing structures	*High structural density*	*High structural density*	*Low structural density*
Political context	*Low politicisation*	*Moderate politicisation*	*Low politicisation*
Resources	*Resources inadequate*	*Inadequate beyond water supply zones*	*Resources adequate*
Ideological consensus	*Moderate consistency*	*Moderate consistency*	*Consistent*
Programmatic uniqueness	*Generic purpose but unique in detail.*	*Unique programmes*	*Generic purpose but unique in detail.*
Programmatic complexity	*High*	*High*	*Moderate*
Institutional comparability	*Disabling*	*Disabling*	*Disabling*
Scales of change	*Potentially large in scale.*	*Moderate to large*	*Small*
Programmatic modification	*Relatively low for generic purpose, but high for detail.*	*Relatively high*	*Manageable and iterative.*

Source: adapted from Benson, 2009.

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