Incentives that work for farmers and wetlands - a case study from the Bhoj wetland, India

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Executive summary
Improving water management for environmental conservation and rural development goals is a global policy challenge. A common problem involves upstream agricultural land use practices reducing water quality for downstream water users. One approach to overcome such problems is to compensate land managers providing environmental services with an incentive to modify land use behaviour which is paid for by downstream users' associated benefits or cost avoidance. Understanding which incentives will motivate desired and feasible land use management change is central to designing effective and sustained institutional arrangements that work for upstream land managers and downstream water users.

Research at the Bhoj wetland in India has investigated exploratory scenarios to estimate incentives which influence upstream farmers' willingness to switch to organic farm management to contribute to improved wetland management. Results indicate that farmers will adopt organic land use management across a range of crop prices subject to farm location, farm size and preference grouping. Farmers are more likely to work together to certify their land if there is a differential between group and individual land certification costs. Two groups of farmers are identified with a polarised willingness to accept land use change incentives. Policy action is specified based on the key findings.

Key words: choice experiment, environmental services, India, rural development, wetland management

CONTENTS

1. Agriculture, wetlands and rural development

Improving water management for rural development and environmental conservation goals is a global policy challenge. It is particularly acute in Asia which is home to 60% of the world's population but has access to 36% of renewable freshwater supplies (UN, 2005). This imbalance is manifested in competitive groundwater pumping by India's farmers, who are rapidly lowering water tables, and increasing conflicts over shared surface water flows (Postel and Wolf, 2001). A cause of growing water tensions is the central role of agriculture in rural economic growth. In India, the development benefits of the Green Revolution and 'Grow more Food' programmes have significantly increased the application of agro-chemicals to cropland since the 1970s, which has been fuelled by input subsidies and access, and free electricity for farmers to pump groundwater to grow a second or third annual crop (World Bank, 2003). This partly reflects the importance of rural development goals and the influence of the rural constituency in India as reflected by the failure to estimate the power and discontent of the rural vote in the 2004 election and the in-coming Prime Minister's pragmatic response that: "our vision of Indian agriculture continues and will continue to be based on smallholder farming[1]. "

Demand for agricultural water use for food, employment and rural development goals often focuses policy attention on water allocation issues rather than the impacts of agriculture on downstream water users, which can be large though may be uncertain. Uncertainty arises due to four characteristics of downstream water impacts: a) the costs are often neglected; b) there is often a time-lag; c) damage may affect groups who are not adequately represented; and, d) the identity of the polluter may be difficult to identify (Pretty et al., 2001). These characteristics often contribute to sub-optimal economic and political decisions. For example, the external costs (and benefits) that farmers create for downstream consumption and production decisions by their use of inputs or production of output have been estimated to be US$1.8 billion in natural resource damage (and US$1.35 billion[2] in environmental service benefits) annually in the UK (Environment Agency, 2002).

[1] Interview with Dr. Manmohan Singh, Prime Minister of India, March 2005, available at: http://www.ifpri.org/pubs/newsletters/ifpriforum/200503/if10Singh.htm
[2] Exchange rate: GBP£1 = US$1.5

Upland agricultural land use also poses threats to biodiversity, such as wetlands, which are impacted by agricultural runoff. Wetlands provide a wide range of environmental goods and services including drinking water, fish, food and fuel. They protect against floods and droughts and may have other important socio-cultural values. Biodiversity depends on wetland habitat integrity. As developing countries' economies grow associated threats to wetlands are focussing attention on how to reduce impacts from urban expansion, dam construction, irrigation demands and pollution runoff (IUCN, n.d.). Environmental groups have responded by attempting to value wetlands as an economic component of water infrastructure to redress policy inaction and market failure (IUCN, 2004). One widely quoted report estimated a global total wetland value of US$14,785 per hectare per year (in 1994 US dollars) (Costanza et al., 1997). This compares to a value of US$92 for a hectare of agricultural land.

The failure to reconcile economic valuations with effective local demand in many developing countries has generated interest in payments for environmental services. Payments for environmental services are incentive-based mechanisms which attempt to identify local sources of finance by explicitly making a relationship between an 'environmental service' (say, clean water) and an 'environmental user' (say, a municipal water treatment plant). People providing environmental services are compensated to maintain an agreed level of service provision by users demanding such services. In relation to watershed services, such as maintaining water quality, it can be conceived of as a negotiation process in which upstream land owners agree an opportunity cost of modifying land use behaviour that is paid for by downstream users' associated benefits or cost avoidance. While this approach is incipient with uncertain social and environmental implications (Wunder, 2005), there is a wide-spread interest and policy support to better understand the opportunities from incentive mechanisms to improve environmental management and contribute to rural development where other approaches have been ineffective (van Noordwijk et al., 2005; Pagiola et al., 2004)

Rewarding farmers that live in upper watershed areas that drain into a degraded wetland for improving their land use management practices illustrates one possible situation where farmers, wetlands and drinking water supply could mutually benefit.

One integrated soil and nutrient management intervention that reduces negative downstream water impacts is to promote farmers switching from using inorganic inputs to organic farm management (Environment Agency, 2002). In a Europe-wide review comparing organic farming to inorganic production, a range of benefits were identified, including supporting higher levels of biodiversity, conserving soil fertility and stability, improvements in water quality from non-use of pesticides and energy benefits (Stolze et al., 2000). Drinking water supplies are also protected by reducing nitrate levels associated with agricultural runoff and leaching into surface and groundwater sources. It is suggested that 70% of nitrogen entering inland surface waters in the European Union is from agriculture (Environment Agency, 2002). When drinking water nitrate guideline levels are exceeded public health costs may be incurred in increased morbidity and increased drinking water treatment costs (WHO, 2004).These factors have led to wide support for organic farming as a desirable agricultural land use management practice. Payments for environmental services suggests one approach to provide farmers with incentives that will encourage switching production system. This is a particularly important for resource-poor small-scale farmers in the developing world who face a range of costs and uncertainties which will influence their decision to switch to organic farming.

Farmer decisions to switch to organic production will be influenced by market demand. Demand for organic food in developing countries is growing though small in value terms with strong international demand for organic produce which is estimated at US$11 billion including imports from developing countries accounting for US$500 million (Harriss et al., 2001). Resource-poor small-scale farmers from developing countries face a number of significant constraints accessing international markets. In particular, certification of organic produce for the European Union market is an absolute requirement and, in the case of small-scale farmers, organisation into producer groups is essential for cost-effective group certification. In a recent global review it is concluded that despite cost, information and scale constraints "there is evidence that resource-poor smallholder farmers can obtain economic and social benefits from participation in organic production and trade" (ibid: 51).

Understanding which incentives will motivate small-scale farmers to commit to switching to organic farming practices is central to designing effective and sustained institutional arrangements that work for farmers and downstream water users. Research at the Bhoj wetland in India has explored the feasibility of farmers adopting organic farming as a measure to reduce pollution in the upper lake, which provides 40% of the drinking water supply to the city of Bhopal. This report illustrates applying a stated choice methodology to elicit this information in order to provide guidelines for what policy action is most likely to influence farmers adopting organic farming for improved environmental management and rural development goals.

2. Bhoj wetland, India

The Bhoj wetland is located on edge of the city of Bhopal, the state capital of Madhya Pradesh, India (Figure 1). The Bhoj wetland dates to the 11th century when the *Raja Bhoj of Dhar* built an earthen dam across the Kolans river. The wetland constitutes an upper and lower lake; the upper lake is the major water body. The upper lake measures 14 km in length and varies between 2 to 12 km in width covering a total area of 36 km^2. Average lake depth is 4 metres with the deepest point reaching 14 metres.

The lake is drained by the 361 km^2 Kolans watershed. Located in the *Vindhyan* range on the borders of the *Malwa* plateau, the main geological formations are *Bhander* sand stone and *Deccan* trap lava flows. This contributes to good black cotton soils and with average rainfall greater than 1200 mm and a gentle topography, agricultural is the main land use amongst the 87 villages in the watershed. Census data from 2001 estimates 14,109 households with 83,909 people living in the watershed (Figure 1).

The wetland provides important cultural, water supply and environmental services. In 2002, RAMSAR declared the wetland a site of international significance. Over 160 species of birds and 14 rare macrophytes have been reported in the area. The wetland also support a wide variety of flora and fauna, several species of phytoplankton and zooplankton, aquatic insects, amphibians, fishes and birds (resident as well as migratory) are found in the wetland (Borgoyary, 2005). The upper lake of the wetland provides 40% of drinking water supplies to the 1.8 million residents of the neighbouring city of Bhopal (Verma, 2001). Livelihoods of many people are also directly linked to the wetland. A fishermen’s co-operative consisting of some 500 families has been given fishing rights by the local authorities. People grow water chestnut in the wetland for local sale. The wetland also has important socio-cultural values represented by the location of the *Mazaar* (tomb of a Muslim saint) located on Takia island, a small island in the upper lake.

Urban pollution is linked to the growth of Bhopal, which has developed rapidly on the borders the wetlands in the past 50 years. Urban pollution includes various industrial effluents, idol immersion, laundry houses (*dhobi ghats*), human sewage and chemical inputs for water chestnut farming. A Japanese Bank of International Cooperation (JBIC) project in the 1990s helped address many of the urban pollution issues in partnership with the Government of Madhya Pradesh (GoMP). Interventions include buffer zones between the lake and the city (forestry and roads), building over 85km of new sewage pipes to divert 56 million litres of sewage per day, re-locating dhobi ghats away from the main lake and collaborating with GoMP to set up the Lake Conservation Authority (LCA), which acts as a state-wide resource for scientific research and policy on management of the state's water bodies (Borgoyary, 2005).

Rural sources of agricultural pollution runoff negatively impact the trophic status of the upper lake (Mishra, 2006). Measured nitrate levels of 1.5 milligrams per litre are within permissible drinking water guidelines of 50 milligrams per litre (WHO, 2004). However the nutrient levels are high in terms of primary productivity in the lake. This leads to algae growth, high coliform counts and turbidity contributing to a eutrophic classification in areas of the lake near inflowing channels from upland rural areas. This contributes to high turbidity and coliform counts which increase water treatment costs for reducing the suspended solids and cleaning. Drainage patterns permit disentangling rural from urban pollution sources in the lake with rural pollution identified as an equally important source of lake pollution as urban sources (ibid).

While extension activities have demonstrated organic farming techniques, such as vermi-composting and improved composting of farm yard manure, to some farming communities, uptake by farmers has been limited and slow. Beyond extension service activities a more thorough understanding of farmer constraints to adopting organic farming needs to be achieved to determine incentives that fulfil both wetland-friendly and socially acceptable land management change. This requires improved understanding of the influence of scenario attributes on farmer behaviour, such as a) willingness to commit land to organic farming, b) access to higher organic crop prices through certification channels, c) farmers' willingness to act collectively to reduce certification transaction costs, d) manure input prices, and e) increased labour effort. Stated choice methods offer one approach to investigate experimental scenarios of people's priorities to future scenarios and to predict their behavioural responses for improved policy action (Hope, 2006; Louviere et al., 2000).

3. Research methodology

Stated choice methods provide an approach to evaluate the impacts, adoption or preferences of target groups to a proposed future scenario that cannot be assessed with existing knowledge (e.g. climate change, price shifts, new technology). It allows policy-makers to estimate and predict people's behaviour to alternative scenario designs. Such techniques have been commonly used in marketing, transport economics, medicine and psychology for many years with the methodological basis, design criteria and econometric models rigorously tested and developed into a broad range of tools and modelling approaches (Louviere et al., 2000).

A limitation of the approach is that choices will be shaped by the way they are framed. Scoping analysis and identification of key attributes are critical to informing a valid and legitimate experimental design. Detailed scoping work with institutional actors and stakeholder groups was conducted to inform a piloting phase (Borgoyary, 2005). During a training workshop in the piloting phase, a locally-based NGO (Centre Advanced Research and Development) scrutinised the design with other interested institutional actors (including GoMP LCA) and attended field-testing of the three pilot designs in watershed communities (Hope et al, 2005). During this process the final questionnaire and choice experiment designs were collectively agreed.

3.1 Questionnaire design

The design of the questionnaire aims to capture specific data related to current farming practices with particular interest in knowledge of and level of organic farming (Appendix 3). The final version of the questionnaire was translated into Hindi and reviewed by a bilingual Hindi-English member of the research team to test for any inconsistencies or anomalies in language, sense or interpretation. The questionnaire has four sections: 1) household selection and data quality; 2) farming system; 3) choice experiment; and, 4) household characteristics (Hope et al., 2005).

3.2 Sampling frame and sampling strategy

The sampling frame was informed by existing research by the LCA in eight communities in the riparian, peri-urban area within Bhopal Municipal Corporation and a need to better understand opportunities for adoption of organic farming across the Kolans watershed. A sampling strategy that captured a broad cross-section of villages across the Kolans watershed is considered to be more representative than a more intensive sampling approach in fewer villages due to the socio-economic and agricultural heterogeneity across the watershed.

The sampling frame operates on three hierarchical levels: a) sampling zone, b) village-level, and c) within village groups of particular interest (female farmers, scheduled caste/tribe and small land owners). Three sampling zones were identified:

> i) Bhoj Municipal Corporation (BMC). Villages located in the riparian zone of the Bhoj wetland within the BMC District and in a peri-urban area;
> ii) Lower Kolans watershed (LOWK). Villages located in the lower watershed area of the Kolans river in the western expanse of the wetland;
> iii) Upper Kolans watershed (UPK). Villages located in the upper watershed area of the Kolans river in a rural and remote setting (Table 1).

Village selection within the three sampling zones was informed by a range of criteria:

- Villages in the BMC zone fell in a riparian cluster;
- Villages in the UPK zone were located on the main Kolans river;
- Villages in the LOWK zone were located near the upper lake shore close to the Kolans river;
- More than 50% percent of village households reported cultivation as their primary income source;
- There was representation of Scheduled Caste, Scheduled Tribes or Other Backward Caste social groups.

Sampling within the village was randomized within the purposive constraints indicated above. Team leaders were instructed to be opportunistic in sampling farmers who volunteered but ensure that farmers were sampled across the village and not only those that may be more entrepreneurial, inquisitive or members of a village elite that are more easily encountered on arrival. Given the complicated and multiple sampling criteria (see below) and the experience of the implementing NGO in the study area, team leaders were instructed to fulfil this requirement pragmatically and sensitively in each village.

3.3 Choice experiment design

Following the pilot phase, attributes and attribute levels that best responded to the research were chosen (Table 2). A feature of the design was to have four standard choices for committing land to organic farming. This attribute alone remained uniform across the numerous choice cards that were generated for testing (see below). This reduced the cognitive complexity for the farmers and provided a 'signpost' from which farmers could vote on the various choice cards generated. In addition to the attributes, a status quo choice is included in all of the choice cards. The status quo option is an important design component as respondents must always be given the opportunity to opt out or reject the scenarios presented (Figure 2). Each choice card also reminds farmers with simple illustrations that crop yield is likely to fall in the first crop season following conversion to organic farming though yields will increase in later years. Cost savings from not buying agro-chemical inputs is also illustrated.

Organic crop price increases were set purposively lower than market prices in order not to raise expectations and to reduce potential response centrality to price as occurred in some of the pilot work. Land certification costs for organic produce were obtained from key informants working in the state. The researchers were interested to explore how sensitive farmers willingness to work in groups were to cost. It was expected that, all things being equal, farmers would prefer lower to higher certification costs, therefore, it was considered sensible to include a lower cost group attribute with two higher but same cost attributes that were distinguished by working as a group or individually. This would help untangle 'cost' and 'collective' signals from the data. Current local compost[3] prices were in the lower end of the range of the attribute levels and farmers were told that it was likely with wider organic farming adoption demand for local compost prices would increase. Labour days to make one trolley of compost were estimated and higher end ranges were chosen as pilot analysis suggested farmers discounted this effort even though many farmer households claimed to be labour poor (Borgoyary, 2005).

The attribute levels result in a 4^3*6*3 factorial design with effects and degrees of freedom (df) decomposed to: main effects (16 df), two-way interactions (100 df), and other interactions (1035df = 1152 – 16 – 100 – 1). Running a mains effects orthogonal design function in SPPS (version 11.5) resulted in a 64 card design with 8 cards repeated. Eliminating duplicate cards would reduce orthogonality and the cards are left in the design. It was decided that respondents were able and willing to answer up to 8 choice cards each. This required the questionnaire to be rotated in units of eight.

To test all choice cards against each land commitment level, each respondent is given 8 choice profiles to 'vote' on. To test each of the 64 choice cards, 8 questionnaire sets are designed, e.g. 8 cards per respondent with a total of 8 sets equal to 64 cards. The 64 cards are shown systematically. Choices from each of the 64 cards are placed systematically in the land conversion columns starting with 25% conversion. For example, for Set 1/Card 1, choices from card 1 are placed in the 25% land conversion column; in Set 1/Card 2, choices from card 2 are placed in the 25% land conversion column, until Set 1/Card 8 is complete. Then choices from card 9 are placed in 25% land conversion in Set 2/Card 1; this continues until choices for the 64th card are placed in Set 8/Card 8. A simple rotation format then allocates the n^{th} + 1 card in the adjacent and higher land conversion column, where n is a factor of 8. For example, in Set 1/Card 2, the choice card in 50% land conversion commences with choices from card 9; 75% conversion starts with choices from card 17; and, 100% conversion starts with choices from card 25. Choices from the 64 cards thus appear across the 8 sets with no repetition (Hope et al., 2005).

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[3] Manure is a collected heap of farm yard waste which may have decomposed but in an uneven and untreated manner. Manure and the term Farm Yard Manure are used interchangeably here. After some level of manure treatment and decomposition the output would be of higher agricultural value and is here termed compost.

Enumerator teams sample in units of 8 respondents to be consistent with the design of the choice experiment. The number of 'sets' is also indicated (Table 2 above). Enumerator team leaders manage the distribution of the 8 questionnaire sets to enumerators to simplify this procedure, i.e. each enumerator is required to complete a full set of 8 questionnaires (marked 'SET 1' to 'SET 8') before a further set is released. This aimed to reduce potential confusion in the field and permit a more thorough statistical analysis.

4. Results

4.1 Exploratory data analysis

The questionnaire took an average of 47 minutes to complete (standard error = 0.40 minutes) with a range of 30-120 minutes. All respondents were male farmers who confirmed that they were responsible for farm decision-making. Data quality checks performed by the enumerators indicate that 65% of the informants may be classified as co-operative and capable, 27% as co-operative but not capable, 4% as busy and 3% as reluctant (1% rounding error)[4]. All questionnaires were evaluated for data elicitation problems by the enumerators and checked by a team leader. Data entry errors were randomly checked by the implementing NGO (CARD) with a separate random check by Winrock International India. No significant data entry problems were found.

Weights are applied to the sample to correct for the uneven samples drawn from the three zones. A simple inverse probability of selection formula is applied, which is later replicated in the modelling analysis[5]. Descriptive data are presented by commonly used farm size classifications used in India, which also broadly correspond to the non-weighted quartile cut-off points for farm land cultivated with papers (see below).

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[4] One sample t-tests identify four of the eleven enumerators with a significant preponderance to code respondents 'cooperative and not capable' compared to the group average. Directional measures indicate that there is a significant relationship between enumerators and the classification 'cooperative and not capable' (Goodman and Kruskal tau, $p < 0.05$; Uncertainty coefficient, $p < 0.05$) though the strength of the relationship is weak (coefficients < 0.20). Given the indicative nature of response coding and no other data anomalies to question the validity of the data, all responses are analysed.

[5] Probability of being including in zone $i = n/\mathrm{N}$, where n = zone sample size, hence probability of selection is weighted $w_i = \mathrm{N}/n_i$.

4.1.1 Household composition, assets and income

Socio-demographic data indicate that male-headed households of Hindu faith are dominant across the watershed (Table 3). In all but the lowest land holding group where there is a relatively even distribution of Other Backward Caste and Schedule Caste families, Other Backward Caste are the most common social group (> 60%) in the watershed. Household size varies between just under six people (2.5-5 acres) to just under eight people (greater than 10 acres). There are between three and six adults in each household mirroring the household size distribution with an adult average age of 40 years across all land holding classes. The proportion of illiterate household members is roughly one in three people across all groups.

Over six in ten dwellings are classified as in poor condition except for the highest land holding group (41%, Table 4). Almost all respondents report owing their own home with electricity access. Poor sanitation access (open field) is reported by seven out of ten households in the three lower land holding groups. Larger land holders depend less on unimproved sanitation (45%) and also tend to have greater access to domestic water in the home (34%) than the other groups. In the dry season months of March through June, domestic water access is accessed from tubewells by three quarters of households with roughly one third of all households further than 500 metres from their main domestic water source. Cases of diarrhoea for both children and adults in the last 30 days fall in the range of 11 – 24% across the sample.

Tractor ownership is skewed to the larger land owning farmers (Table 5). Only 4% of the farmers with less than 2.5 acres own one compared to 67% of farmers with greater than 10 acres. Bullock cart ownership also favours larger farmers though they are less common (42%) than tractors. Access to a water pump or tubewell increase with land size. Water pumps are reported by one in five households in the lowest land group compared to seven out of ten households in the highest land group. Tubewells are more common ranging from two in three households in the smallest farmers to almost all of the largest land owning farmers reporting one. Threshers tend to be owned by the two higher land groups (23% and 56%, respectively). Winnowers are owned by less than one in five of largest land owners with less than one in ten of other farmers reporting ownership. The distribution of sewing machines reflects land ownership from 16% in the lowest land group to 44% in the top group. Livestock ownership data are likely to distort in-group variance but highlight that largest land owners own more buffalos and cows. Bullock ownership is slightly more even though low (less than one per household) for all farmers except the lowest land owning group.

Annual income distribution mirrors farm size with all households gaining the majority of their income from cultivation (Table 6). This is also reflected by two out of three household members over 7 years working the land in the last year. Livestock, wage and other income sources represent minor income sources in comparison to cultivation income for all but the lowest land owning group who appear equally dependent on wage income (US$211 from wage compared to US$240 from cultivation). The largest land owners appear to be most dependent on cultivation for household income (83%) with a smaller relative contribution from livestock (US$359) though larger than any other farmer group.

4.1.2 Farm system practices

Most land owned is cultivated with a minor proportion leased out or not cultivated (Table 7). Less than one acre of land is leased-in for cultivation by the three lower land owning groups. This compares to an average of over 4 extra acres leased-in by farmers in the largest land group. It is noteworthy that the area of land leased-in does not tally with the area leased-out[6]. Almost all available farm land is cropped in the kharif and rabi seasons (Table 8). Farmers irrigate around half their land in the kharif season with almost all cultivable land irrigated in the rabi season. Less than one acre is farmed or irrigated across all farmer groups in the zaid season.

Household allocation of last year’s harvest is decomposed by kharif and rabi season (Table 9). The kharif crop (usually soya) is mainly sold for income (range 73-80% of yield) with seed storage the next most important allocation (range 12-18% of yield). Alternatively, the rabi crop (usually wheat) is used as a source of household food (particularly the smaller farmers – 49% and 38% respectively) or sold for income (particularly for larger farmers – 58% and 66% respectively). Non-financial exchange, sold/given to repay debt and other categories represent ten percent or less of allocations across the two reported seasons.

[6] This is believed to be partly due to increasing prevalence of absentee landlords buying land in peri-urban areas in the expectation of proposed road developments.

A small proportion of the watershed is currently farmed with compost manure (Table 10). Only 36 farmers (6% of sample) reported using compost with farmers in the 5-10 acre category reporting more than one acre farmed with compost (1.09 acres). While use of farm yard manure is more common (74% of sample) only the largest farmer group applies manure to more than acre of land (1.34 acres). Estimates of the quantity of organic manure (trolley load) applied by season indicate that farm yard manure is the most significant use with over 3 trolleys applied in the kharif season. (Table 11). There is little use of compost or vermi-compost across the watershed (less than 0.20 litres per acre across all seasons). Farmer allocation of available farm dung is split between dung cakes and farm yard manure across land holding groups (Table 12). Small farmers tend to use more dung for fuel cakes (56% of supply) while larger farmers tend to allocate to farm yard manure (57% of supply). There are minor allocations (less than 1%) to either compost or vermi-compost.

Fertilisers and pesticides are applied widely across the watershed (Table 13). Fertiliser application ranges from 34-44 kilograms per acre in the kharif season. This increases in the rabi season to between 135-154 kilograms per acre. Figures for the zaid season are more variable (range 86-145 kilograms per acre) which partly represents a smaller sample size and higher variance[7]. Pesticide use is concentrated in the kharif season (range 0.67-0.84 litres per acre) with lower application in the rabi season (range 0.05-0.09 litres per acre)[8]. Bio-pesticide use (litres per year) is also reported though in limited quantities across the watershed and by farmer group (up to 0.91 litres per year).

4.2 Choice experiment

4.2.1 Multinomial Logit models

Results for the estimated coefficients of weighted and non-weighted multinomial logit models are presented in table 14. As before, the land area data used include own land and leased-in land. All attributes have the expected sign and are significant at the 1%

[7] As a back-of-envelope estimate, if 70% of the 14,000 households in the watershed farm land and they apply roughly 150 kg of fertiliser and 0.50 litres of pesticide/insecticide per acre per year, then scaling-up a sample average of 10 acres per farm household suggests 15,000 tonnes of fertiliser and 50,000 litres of pesticide/insecticide are applied each year in the watershed.

[8] Interpreting higher zaid pesticide usage should be done with caution due to the above noted smaller sample and area farmed.

level. The importance of weighting data is highlighted by the improvement in estimates of the goodness-of-model fit. For example, the log likelihood at convergence is reduce by 4035 points (-5881 to -1846) when weights are used and the pseudo-R^2 coefficient increases from 0.20 to 0.28. Independence of Irrelevant Alternatives (IIA) tests promote exploring less restricted model specifications (see below).

Model estimates provide policy guidance on farmer likelihood of committing land to organic farming. The land commitment coefficient is negative highlighting that farmers associate negative utility (or insufficient benefits) with organic farming. This is consistent with current low levels of organic farming in the watershed. This emphasizes the need for incentives to overcome farmer constraints. Increasing crop price (here, the scenario range was 5-15%) will be an expected positive factor in promoting adoption of organic production. The marginal rate of substitution between land commitment (utiles per acre) and price increase (utiles per percent Rupee increase in crop price) indicate that a 35% Rupee increase in organic crop price above existing market prices for inorganic crops will be required for farmers to commit an average acre to organic production (0.042/0.121 = 0.35), all else equal. By the same formula, it can be seen that an equivalent price increase will be required to motivate additional labour to be expended on the extra effort associated with organic farm management.

Certification estimates are in an expected order with lower costs being preferred to higher costs by farmers. Farmers are 1.96 more times likely to certify as group for organic farming than as an individual if the cost of group certification is R1,000 compared to R3,000 to certify land as an individual (3.488/1.779). Alternatively, if certification cost is equivalent (R3,000) farmers are only 1.24 times more likely to prefer to work as a group (1.779/1.430). This provides guidance on farmer sensitivity to working in a group for organic certification, which has been earlier identified as a key obstacle for resource-poor small-scale farmers accessing international organic markets (Harriss et al., 2001).

The implications of these aggregate findings are that organic farming will not be adopted without external support and incentives. This is supported by cross-tabulation of actual choices versus model predictions (Table 15). Actual choices are skewed to farmers choosing 25% or 50% land commitments to organic farming (61% of total) with an even split (18-19% to total) choosing the higher land commitments with a small percentage preferring the current farming situation (3%).

Watershed zoning analysis provides spatially-differentiated insights (Table 16). Farmers in the Upper Kolans zone record a higher level of disutility to committing land to organic farming (-0.070) than either the BMC (-0.049) or the LOWK (-0.040) zones. However, upland farmers appear more influenced by higher crop prices and less constrained by labour effort than the lower watershed farmers. Considering the marginal rate of substitution of percent crop price increase for unit land converted to organic farming suggests it will take a 28% crop price for BMC farmers to convert an average acre to organic production compared to an incentive of a 33% or a 53% price increase for Lower Kolans and Upper Kolans farmers, respectively.

Certification cost coefficients suggest BMC farmers are just over twice as likely to work as a group (2.02) to certify their land given a lower cost compared to 1.94 times and 1.87 times as likely as the Upper and Lower Kolans farmers, all else equal. Comparing the same certification costs, the results suggest that Upper Kolans farmers are 1.30 times more likely to work as group compared to 1.23 times and 1.18 times for BMC and Lower Kolans' farmers, respectively. These findings would promote the BMC as a preferred pilot area in the watershed to further test and refine incentives for organic farming.

Estimating farmer preferences by farm size is decomposed by three categories: a) less than 5 acres, b) less than 10 acres, and, c) greater than 10 acres (Table 17)[9]. A key finding from disaggregating farm size is that farmers with more than 10 acres are less resistant to switching to organic farming than farmers with less than 10 acres. In terms of a required crop price increase to switch an average acre, larger landowners would, all else equal, respond to a 32% increase compared to an equivalent 114% increase for the two smaller groups reported. However, smaller land owners are more responsive to working in groups subject to certification costs. Farmers in the less than 5 acre

[9] Coefficient estimates for farmers with less than 2.5 acres were insignificant and are not reported, though this group is clearly of policy importance from a poverty perspective.

group are 2.31 times more likely to work together for group certification with the R1,000 to R3,000 cost differential. This compares to 1.96 and 1.80 times more likely to certify land as a group for the less than 10 acre and over 10 acre groups, respectively. This pattern holds true for farmer group certification at the same R3,000 cost with estimates of 1.36, 1.23 and 1.20 for the smaller to larger land owning groups.

4.2.2 Latent class modelling

Latent class modelling overcomes a limitation of understanding preference heterogeneity in the multinomial logit (MNL) model by assuming there are hidden classes in the population which can be revealed by assigning individuals simultaneously to classes and inferring welfare estimates (Hope, 2006). In this application, two latent classes are specified alongside the earlier MNL model estimates (Table 18). Estimated probabilities of class membership are significant for both classes at the 1% level. Farmers are more likely to belong to Class 1 (60% probability of membership) then Class 2 (40% probability of membership).

Profiling farmers belonging to each latent class is an important next step as the findings reveal strong and polarised preferences between farmers' willingness to switch to organic production. Class 1 farmers are willing to convert an average acre with an 11% percent crop price increase. They are 2.72 times more likely to work as a group with an incentive of a lower certification cost of R1,000, though are still 1.67 times more likely to work in a farmer certification group with an equivalent R3,000 cost than certify individually, given a choice. This is in stark contrast to Class 2 farmers. This second group are willing to convert an average acre with a 54% crop price increase. They are 1.33 more times likely to work as a group given the cost incentive but only 1.08 times more likely to work in a farmer certification group with an equivalent cost to working individually. There is merit in more clearly establishing the profile and characteristics of farmers from Class 1 and Class 2. Other model estimates suggest Class 1 farmers will include own more than 10 acres and are more commonly located in the BMC zone. However, the lower crop price incentive estimate and higher willingness to work in a group for land certification for Class 1 farmers suggest there other farmers outside the BMC zone or with less than 10 acres may represent promising candidates for adopting organic farming. A key question unanswered from this analysis is a clearer understanding of the profile of Class 1 farmers. These farmers are the more likely to be influenced by incentives to adopt organic farming but are only partially identified here.

4.2.3 Simulation and scenario testing

A number of simulations are conducted to test scenarios against changing attribute levels. This results in re-computing probabilities and sample shares from a base share so as to examine the effect of the change. This tests the likely impact of potential policy interventions. Simulations are restricted to the four organic land use commitment choices with the status quo option excluded. The first simulation doubles compost prices for farmers only willing to commit 50% or less of their land to organic farming. The second simulation doubles organic crop price for only those farmers committing 75% or 100% of their farmland to organic. The third simulation doubles the labour effort required by farmers only willing to commit 50% of less of their land to organic (Table 19).

Results indicate that the two simulations likely to induce farmers to commit 75% of more land to organic are a) doubling compost costs for farmers committing 50% or less land to organic, and b) doubling crop prices only for farmers willing to commit to 75% or more organic farmland. In both cases, the simulations result in shifting the base share percentages from 50% commitment to 75-100% organic land commitment to 68%. Increasing labour effort results in little change from the base share.

Simulating changes in certification alternatives explores the following scenarios: a) withdrawing group certification at R1,000 per acre, b) offering group certification at R1,000 per acre for farmers committing 75% or more land to organic, and c) offering group certification at R1,000 per acre for farmers committing 50% or less land to organic (Table 20). Results demonstrated that land commitment to organic farming is strongly influenced by being able to certify at the lower price. In both the lower and higher land commitment choices, base shares increase from roughly 50% to over 75% if group certification is only offered on the basis of organic land commitment. This contrasts with little change from base shares for scenario a).

5. Conclusion and policy recommendations

This report has explored incentives for farmer adoption of organic farm management in the Kolans watershed to reduce agro-chemical pollution draining into the Bhoj wetland. The choice experiment method has provide insights into which incentives and level of incentive are likely to influence farmer decisions to switch to organic land use. As organic farming has to be an all-year and multiple year commitment, the report has considered incentives to influence farmers to both commit some of their land to organic farm management and what is likely to motivate farmers to move to 75% or 100% organic land use.

Farmers report a loss of utility converting farmland to organic crops. This is consistent with current behaviour in the watershed. Policy that wishes to promote organic farming in the Kolans watershed must provide the right incentives to make organic farming a sustainable and wide-spread land use change. A premise of this report is that payments for environmental services is an innovative financing mechanism to fund a transition period in which farmers have to wait (usually three years) until their land can be certified so that their produce will qualify for higher organic market prices. Land certification also promotes a potential self-enforcing land use change mechanism as higher organic crop prices are dependent on land certification. This is likely to reduce downstream monitoring costs and limit costs of external intervention to the period in which farmers begin to benefit from higher organic prices. Clearly, there are further technical, institutional and policy stages to achieve the multiple environmental and social benefits associated with farmer adoption of organic farming in the Kolans watershed but these results suggest that with the right incentives farmers are likely to commit to organic farming. Based on these results five policy recommendations are suggested.

Recommendation 1. Prices are key.

Model estimates suggest an organic crop price premium of between 11% and 114% is required to motivate farmers to adopt organic farming. The aggregate result across the watershed indicates a 35% crop price premium is required for farmers to commit an average acre to organic production. The best case scenario (Class 1 farmers, Section 4.2.2) indicates a premium of 11%. This promotes an evaluation of farmer returns based on access to a range of organic produce prices from national and international markets to establish the economic feasibility of conversion to organic farming.

Recommendation 2. Certification matters.

Forming farmer production and certification groups has been identified as a crucial component in improving small-scale farmers' ability to access premium markets. Farmer preferences to working in groups for land certification are influenced by cost. Model estimates reveal that Class 1 farmers are most likely to work in a group. A cost differential of R1,000 to R3,000 per acre broadly doubles the likelihood of farmers working together except for Class 2 farmers. If certification costs per acre are equivalent then the probability of farmers working together is reduced (range 1.67 to 1.08 times more likely) subject to location, land holding and preference grouping. It is advised that a reduced or minimal certification cost is offered to farmers who agree to work as a group.

Recommendation 3. More farmers first.

Descriptive results from farmer voting patterns highlight resistance to committing to 75% or 100% organic farm conversion. However, simulation scenario testing highlights both 'carrot' and 'stick' incentives to influence farmers to opt for a higher level of organic land conversion. It is judged a more pragmatic implementation strategy to encourage more farmers to convert some land to organic farming initially than to motivate fewer farmers to convert the majority of their land. This is likely to increase participation of smaller farmers under the support structure of a producer and certification group.

Recommendation 4. Target larger farmers.

Findings promote targeting larger farmers as the best initial candidates for organic farming. Farmers with over 10 acres of cropland have more livestock, depend more on agricultural income, have more labour, own more tractors and bullock carts, and have greater access to irrigation. In addition, they also currently farm more land with organic manure and apply more bio-pesticides than other farmers. They are also motivated by a much lower crop price (32%) incentive than smaller farmers (114%). This recommendation is not inconsistent with a rural development goal if complementary measures identify ways to include small-scale farmers (e.g.

mentoring) in the short term (1-5 years) or the time-horizon for assessment of the development impacts of wider adoption of organic farming in the watershed is seen in the medium term (5-10 years).

Recommendation 5. Start in the lower watershed.
Watershed zoning analysis promotes working with farmers in either the BMC or Lower Kolans zones initially. Given likely higher pollution impacts from farmers bordering the wetland, it is recommended that farmers in this area represent a sensible entry point.

These five recommendations identify policy action to promote farmer adoption of organic farm management in the study watershed. They provide policy guidance to complement wider institutional effort to promote improved environmental management and rural development.

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Appendices

Appendix 1. Figures

Figure 1. Location of villages in Kolans watershed

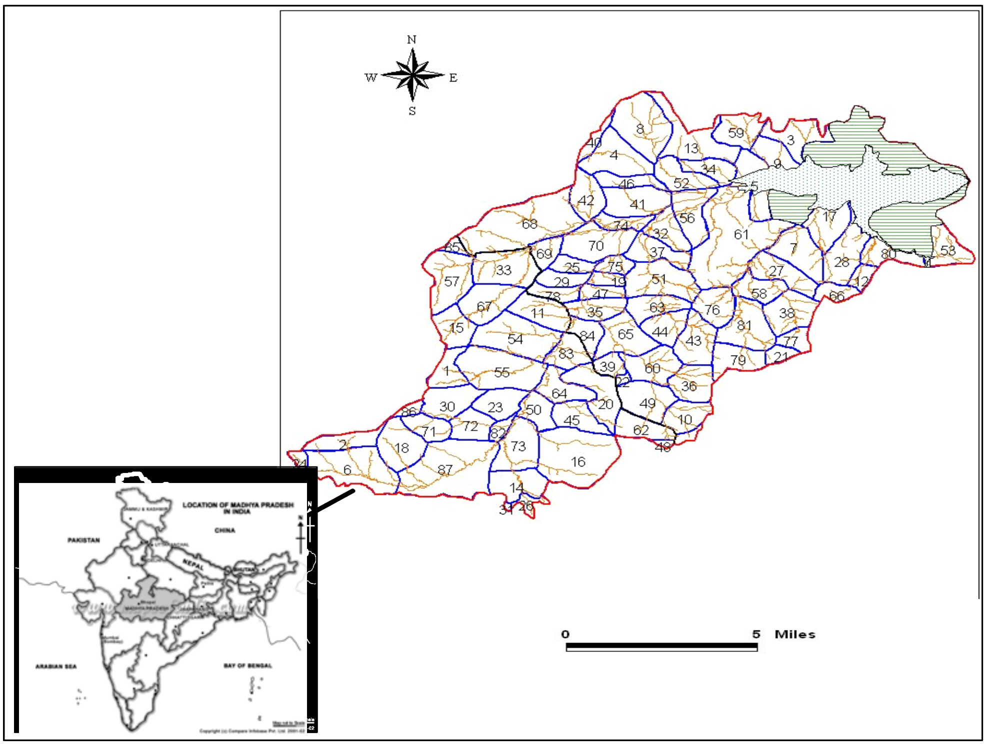

Figure 2. Choice card example

Card 6 **Set 5**

	# 1	# 2	# 3	# 4	# 5
LAND COMMITTED TO ORGANIC FARMING	25%	50%	75%	100%	CURRENT SITUATION (Q.4/5)
ORGANIC CROP PRICE *INCREASE* PER **100** RUPEES	$13	$9	$7	$11	?
COST OF CERTIFICATION PER ACRE	$3000	$3000	$3000	$1000	?
PRICE COMPOST TROLLEY(2 tonnes)	$1200	$1200	$1500	$900	?
FARMER DAYS TO COMPOST ONE TROLLEY	12	16	16	4	?
VOTE FOR **ONE** ONLY					

Yield	$Fertiliser
↓	↓

Appendix 2. Tables

Table 1. Sample frame

ID	ZONE	VILLAGE	Sample size (farmer households)	No. of Sets (units of 8)
7	BMC	Barkheda Nathu	48	6
28	BMC	Goria	8	1
58	BMC	Malikhedi	24	3
61	BMC	Mugaliyachhap	56	7
66	BMC	Neelbad	8	1
		sub-total	*144*	*18*
32	LOWK	Int Khedichhap	32	4
37	LOWK	Kajlas	32	4
41	LOWK	Khajoori Sadak	64	8
52	LOWK	Kolu Khedi	32	4
56	LOWK	Lakhapur	48	6
70	LOWK	Pipaliya Dhakad	40	5
		sub-total	*248*	*31*
16	UPK	Bilkisganj	48	6
23	UPK	Dhabla	48	6
43	UPK	Kharpa	8	1
44	UPK	Kharpi	48	6
55	UPK	Kulas Khurd	48	6
87	UPK	Uljhawan	48	6
		sub-total	*248*	*31*
		Total	*640*	*80*

Table 2. Choice attributes and attribute levels

Attributes	Levels					
Land commitment to organic farming (acres)	25%		50%		75%	100%
Organic crop price increase per 100 Rupees	5	7	9	11	13	15
Cost of certification per acre	R1,000 as a group		R3,000 as a group		R3,000 as an individual	
Compost price per trolley (Rupees)	R600		R900		R1,200	R1,500
Days to compost per trolley	4		8		12	16

Table 3. Socio-demographic characteristics by farm size

		Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Social group	Other Backward Caste	44%	63%	72%	73%
	Scheduled Caste	33%	17%	12%	7%
	Scheduled Tribe	11%	10%	3%	2%
	Other	12%	10%	12%	18%
Religion	Hindu	90%	90%	89%	91%
	Muslim	10%	10%	11%	9%
Female-headed households		8%	2%	5%	1%
Household size		6.50 (0.36)	5.83 (0.11)	6.67 (0.13)	7.84 (0.15)
Adults (>16 years)		3.76 (0.11)	3.46 (0.08)	4.12 (0.09)	5.10 (0.09)
Adult average age		39.60 (0.56)	40.36 (0.47)	39.44 (0.49)	39.93 (0.46)
Proportion of household members who are illiterate* (>7 years)		0.39 (0.02)	0.34 (0.01)	0.32 (0.01)	0.32 (0.01)

Mean (standard error). Farm size is determined by all cultivated land with papers (see below). Data weighted by inverse probability of selection by sample zone. * Government of India measures literacy levels from 7 years.

Table 4. Living conditions

		Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Home owned		100%	100%	97%	99%
Poor (‘kaccha’) dwelling condition		78%	63%	66%	41%
Electricity access		89%	89%	92%	97%
‘Open field’ sanitation access		78%	72%	74%	45%
Drinking water access in dry season (Mar-June)	Tubewell or handpump	77%	75%	77%	75%
	Access in home	20%	17%	20%	34%
	Access >500 metres	30%	35%	31%	30%
Households reporting one or more cases of diarrhoea in last 30 days	Under 5 years	16%	11%	16%	16%
	Over 5 years	24%	19%	15%	13%

Table 5. Productive assets

	Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Tractor	4%	9%	21%	67%
Bullock cart	21%	36%	42%	42%
Water pump	19%	40%	48%	68%
Tubewell	68%	73%	82%	95%
Thresher	7%	8%	23%	56%
Winnower	2%	4%	7%	17%
Sewing machine	16%	18%	29%	44%
Buffalo	0.63 (0.08)	1.19 (0.08)	1.67 (0.12)	3.85 (0.18)
Bullocks	0.35 (0.04)	0.70 (0.04)	0.90 (0.05)	0.98 (0.05)
Cows	1.06 (0.07)	1.10 (0.05)	1.19 (0.04)	2.19 (0.10)

Table 6. Household income sources

		Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Estimated total annual household income (US$)*		661 (62)	829 (76)	1187 (67)	2942 (136)
Income source by sector	Cultivation	240 (17)	416 (24)	868 (59)	2412 (128)
	Livestock	85 (14)	100 (11)	166 (28)	359 (36)
	Wage	211 (52)	155 (15)	58 (7)	33 (6)
	Other	126 (21)	158 (69)	95 (16)	137 (20)
Cultivation income as proportion of total income		0.51 (0.02)	0.63 (0.02)	0.77 (0.01)	0.83 (0.01)
Proportion of household members cultivating last year (>7 years)		0.64 (0.02)	0.70 (0.01)	0.67 (0.01)	0.68 (0.01)

* US$1 = 50 Rupees (2005)

Table 7. Land ownership and management (acres)

	Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
a) Total land owned	1.68 (0.05)	3.30 (0.05)	6.16 (0.11)	18.61 (0.56)
b) Land owned and cultivated	1.48 (0.04)	3.12 (0.04)	5.57 (0.08)	17.35 (0.50)
c) Land owned and not cultivated	0.07 (0.02)	0.15 (0.03)	0.34 (0.04)	1.24 (0.17)
d) Land owned and leased out	0	0.08 (0.03)	0.19 (0.05)	0.17 (0.06)
e) Land leased in for cultivation	0.09 (0.02)	0.21 (0.03)	0.60 (0.07)	4.47 (0.46)
Total land cultivated (b + e)	1.61 (0.03)	3.36 (0.03)	6.27 (0.06)	22.09 (0.68)

Land ownership reported here is with papers. Evaluation of these five categories for land 'without papers' indicated that this is not a significant farm management issue (<0.50 acres) in this watershed.

Table 8. Land cropped and irrigated by season (acres)

		Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Area cropped	Kharif	1.78 (0.06)	3.04 (0.07)	5.59 (0.09)	19.91 (0.68)
	Rabi	1.64 (0.06)	3.24 (0.10)	6.44 (0.19)	20.36 (0.66)
	Zaid	0.13 (0.02)	0.22 (0.02)	0.61 (0.12)	0.72 (0.07)
Area irrigated	Kharif	1.07 (0.07)	1.70 (0.08)	2.87 (1.13)	10.38 (0.44)
	Rabi	1.29 (0.08)	2.52 (0.07)	4.79 (0.12)	18.32 (0.84)
	Zaid	0.13 (0.02)	0.24 (0.03)	0.36 (0.04)	0.65 (0.08)

Table 9. Household allocation of last year's harvest

		Less than 2.5 acres (n=84)	2.5 – 4.99 acres (n=149)	5.0 – 9.99 acres (n=178)	Greater than 10 acres (n=214)
Kharif	Eaten	6% (1.31)	4% (0.76)	2% (0.43)	1% (0.20)
	Seeds stored	13% (1.18)	14% (0.84)	12% (0.56)	18% (0.55)
	Sold for income	76% (1.93)	73% (0.48)	80% (1.10)	79% (0.69)
Rabi	Eaten	49% (2.19)	38% (1.35)	29% (0.95)	22% (0.64)
	Seeds stored	9% (0.85)	9% (0.38)	10% (0.29)	11% (0.25)
	Sold for income	35% (2.05)	43% (1.38)	58% (1.05)	66% (0.84)

Percentage (standard error). Zaid is not reported due to insignificant land use (see Table 8). Rounding errors due to other minor categories not reported – 'non-financial exchange', 'sold/given to repay debt' and 'lost/left/stolen/other'

Table 10. Annual area farmed only with compost or farm yard manure (acres)

	Less than 2.5 acres	2.5 – 4.99 acres	5.0 – 9.99 acres	Greater than 10 acres
Area farmed only with compost manure (n=36)	0.50 (0.09)	0.67 (0.05)	1.09 (0.21)	0.91 (0.07)
Area farmed only with farm yard manure (n=476)	0.36 (0.02)	0.57 (0.03)	0.70 (0.03)	1.34 (0.07)

Table 11. Organic manure applied by season (trolley load)

	Kharif	Rabi	Zaid
Farm yard manure	3.03 (0.15)	0.11 (0.02)	0.62 (0.06)
Compost	0.11 (0.02)	0.11 (0.04)	0.30 (0.17)
Vermi-compost	0.03 (0.01)	0.01 (0.00)	0.15 (0.08)

Table 12. Current uses of farm dung

	Less than 2.5 acres	2.5 – 4.99 acres	5.0 – 9.99 acres	Greater than 10 acres
Dung cakes	56.09 (1.50)	48.18 (1.09)	47.83 (0.93)	40.64 (0.76)
Farm yard manure	43.91 (1.50)	50.57 (1.12)	50.63 (0.99)	56.66 (0.80)
Compost	0	1.08 (0.36)	1.17 (0.38)	1.72 (0.37)
Vermi-compost	0	0	0.03 (0.02)	0.33 (0.15)
Other	0	0.17 (0.04)	0.34 (0.17)	0.65 (0.28)

Sample drawn only from farmers reporting farm dung (n= 581).

Table 13. Fertilisers, pesticides and bio-pesticides applied by season

		Less than 2.5 acres	2.5 – 4.99 acres	5.0 – 9.99 acres	Greater than 10 acres
Fertilisers applied by cropped area (kg per acre)*	Kharif	43.60 (4.23)	34.08 (2.55)	38.29 (2.55)	36.49 (2.46)
	Rabi	142.77 (7.39)	153.11 (5.56)	135.38 (4.44)	137.18 (3.66)
	Zaid	144.65 (11.70)	143.34 (12.75)	128.24 (10.46)	86.64 (6.77)
Pesticides and herbicides applied by cropped area (litres per acre)**	Kharif	0.84 (0.19)	0.67 (0.07)	0.70 (0.09)	0.76 (0.11)
	Rabi	0.05 (0.01)	0.09 (0.02)	0.09 (0.02)	0.07 (0.01)
	Zaid	0.74 (0.17)	2.19 (0.77)	1.81 (0.35)	1.16 (0.20)
Bio-pesticides applied across all seasons (litres) (n=32)		0	0.26 (0.10)	0.32 (0.08)	0.91 (0.16)

* outliers (>500 kg per acre) excluded; ** outliers (>50 litres per acre) excluded.

Table 14. Multinomial Logit model

		Probability weighted^	
		Naïve	Weights^^
Land committed to organic farming (acres)		-0.046**	-0.042**
Organic crop price increase (Rupees)		0.123**	0.121**
Compost price (trolley)		-0.001**	-0.001**
Labour effort for organic farming (days)		-0.042**	-0.043**
Group land certification at R1,000 per acre		3.528**	3.488**
Group land certification at R3,000 per acre		1.814**	1.779**
Individual land certification at R3,000 per acre		1.459**	1.430**
Model specifications	Observations	5,115	5,115
	Log-likelihood	-5881.67	-1846.52
	Pseudo R^2	0.20	0.28
	IIA test[#] - Chi sq (df)	103.76 (7)**	35.24 (7)**

** significant at 1% level; ^ Probability weights are estimated from $w(t,j)$ = Estimated $P(t,j)/\sum_t$ Estimated $P(t,j)$ where t indexes individual observations and j indexes alternatives; ^^ weights are estimated by inverse probability of selection for uneven sample sizes across the three watershed zones; [#] Independence from Irrelevant Alternatives (IIA) test (here excluding choice 1 in both models) is violated suggesting exploring less restrictive models (Hausman and McFadden, 1984).

Table 15. Cross-tabulation of actual and predicted choices

	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5	Actual choices
Choice 1 (25% land organic)	718	341	326	290	46	1721 (34%)
Choice 2 (50% land organic)	271	577	264	244	32	1388 (27%)
Choice 3 (75% land organic)	197	162	369	169	23	920 (18%)
Choice 4 (100% land organic)	189	178	159	402	27	956 (19%)
Choice 5 (status quo)	42	30	32	24	5	134 (3%)
Predicted choices	1417 (28%)	1289 (25%)	1150 (22%)	1130 (22%)	133 (3%)	5119

Note: own and leased-in land cultivated; totals may be subject to rounding errors.

Table 16. Watershed zoning analysis

		Bhopal Municipal Corporation	Lower Kolans	Upper Kolans
Land committed to organic farming (acres)		-0.031**	-0.040**	-0.070**
Organic crop price increase (Rupees)		0.112**	0.121**	0.133**
Compost price (trolley)		-0.001**	-0.001**	-0.001**
Labour effort for organic farming (days)		-0.047**	-0.045**	-0.036**
Group land certification at R1,000 per acre		3.351**	3.456**	3.834**
Group land certification at R3,000 per acre		1.661**	1.785**	2.047**
Individual land certification at R3,000 per acre		1.345**	1.518**	1.575**
Model specifications	Observations	1152	1984	1984
	Log-likelihood	-629.20	-623.69	-586.37

Data are probability weighted and weighted by zone, as before.

Table 17. Farmer preferences by farm size

		Less than 5 acres	Less than 10 acres	Greater than 10 acres
Land committed to organic farming (acres)		-0.136**	-0.136**	-0.039**
Organic crop price increase (Rupees)		0.119**	0.119**	0.122**
Compost price (trolley)		-0.001**	-0.001**	-0.001**
Labour effort for organic farming (days)		-0.031**	-0.036**	-0.048**
Group land certification at R1,000 per acre		3.026**	3.525**	3.933**
Group land certification at R3,000 per acre		1.311**	1.800**	2.188**
Individual land certification at R3,000 per acre		0.967**	1.469**	1.825**
Model specifications	Observations	2768	3844	1610
	Log-likelihood	-1022.29	-1374.66	-573.20

**significant at 1% level or lower. Land classes drawn from own land and leased-in land. All estimates are probability weighted and sample weighted as before. No model is reported for farmers with less than 2.5 acres as key coefficients were insignificant. Note that the ‘less than 10 acre’ group includes land from 0.01 to 9.99 acres.

Table 18. Latent class model

		MNL	Class 1	Class 2
Land committed to organic farming (acres)		-0.042**	-0.016**	-0.148**
Organic crop price increase (Rupees)		0.121**	0.152**	0.096**
Compost price (trolley)		-0.001**	-0.001**	-0.000**
Labour effort for organic farming (days)		-0.043**	-0.053**	-0.049**
Group land certification at R1,000 per acre		3.488**	3.338**	5.089**
Group land certification at R3,000 per acre		1.779**	1.229**	3.829**
Individual land certification at R3,000 per acre		1.430**	0.7348**	3.536**
Model summary	Observations		5, 115	
	Log likelihood	-1846.52	-1701.34	
Estimated latent class probabilities			0.60**	0.40**

** significant at the 1% level; * significant at the 5% level. Usual weights applied.

Table 19. Simulating crop price and labour scenarios

	Base share (%)	Compost price x2 for ≤ 50% organic land	Crop price x2 for ≥ 50% organic land	Labour days x2 for ≤ 50% organic land
Choice 1 (25%)	22.46	14.59 (-7.88)	14.32 (-8.14)	20.96 (-1.50)
Choice 2 (50%)	27.08	17.42 (-9.65)	16.77 (-10.30)	25.13 (-1.94)
Choice 3 (75%)	26.44	35.47 (9.03)	35.93 (9.50)	28.12 (1.68)
Choice 4 (100%)	24.03	32.53 (8.49)	32.98 (8.94)	25.78 (1.76)
	100.00	100.00	100.00	100.00

Table 20. Simulating group certification scenarios

	Base share (%)	Withdraw group certification at R1,000 per acre	Group certification at R1,000 per acre for committing ≥ 50% land to organic farming	Group certification at R1,000 per acre for committing ≤ 50% land to organic farming
Choice 1 (25%)	21.69	24.60 (2.91)	10.61 (-11.08)	35.26 (13.56)
Choice 2 (50%)	28.08	25.71 (-2.37)	11.68 (-16.40)	40.73 (12.66)
Choice 3 (75%)	27.42	25.35 (-2.07)	41.89 (14.47)	12.65 (-14.77)
Choice 4 (100%)	22.81	24.34 (1.53)	35.82 (13.01)	11.36 (-11.45)
	100.00	100.00	100.00	100.00

Appendix 3. Questionnaire

Choice experiment
- household questionnaire

Introduction to respondent:

"We are conducting a farm survey in this area. The survey is investigating ways to improve farmer livelihoods and the environment. All information collected is completely ***confidential****.*

Accurate information will improve the quality of any recommendations.

Your time and assistance is greatly valued. Thank you very much."

SECTION 1. HOUSEHOLD SELECTION AND DATA QUALITY

1.1 IDENTIFICATION OF SAMPLE HOUSEHOLD	
Village: ……………………………	Date: ……….. (day)
Block: ………………………………	……………. (month)
District: ……………………………..	Sample code[1]: …………………
Name of respondent:………………………	Response code[2]: ……..
Gender of respondent : Male ☐ Female ☐	Enumerator code: ……/………/………… (letter) (date) (number)
Do you farm any land? Yes ☐ No ☐	
Are you responsible for farm decision-making? Yes ☐ No ☐	

[1]Sample code – **BMC** (Bhopal Municipal Corporation riparian zone); **UPK** (Upper Kolans catchment); **LOWK** (Lower Kolans catchment).
[2] Response code – (1) co-operative and capable; (2) co-operative but not capable; (3) busy; (4) informant reluctant; (5) other.

1.2 POST-INTERVIEW DATA REVIEW
1. Total time taken to complete interview : ……………. minutes
2. Enumerator remarks on any difficulties or omissions in the interview:
3. What action was taken by the enumerator to specific problems:
4. Remarks by team leader in relation to points (2) and (3): Signature ……………………….. (enumerator) Date ………………… ………………………… (team leader) Date ………………..

SECTION 2. FARMING SYSTEM

2.1 LAND MANAGEMENT				
			With papers	Without papers
1.	Type of land owned (**acres**)	a) Total land owned (**all**)		
		b) Land owned and cultivated		
		c) Land owned and leased out		
		d) Land owned and not cultivated		
		e) Land leased-in for cultivation		
		Total land cultivated (**b+e**)		

			Kharif	Rabi	Zaid
2.	Area cropped (acres)				
3.	Area irrigated (acres)				
4.	Area farmed <u>only</u> with compost manure (acres)				
5.	Area farmed <u>only</u> with farm yard manure (acres)				
			Kharif	Rabi	Zaid
6.	Fertilisers (**kg** per season)	Urea			
		DAP			
		Super phosphate			
		Other			
7.	Pesticides and herbicides (**litres** per season)	Name 1 (………………….)			
		Name 2 (…………………..)			
		Name 3 (…………………..)			
8.	Where do you usually purchase fertilizers, pesticides, herbicides, etc. from?[1]				
			Kharif	Rabi	Zaid
9.	Organic manure/ bio-fertilizers (**trolley**)	Farm yard manure			
		Compost			
		Vermi-compost			
		Other (name ……………...)			
		Total land **applied** (acres)			
10.	Bio-pesticides	*Please name (if any):*			

		Dung cakes	Farm yard compost	Compost	Other
11.	What proportion of your dung do you use for…				

12.	In the last year, did you …	Dung (Trolley)	Farm yard manure (Trolley)	Compost (Trolley)	Vermi-compost (Quintal)	Poultry waste (Quintal)	Other (unit?)
	… buy						
	… sell/exchange						
	… give						

13.	Do you buy farm inputs ….	….by cash?		
		…. by credit?		
		… other?		
14.	What is your usual method of ploughing?[2]			
15.	What is your main source of irrigation?[3]	Kharif	Rabi	Zaid

			Kharif	Rabi	Zaid
16.	What percentage of the last harvest crops were …	…eaten by the home?			
		…seeds stored for the future?			
		…exchanged (no money)?			
		…sold for household income?			
		…sold/given to repay debt?			
		…lost/left/stolen/other?			
		*Total by season**			

CODE:
[1] – (1) local supplier; (2) open market; (3) Mandi market; (4) other.
[2] – (1) Animal power; (2) Tractor; (3) Other
[3] – (1) Tube well; (2) Well; (3) Tank; (4) Reservoir; (5) Canal; (6) River/spring; (7) Other
* This must add to 100% , it is important point is to be as accurate as possible.

Enumerator notes and space for farm land diagram:

SECTION 3. CHOICE EXPERIMENT

Carefully introduce this section to the farmer as "*a method to test possible future scenarios that aim to benefit the farmer and the environment*". Before showing the choice cards to the farmer the enumerator must:

1. **Explain impacts of chemical agriculture on the environment (3.1);**
2. **Explain what shifting to organic farming implies (3.2);**
3. **Explain the voting game approach (3.3);**
4. **Explain voting is a 'voluntary and serious' exercise (3.4);**
5. **Test a dummy choice card (3.5).**

3.1 Impact of chemical agriculture: Use of chemicals fertilizers and pesticides have increased in recent years. While their use has contributed to higher crop yields, their price has also increased over time. In addition, there are negative environmental impacts of using chemical farm inputs on the environment, particularly water resources. In this area, fertilizer and pesticide residues accumulate in the soil, enter into ground water systems, and flow into the Upper Bhoj lake. This affects the health of the soil, quality of food, and, importantly, drinking water supplies locally and in a wider area.

3.2 Shifting to organic agriculture implies that you, the farmer:

- Don't apply chemical fertilizer and pesticides (and save on purchasing them)
- Apply compost of various types – Farm Yard Manure, Bhu- NADEP, Vermi-compost etc. You may make the compost yourself, or buy some of the raw materials, e.g. dung, or buy prepared compost.
- Apply organic methods of pest control – bio-pesticides etc
- May be able to access higher prices from the market by certifying organically-grown farm and crop produce.

3.3 Voting Game: In this experiment (or voting game) we will give you eight different organic farming scenarios. Each scenario will contain five options and each option will have information on five factors relevant to converting to organic farming.

- Please vote for only one of the five options.
- If you don't like options 1-4, choose the current situation (Option 5).
- Please note a vote implies that in the given scenario you would try composting for at least ONE year.
- The **purpose** of this exercise is to determine what factors are important to farmers and inform the design of interventions beneficial for the farmer and the environment.

3.4 Voluntary and Serious responses: This is a voluntary exercise. We request you to consider your situation and the options given and give serious responses. Any interventions/changes to crop prices and availability and prices of organic manure will be subject to regular monitoring and evaluation of farmers' commitments being honoured.

3.5 Dummy card testing; The dummy card provides an opportunity to see if the respondent has really understood the experimental design. Ask the respondent to vote on the 'dummy' choice card below. If the respondent has chosen randomly or is unable to explain the choice as being beneficial to his/her particular circumstances then there may have been a lack of understanding of the method or the respondent is unwilling to participate meaningfully.

Clarify if there is any misunderstanding or respondent resistance before preceding to showing the eight choice cards.

SECTION 4. HOUSEHOLD CHARACTERISTICS

2.1 HOUSEHOLD ASSESSMENT							
1.	Social group[1]		**6.**	Drinking water access		Main Source[6]	Distance[7]
2.	Religion[2]						
3.	Household dwelling code[3]				a) July-Feb		
4.	Dwelling condition[4]				c) Mar-June		
5.	Household sanitation access[5]		**7.**	How many household members have had diarrhoea in the last 30 days?	a) Under 5 years		
					b) Over 5 years		

CODES:
[1] – (1) Scheduled tribe; (2) Scheduled caste; (3) Other backward caste; (4) Other.
[2] – (1) Hindu; (2) Muslim; (3) Sikh; (4) Christian; (5) Other
[3]– (1) Owned; (2) Hired; (3) Other.
[4] – (1) Pucca; (2) Semi-pucca; (3) Kaccha.
[5]– (1) Open field (2) Single pit (no water); (3) Flush toilet; (4) Other
[6] – (1) Tap – public supply ; (2) Tap – own supply (3) Tubewell or handpump; (4) well; (5) tank or pond reserved for drinking; (6) other tank/pond; (7) River/canal/lake; (8) Spring; (11) Tanker; (12) Other.
[7] – (1) In the house; (2) < 500 metres (d) > 500 metres.

2.2 HOUSEHOLD ASSETS		
	Yes	No
...electricity?	☐(1)	☐(0)
...radio?	☐(1)	☐(0)
...television?	☐(1)	☐(0)
...cell phone?	☐(1)	☐(0)
…tractor?	☐(1)	☐(0)
…water pumping set?	☐(1)	☐(0)
…VCD?	☐(1)	☐(0)
...bicycle?	☐(1)	☐(0)
...motorcycle/ scooter?	☐(1)	☐(0)
...thresher?	☐(1)	☐(0)
...bullock cart?	☐(1)	☐(0)
...winnower?	☐(1)	☐(0)
…sewing machine?	☐(1)	☐(0)
…tubewell?	☐(1)	☐(0)
…bio gas?	☐(1)	☐(0)
…pressure cooker?	☐(1)	☐(0)
…number of bullocks?		
…number of buffalo?		
…number of cows?		
…number of goats?		
…number of chicken?		
…number of pigs ?		

2.3 SOCIO-DEMOGRAPHIC CHARACTERISTICS									
No.	Name (over 7 yrs only)	Gender Male (1) Female (2)	Age	Education code[1]	Engaged in farming in last year Yes (1), No (0).	Estimated income from last year (Rupees)			
						Cultivation	Livestock	Wage labour	Other
1	(**Head of HH)**								
2									
3									
4									
5									
6									
7									
8									
9									
10									
CHILDREN UNDER AGE OF 7 YEARS				**CODE –** [1] – (1) Illiterate; (2) Literate without formal schooling; (3) Literate below primary; (4) Primary; (5) Middle; (6) Secondary; (7) Higher secondary; (8) Diploma/certificate; (9) Graduate; (10) Above.					
11	Number of female children under 7 years								
12	Number of male children under 7 years								