



Wastewater-reuse and poor livelihoods in peri-urban Kolkata

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AQUACULTURE AND HORTICULTURE practices exploiting wastewater resources in PU Kolkata were developed and refined by farmers; Bunting, Kundu and Mukherjee (2001) present a review concerning the evolution and present status of these production systems. Currently, the pond area managed for wastewater aquaculture extends to nearly 3,500 ha, divided into several hundred fisheries. Various historical reasons and government interventions have contributed to the scale and distribution of land holdings in the area, furthermore, landowners are commonly absentee landlords and management of the fisheries is largely undertaken by leaseholders; others are operated by fishermen's cooperatives and groups and a small number are under government control. Recently it was estimated that ponds managed for wastewater aquaculture produce $\sim 13,000 \text{ t y}^{-1}$ of fish for sale in urban markets, many of which service poor communities. Estimates have also suggested that horticulture, commonly irrigated with wastewater, occupies an area of $\sim 320 \text{ ha}$, and that vegetable production from this area may be up to $370 \text{ t ha}^{-1} \text{ y}^{-1}$; many vegetable growers also exploit inputs of solid waste from the city to enhance production, maintain soil quality and inhibit weed growth.

Further to producing significant quantities of fresh produce for urban and PU markets, it is widely acknowledged that these farms provide direct and indirect employment for several thousand people, and that managed wastewater reuse provides a valuable service to society, reducing health risks from unregulated discharges and protecting downstream environments. Regardless, however, producers face several threats to the continued operation of their farms, whilst a limited willingness to invest time and money in maintaining and enhancing their farms due to growing insecurity makes them more vulnerable to emerging constraints. Considering the benefits, particularly to poor communities, and growing constraints facing producers, it was apparent that a primary objective of research in this region should be to generate new knowledge on both the direct and indirect benefits PU farming affords society, and to communicate this effectively to senior government officials and development agents. This could increase prospects for policies and development plans that ensure the continued operation of the various production systems and encourage initiatives to enhance the efficiency and quality of production on these largely traditional farms.

Research strategy

Failure of past research to address constraints facing producers and poor communities, or to communicate findings

effectively to policy makers and development agencies, has caused widespread scepticism amongst certain stakeholder groups regarding further studies. Considering this legacy and the complex physical, institutional and social nature of PU areas, it was apparent that an effective research project would need to engage with a range of stakeholder groups, using appropriate research tools, to identify opportunities to enhance poor livelihoods, which are mutually acceptable, and ideally benefit all stakeholder groups.

Consolidating the significant body of research concerning farming practices in PU Kolkata was the first step to identifying key knowledge gaps (Bunting et al., 2001). Subsequent project activities have consequently focused on generating new knowledge on the contribution of PU farming, both directly and indirectly, to livelihoods in poor households and communities, and emerging constraints threatening the continued operation of the system. A key component in the research process was a workshop where the participation of representatives from several stakeholder groups was encouraged (Bunting, Kundu, Punch and Little, 2001). Important outcomes from this meeting included new knowledge on poor groups that benefit from PU farming, leading to more targeted household interviews and focus groups, and information on the diverse stakeholder groups associated with PU Kolkata, which assisted greatly in facilitating the institutional assessment. The workshop also contributed to initiating a constructive dialogue with several stakeholder groups and target institutions.

In addition to working closely with respected local researchers, access to poor communities was facilitated partly through interviews undertaken with farm managers, where the number and background of people whose livelihoods depend either directly or indirectly on farming systems at the Kolkata PU interface was assessed. Outcomes from this work were used to guide a more focused assessment of the benefits poor people derive from PU farming. Based on knowledge from both the stakeholder workshop and farm manager interviews, selected poor groups were identified and representatives invited to participate in household interviews and focus groups to share perceptions of their livelihoods and discuss constraints and opportunities. Emerging constraints identified during this project phase are discussed further below. To ensure outcomes and recommendations are disseminated effectively a constructive dialogue with stakeholder has been fostered through workshops, participatory research approaches and a process of institutional analysis. Representatives from various stakeholder groups, including government

agencies, producer associations, development agencies, NGOs and CBOs were interviewed to better understand their perceptions of PU farming, policies and agendas that govern PU natural resource management and constraints and opportunities they considered important. Other project activities included assessments of market networks in supporting poor livelihoods and the role of products from PU farming in the food security of poor households and communities; consumers are also being interviewed to assess their perceptions of products from PU farms. In all activities particular emphasis has been given to the influence of the PU setting and role of age and gender in regulating access to different livelihood strategies. Formulation of an effective communication strategy for project outcomes, resulting in appropriate media for target institutions and key stakeholders was also regarded as crucial to project success, and increasing prospects for developing PU natural resource management strategies that benefit the poor.

Although largely successful in engaging with diverse stakeholder groups associated with farming in PU Kolkata, limitations were noted with identifying representatives from all groups and bringing together stakeholders with different backgrounds. During the project workshop it was obvious that a great deal of attention must be given to the timing and location of the meeting, the format of presentations and activities, including differences in language and terminology, and ensuring that less vocal or confident participants are able to express their opinions and concerns. The diverse nature of media considered useful by

participants presents a dilemma as practical restrictions prohibit producing all the media requested. However, taking account of the project aims and an understanding of the likely contribution of particular stakeholder groups to achieving these, it should be possible to prioritise and target outputs.

Outcomes and knowledge for policy makers

Having undertaken a literature review, stakeholder workshop, farm manager survey, institutional assessment and several household and focus group interviews, it is apparent that the PU Kolkata environment is characterised by complex physical, political and social arrangements, which are greatly influenced by processes of urbanisation, and changing access to natural resources, including wastewater and solid organic waste. Furthermore, emerging constraints, outlined in Table 1, may seriously threaten the continued operation of traditional wastewater-reuse farming practices. Siltation of canals and ponds, decreasing access to wastewater (and solid organic waste) and declining quality, increased contamination, potential changes in wastewater treatment and distribution, urbanisation, changing consumer perceptions, excessive labour union demands and restrictive conservation measures all represent potential constraints. Furthermore, although potential management strategies to mitigate such factors may be proposed, the consequences of untested approaches are not always predictable and may in turn create problems. The limited

Table 1. Emerging constraints to the viability of farming systems exploiting wastewater in PU Kolkata and potential management strategies

Constraint	Potential management strategies
Siltation of canals and ponds	<ul style="list-style-type: none"> - desiltation of canals and ponds, using sediment to enforce embankments and off-site as fill for construction sites - primary effluent treatment to reduce suspended solids load entering drainage network and ponds
Decreasing access to wastewater	<ul style="list-style-type: none"> - renovate canal network and increase pumping capacity, permitting wastewater transfer to secondary canals servicing fisheries
Increasing industrial contamination	<ul style="list-style-type: none"> - improved planning, discharge standard enforcement, treatment, HACCP and product monitoring
Advanced wastewater treatment plant	<ul style="list-style-type: none"> - increase wastewater supplied to ponds or provide supplementary nutrients to sustain production
Wastewater from new urban developments	<ul style="list-style-type: none"> - re-engineer distribution network to accommodate new and existing flows
Changing consumer perceptions	<ul style="list-style-type: none"> - promote strategies to limit health risks, HACCP, monitor products to reassure public and provide consumers with guidance on storing and preparing products from PU farms

capacity of most farmers and households in PU Kolkata to pre-empt and plan for many of the emerging constraints means that traditional farming practices, and the poor that depend upon them, are increasingly vulnerable. Initiatives to increase the capacity of local communities and farmers to assess and manage emerging and unforeseen problems are therefore required; it is anticipated that knowledge from the current project could contribute to this processes of awareness raising and empowerment.

Constraints to further research

Resistance to further research may represent a significant constraint to testing enhanced management strategies such as those proposed in Table 1 and developing action plans that meet the demands and expectations of stakeholders, particularly those poorly served by existing approaches to policy formulation. To overcome this, prior to further research, it would be advisable to consult with local stakeholders and target institutions to assist in both assessing the existing knowledge base and to prioritise specific research areas. Such an approach would engender greater ownership and may yield more valuable outcomes. Inappropriate and extractive research methods, poorly targeted investigations and the replication of studies has further alienated stakeholders in PU Kolkata. One strategy to avoid such problems would be to convene a steering committee to oversee the research process; the multi-disciplinary committee, consisting of representatives from key stakeholder groups could develop a research and development strategy for the PU region to address priority issues, evaluate research proposals and communicate findings to appropriate policy makers and implementing agencies. The strategic perspective of the committee should ensure resources are targeted at key development constraints and prevent replication of effort. Furthermore, approval from the committee may reassure participants that knowledge generated would be used effectively to formulate policy and bring about substantive livelihoods enhancement. Additionally, the committee would be beneficial to strategic development planning at the Kolkata PU interface more generally, providing a point of contact for external agencies wishing to support research and development in the area. Encouraging diverse stakeholder groups to participate on the committee would permit local agencies and institutions greater ownership of research undertaken and help avoid conflict between institutional bodies. The committee would command a strong position to promote commissioning of research to address emerging threats to PU farming systems and to safeguard livelihoods that may otherwise be vulnerable. However, despite its potential, such an approach would require broad-based support from stakeholders including policy makers, producers and local communities, and to achieve such support it may first be necessary to reach a consensus amongst these different groups concerning the objective and functioning of the committee.

Implications of changing access to PU natural resources

Preliminary discussion with farm managers revealed that the perceived nutrient status of the wastewater resource had decreased following the removal of cattle sheds from the city. Furthermore, as part of the forthcoming ADB-DFID funded CEIP (Calcutta Environmental Improvement Project), engineers are proposing to construct an extended aeration wastewater treatment plant to remove potentially harmful substances from wastewater flowing through PU Kolkata. However, treatment using this process is likely to remove a significant proportion of the nutrients present in the wastewater, whilst pathogen removal may be variable. Consequently, access to nutrients by producers is likely to decline, whilst using more water to deliver the required nutrient levels to fishponds and irrigated agriculture will increase costs and may increase risks from pathogen transfer and microbiological contamination. Under such circumstances, alternative management approaches involving feeds and fertilisers to produce larger fish may become appropriate, however, the strong position of labour unions makes changes to management practices problematic and may require negotiation with unions, retraining of labour, etc.

Bioeconomic modelling could provide an insight concerning likely impacts of changing wastewater quality or modified farming practices on production and financial returns, enabling producers to refine their management and providing knowledge to inform influential labour union bosses. The model may also be employed to assess likely microbiological impacts of alternative wastewater application strategies. The contribution of a multi-disciplinary stakeholder committee, including labour union representatives, in guiding research could be crucial in facilitating the assessment of strategies to enable the equitable implementation of such changes. Furthermore, results of such research are more likely to be implemented having been sanctioned and overseen by union representatives together with other stakeholders. A question also remains as to whether extended aeration is the most appropriate treatment process for wastewater that is valued as an input to farming systems; Mara, Edwards, Clark and Mills (1993) described a lagoon-based treatment approach that optimised pathogen removal whilst limiting nutrient retention; such a strategy may be more appropriate for Kolkata. Changes in access to municipal solid waste have also been reported and as capacity at the commercial organic composting plant increases, the quality and quantity of solid waste resources available to PU farmers is likely to further decline. This too may lead to a higher requirement for waste applications to maintain production, heightening risks from microbiological contamination and increasing associated transport and waste handling and sorting costs. Furthermore, reduced access to solid waste and a shift to inorganic fertiliser may have negative impacts on soil quality and permit colonisation by weeds; consequently research on enhanced management practices may be required to mitigate against such negative outcomes.

Safeguarding public, producer and environmental health

Public perception and food safety issues may be critical to continuing consumer acceptance of products from PU farms. Furthermore, safeguarding the health of poor labourers may make a significant contribution to enhancing their livelihoods and those of their families. Generally good hygienic practice and food preparation by Bengalis has been proposed as one mitigating factor that reduces the risk of food-borne illness from aquatic products. However, with a growing immigrant population in both urban and PU Kolkata, dependence on such cultural facets may no longer be adequate. Therefore a public information exercise, at markets and in the mass media, to inform consumers of general food safety issues, particularly the storage and preparation of aquatic products, could have a significant impact. Furthermore, where management practices are modified due to changing access to waste resources, health risks associated with traditional farming practices may change significantly as prior safeguards, precautions and mitigating factors are rendered obsolete. Development and implementation of a HACCP (Hazard Analysis and Critical Control Point) framework for farms reusing wastewater could make a significant contribution to improving both the health of workers and food safety. Furthermore, HACCP could be used to identify changes in health risks associated with modified management practices, and consequently opportunities to avoid such problems. Such an initiative could also extend beyond waste management, to include other health and safety issues at work, and possibly personal and household health. HACCP appears preferable to product monitoring due to the logistics of sampling and testing produce which is sent daily to market by the large number of PU producers, the complex and disparate distribution networks involved and the limited capacity of institutions with facilities to implement such a programme. Although desirable, several limitations have been suggested, constraining development of HACCP for small-scale farmers, therefore, only by working together may producers be able to formulate management plans that minimise risks to the environment, workers, local communities and consumers. Furthermore, given the need to base HACCP on sound scientific principles, it is evident that local government agencies and NGOs would have important roles in monitoring the system, identifying critical control points and assessing the magnitude of risks posed.

Summary

Working closely with several stakeholders and using appropriate research approaches has assisted in developing a productive dialogue with the various groups, thus enhancing the likelihood of project findings being appropriate for stakeholder needs, and of outcomes being used to develop natural resource management strategies that benefit the poor. With suitable adaptations it is proposed that the research approach outlined in this paper should be suitable for studies in other PU areas. However, the key to implementing successful research in such areas appears to be a multi-disciplinary approach, ongoing dialogue with varied stakeholder groups, and where possible, the involvement of beneficiaries and target institutions in planning, implementation and evaluation.

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