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Impact of policies favouring organic inputs on small farms in Karnataka, India: a multicriteria approach

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Abstract Over 56% of the population of Karnataka state in India depends on agriculture for its livelihood. A majority of these are small and marginal farmers, with land under 2 ha, responsible for nearly half the food production in the state. The increasing rate of farmers' suicides in the state is reportedly fuelled among others, by increasing input costs, crop failure and accumulating debt. This triggered several policy measures, intended to improve the sustainability of farm livelihoods including those promoting organic practices in farming. The paper presents the results of a multicriteria analysis conducted to comprehend the effects of two different practice–policy scenarios on smallholders in Karnataka—one scenario 'with policy' (WP) to support organic agricultural practices and the other a 'business as usual' (BAU) scenario that continues to stress on market-based, synthetic inputs for cultivation. The paper integrates results from quantitative and participatory techniques to compare and project effects on ecological, economic and socio-cultural indicators. Ecological and economic indicators in WP are projected to be significantly higher than BAU in a majority of the study sites, while socio-cultural indicators show mixed outcomes, depending on regional and social characteristics. Across the study sites, small and rain-fed farms are benefitted better in WP compared to large and irrigated farms, respectively. Among small and rain-fed farms, soil fertility, water quality, agro-diversity, net income and freedom from indebtedness improve considerably, while there is slight reduction in collective activities and no perceivable change in land-based subsistence.

Keywords Multicriteria analysis · Organic practices · Policy evaluation · Agrarian distress · Farmer suicide · Smallholder

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1 Introduction

Agriculture is the most important livelihood in India, providing employment to almost two-thirds of the population. A large number of farmers in India are small and marginal with a land holding of <2 ha. Indian agriculture was traditionally organic in practice; however, this changed with the green revolution in the 1960s, with many farmers switching to the use of fertilizers, pesticides, irrigation and high yielding varieties of crops (Bhattacharyya and Chakraborty 2005). While the green revolution increased production of certain crops and made India largely self-sufficient in major food grains, the high dependence on external inputs increased risks and caused ecological (Singh 2000) and even social problems (Deshpande 2002). These impacts were also driven by economic growth, technological change, population growth and sectoral policies (Bhalla and Singh 2009; Rao and Gulati 2005). Since the 1990s, agricultural output growth in India has been slowing (Fan and Chan-Kang 2005), and this slowdown has put serious strain on the income and livelihood of smallholders (Chand et al. 2011). Farm holdings are being further fragmented; the share of agriculture in Gross Domestic Product has been decreasing, while the proportion of population dependent on agriculture for their livelihood has remained significant (Suri 2006).

The state of Karnataka, located in south-western India, has diverse agro-climatic conditions and hence a great diversity in crops. It recorded the highest growth rates in the country in terms of Gross State Domestic Product (GSDP) and per capita GSDP (56.2 and 43.9%, respectively, in the decade 1996–2005) mostly deriving from the service and manufacturing sectors. The state has 56% of its workforce engaged in agriculture, and 75% of these are small and marginal farmers, operating in <2 ha of land (DES 2006). Nearly 80% of agricultural land is unirrigated and depends on (uncertain) monsoons. The state is currently representative of both high rates of economic growth and agrarian distress characterized by an increasing number of farmers' suicides (24,252 farmers' suicides between 1999 and 2009) (NCRB 1999–2009). More suicides are reported among farmers who cultivated crops with high cost of cultivation (Government of Karnataka 2007). Heavy investment and accumulated indebtedness (often due to crop loss from floods, pest attacks or droughts) often caused financial crises for farmers. Even when the harvest is good, a slump in prices could cause huge losses (Suri 2006). Over 61% of all farmer households in Karnataka were indebted (higher than the country average of 48.6%), and 73% of these indebted households incurred these loans for cultivation expenditure (NSSO 2003). Irrigation (borewell) failure, accidents and illnesses also contribute to distress.

Agriculture in Karnataka witnessed rapid commercialization in crop choice and agricultural inputs (Purushothaman and Kashyap 2010) though recent trends show a new direction in policy attention. It is one of the first Indian states to specify standards and implement pilot projects for organic farming in partnership with Non-Governmental Organisations (NGOs) (Giovannucci 2005). In the wake of changing policies and increasing interest towards sustainable agriculture, this paper compares the effects of conventional non-organic input practices and recently incentivized organic inputs in different parts of the state.

Next section describes the larger problem in Indian farming focusing on small farms, current practices in the small farm sector of the state as well as recent agricultural policy inclination. Later (Sect. 3), we move on to the suitability of multicriteria analysis (MCA), before discussing its application (Sect. 4) and results (Sect. 5) in the study sites and across categories of farmers. The paper concludes by drawing broad inferences on the sustainability of small-scale farming with respect to ecological, economic and socio-cultural indicators.

2 Problems, policies and the study sites

Small farmers have been characterized as 'complex, diverse and risk-prone' (Chambers et al. 1989). Though there are several stress factors identified as affecting small farmers (Viswanathan et al. 2012), they are also recognized as possessing certain 'resilience factors' including efficiencies associated with the use of family labour, livelihood diversity allowing spreading of risks, and indigenous knowledge to help cope with crises. While some studies predict the decline in smallholder agriculture, some others see the possibility, given appropriate policies, of pro-poor growth based on efficiency and employment generation associated with family farms (Morton 2007).

Traditionally, agricultural economic theory believed that small farms were inefficient, this later shifted to an acknowledgement of an inverse relationship between farm size and productivity; however, it is still believed that large-scale, mechanized farms are more efficient than the peasant sector (Ellis and Biggs 2001). The validity of an inverse relationship between farm size and productivity depends on various factors including intensity of land and input use, soil fertility, opportunity cost of family labour, level of technology adoption and other managerial factors (Fan and Chan-Kang 2005). Thus, Verma and Bromley (1987) find no single answer to the relationship between farm size and agricultural productivity and state that preoccupation with this issue is often unnecessary. Chand et al. (2011) in turn argue that policies that aim to consolidate farm size because of supposed non-viability of smallholders will affect adversely the productivity and growth of the agricultural sector. They also find that marginal and smallholders in India have higher productivity (per acre) than larger farms, and a lower fertilizer imbalance index, because they use inputs in an efficient manner.

Meanwhile, loss of soil fertility, declining groundwater levels, water salinity, stagnating yields, slow agricultural growth, indebtedness and marginalization are problems that snowball into severe distress that often culminates in farmers' suicides (Vasavi 1999; Deshpande and Prabhu 2005) in India. A possible way to deal with the current agrarian crisis is to switch over to cost-effective and ecologically sustainable inputs, but their adoption at larger scales can be expanded only through policy support (Reddy and Galab 2006). Several policy measures were introduced to mitigate agrarian problems (Deshpande 2007), including loan waivers by central and state governments and crop insurance schemes.

Government of Karnataka in 2006 introduced the Karnataka State Policy on Organic Farming (KSPoOF[1]) in order to improve the sustainability of farm livelihoods. For smallholders in the state, organic farming mostly implies non-certified practices with self-reliance in most inputs.[2] The policy defined organic farming as farming that requires less external inputs, relying more on natural and human resources that are available in the farms. Thus, it aims at reducing farmers' financial burden, engaging them in productive activities on-farm and curbing migration to urban areas. It provides support for organic

[1] http://raitamitra.kar.nic.in/kda_booklet.pdf. Accessed on 21 Nov 2010.

[2] In fact the non-certified organic area has been much more than area under certified organic farming (Bhattacharyya and Chakraborty 2005).

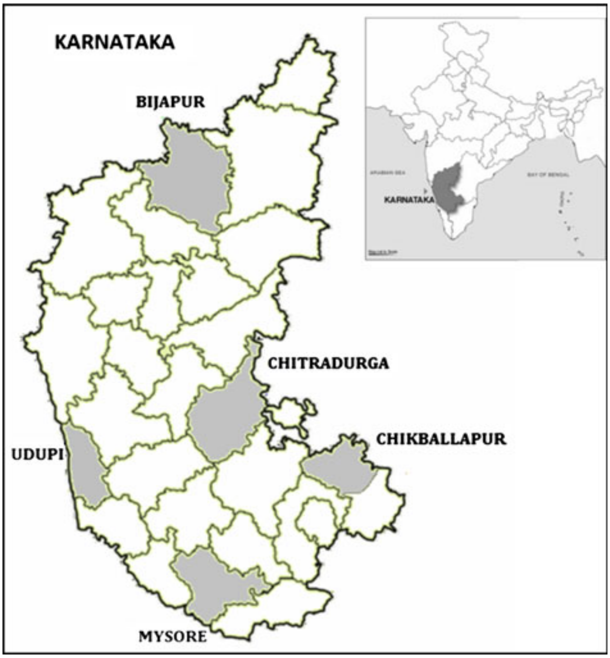

Fig. 1 Map of Karnataka, with study districts

seeds and seedlings, vermicompost pits, azolla culture, biopesticides and livestock. The policy has been implemented in all the taluks (subdistrict) of the state covering 100 ha of contiguous land area (mostly in one village) in each taluk. The KSPoOF was initially implemented with active involvement of local NGOs and is now being supplemented by larger statewide policies in the same direction (e.g. Karnataka State Organic Farming Mission, support for organic inputs from National Horticultural Mission) where NGOs are not involved. In KSPoOF, NGOs focused on guiding farmers through gradual conversion to organic cultivation, producing vermicompost and azolla culture and biopesticides as also in exchange visits and trainings. Since 2006, the number of farmers registered under the policy has grown fivefold, and budgetary support allocated for subsidies for organic inputs increased by nearly 20%.[3] Henceforth in the paper, 'organic' will refer to increasing use of organic inputs as influenced by various policies and not certified organic practices aiming at niche markets.

The study focuses on districts with notable temporal change in agricultural land use and farmers' distress as also that represents a cross-section of major agro-climatic regions in the state. Identification of study sites was based on analyses of temporal data on land use, cropping pattern and farmers' suicides followed by a workshop based on this analysis with researchers, officials and farmers. Selected districts—Bijapur, Chikballapur, Udupi, Chitradurga and Mysore (Fig. 1)—cover major agro-climatic zones of the state. The characteristics of these districts are provided in Table 1.

[3] http://www.kar.nic.in/finance/bud2010/budhig10e.pdf and Karnataka State Annual Budget 2011–2012.

Table 1 Characteristics of the districts studied

	Bijapur	Chitradurga	Chikballapur	Mysore	Udupi
Agro-climatic zone	Northern dry zone	Central dry zone	Eastern dry zone	Southern transition zone	Coastal zone
Geographical Area (ha)[c]	1,053,471	770,702	404,501	676,382	356,446
Average annual rainfall (2004–2008) (mm)[a]	582	656	841	815	4,274
Average size of operational land holding[b] (2005–2006) (ha)[b]	3.03	2.05	1.15 [g]	0.97	0.78
Net sown area (2008–2009) (%)[c]	71	51	26	49	26
Net irrigated area (2008–2009) (%)[c]	35	19	25	47	33
Fertilizers distributed (N + P + K, tonnes) (2009–2010)[c]	68,856	30,817	40,977	77,603	7,012
Population density (2011) (per km^2)[d]	207	197	298	437	304
Human development index (2001)[e]	0.59	0.63	0.63[g]	0.63	0.71
Farmers' suicides (2003–2007)[f]	408	1,058	241[g]	383	192

[a] Karnataka State Natural Disaster Monitoring Centre; DES (2006[b], 2011[c]); [d] Census of India 2011; [e] Karnataka Human Development Report 2005–2006; [f] State Crime Records Bureau, Government of Karnataka; [g] Chikballapur was formed as a new district from larger Kolar district on 23 August 2007, hence this data is available only for Chikballapur and Kolar combined

3 MCA in assessing sustainability of farming

Agricultural sustainability is not precisely measurable (and hence not easily comparable), especially because externalities of any agricultural system are very difficult to measure (Pretty 1995). Nevertheless, it is now accepted that the best way of developing management strategies to address challenges in the farming sector is to view the agricultural system as an integrated whole (Reenberg and Paarup Laursen 1997; Ikerd 1993; Zander and Kachele 1999), and studies (e.g. Cai and Smith 1994; Van Calker et al. 2005) suggest that sustainability should be studied in terms of its economic, social and ecological aspects.

Multicriteria analysis (MCA) is generally used to assist decision-makers faced with such numerous and sometimes conflicting evaluations. Multicriteria decision-making techniques are particularly helpful in the short term, while in the long term, more efforts can be made towards understanding the costs and benefits involved (Tiwari et al. 1999).

MCA is also regarded by some as a dialogue tool and is not meant to provide a prescriptive solution. Multiple-criteria decision aid evolved from Keeney and Raiffa (1976) and Munda et al. (1994) is used to build alternative solutions and to help in decision-making among stakeholders with differing preferences. The open and explicit nature of MCA provides it with advantages over informal judgment (see Dodgson et al. 2009). MCA can thus be used to compare the consequences of different scenarios on sustainability criteria. A review of potential MCA applications in the context of farm sustainability (Sadok et al. 2008) indicates that there are few such applications in tropical agriculture.

This study uses MCA to compare the indicators of sustainability of small farms in different practice/policy scenarios rather than to arrive at a unique solution. The first step in understanding sustainability criteria involves the translation of ecological, economic and

Table 2 LUFs and indicators for assessment criteria

Assessment criteria	Land use function	Indicator	Measurement of indicator
Ecological	Ecosystem processes	Soil fertility	SOC (% of total carbon)
	Water	Water quality	1/EC $(dS/m)^{-1}$
	Biodiversity	Agro-biodiversity	(Species of crops, domesticated animals and multipurpose trees)/acre
Economic	Economic production	Net income	INR/acre/year
	Provision of food	Food from farm	kg/person/year
	Financial services	No overdue loans	Probability from logistic function
Socio-cultural	Social capital	Collective activities	Number
	Social equity	Asset distribution	Range between average high and low asset indices for the village

social complexity into a more limited number of functions and attributes (Limburg et al. 2002 cited in Zendehdel et al. 2008). The process includes selection of indicators within a land use function (LUF) framework (following Pérez-Soba et al. 2008; König et al. 2010), collection of primary data and comparing indicators in two current situations and future scenarios. Stakeholders' preferences for each LUF were collected through deliberation and consensus building in Participatory Impact Assessment (PIA) workshops, to be applied as weightages in MCA.

3.1 Indicator framework

Land use functions are defined as those goods and services that are produced through land use in its interaction with the geophysical and socio-cultural landscape and that summarize the most relevant societal, economic and environmental issues of a region (Pérez-Soba et al. 2008). Each of the three assessment criteria (ecological, economic and socio-cultural) of farm sustainability is represented by a set of LUFs. For each LUF, a corresponding indicator was chosen (Table 2). Indicators were selected based on our understanding of the local context, consultation with local stakeholders and data measurability. The MCA attempts to compare indicators of the land use functions in two scenarios involving organic and non-organic input application.

3.2 Measurement of indicators

Primary data were collected in the study districts on socio-economic parameters, soil and water quality and agro-biodiversity. Of the three ecological indicators, soil organic carbon (SOC), an important indicator of soil fertility and productivity, is measured in terms of the proportion of active carbon content in soil and water quality (WQ) is given by the inverse of electrical conductivity.[4] Agro-biodiversity (BD) is quantified as the number of species (crops, domesticated cattle and all multipurpose trees) per acre of farmland.

Among the economic indicators, net income (IN) is calculated by subtracting cash expenses on material (organic and inorganic) inputs, hired labour and transport from the

[4] The quality of irrigation water depends on the amount of salts dissolved. The greater the dissolved salts, greater the EC (measured in deciSiemens/meter) and poorer the quality of water.

gross agricultural income per acre. Here, some of the organic inputs are farm-generated, and when there is additional requirement for organic manure, we attribute a shadow price (price prevailing in informal transactions[5]) for meeting the additional requirement of organic inputs that is in excess of what is produced on farm. For mineral fertilizers, the prevailing market price was used. Thus, IN is of two types—(a) net cash income and (b) net income with attributed price for additional organic manure. Food from farm (FF) is measured as the quantity of food (grains and vegetables) grown in the farm that is available for consumption (per head) in the farm family. The indicator no overdue loans (NDT) is the probability[6] of the farmer not having defaulted or overdue loans.

We selected two socio-cultural indicators, asset distribution (AD) and collective activities (CA), to represent the socio-cultural LUFs. Asset distribution is measured as the range of asset index (index of land area, vehicles and gadgets owned) in the village. The indicator is measured as the range between (average) asset index for households above and below the mean asset index of all households in the village. Thus, an inverse of this range was considered, so that the higher this number (to be in line with the direction of values for other indicators), more equal the distribution of assets in the village. Collective activities are measure of involvement of the family in village events and activities. It is the number of associations, groups or events in the village that family members participate in.

Using the above-mentioned eight indicators, we assess the current and projected effect of policy-driven changes in farming practices on ecological, economic and socio-cultural LUFs of small farms in the selected districts.

3.3 Data for quantifying the indicators

For initial implementation of the KSPoOF, one village per taluk was selected by the department of agriculture based on willingness among farmers, availability of livestock and presence of local NGOs. Three villages where the policy was implemented since 2006 (policy villages) and three neighbouring (non-policy) villages where KSPoOF had not been implemented were selected in each study district (except for Udupi, a smaller district, where only 4 villages were selected in total). In 2009–2010, we conducted a primary survey using a tested semi-structured questionnaire in 14 ‘policy’ villages and 14 ‘non-policy’ villages. Thus, data are available from villages where organic practices had been supported for more than 3 years (since 2006) and for neighbouring villages where such incentives were not given. Small farmers were the target beneficiaries of organic farming policy although large farmers were not totally excluded from the policy. In four out of five districts studied, the farm households selected for socio-economic interview had an average landholding size between 2.25 and 6.3 acres (0.9 and 2.6 ha), while in Chitradurga, the landholdings were larger with an average size of 13.5 acres (5.62 ha). Small farmers (with landholding $<$2 ha) constituted 61% out of total 260 respondents in all districts.

Analysis of the data collected revealed that there were also farmers who applied considerable amount of organic manure in non-policy villages. Since the policy emphasis was not on complete conversion to certified organic farming, we decided to classify farmers into two groups based on the quantity of organic fertilizer applied per unit area of land.

[5] No formal existing market for farm yard manure.

[6] The probability of being free from overdue loans is measured using a binary logistic function for each district. Most common determinants of this probability were Cropping intensity, Gross agricultural income, Landholding size, area under commercial crops and irrigation. Equation explaining probability of being free from overdue loans is given in “Appendix 3”.

One group of farmers, the 'with-policy' (WP) group, included those farmers who applied (either voluntarily or by policy influence) 70% or more nutrients out of the total input application sourced from organic matter. The other group, 'Business as usual' (BAU), was formed of farmers whose organic nutrient use was less than 70% of the total nutrients applied. However, in Udupi, only farmers who applied 100% organic matter were classified as 'WP', as the availability and use of organic matter (farm yard manure, leaf manure) was higher compared to other districts, owing to the nature of major crops like areca and paddy (Sinu et al. 2012) and more biomass in the landscape.

The questionnaire used for primary data collection of socio-economic information of farm household covered details about the family, education, cropping pattern, crop inputs, crop yield, livestock, trees, gadgets and machinery, housing, irrigation, income, food consumption (bought and produced), assets, marketing facilities, collective activities, labour employed and defaulted loans. Soil and water samples from the farms (in both WP and BAU groups) were collected and analysed for SOC and Water EC at the state run Krishi Vigyan Kendra (KVK) laboratories in the respective districts. The data collected were used to compute values of the indicators as explained in Sect. 3.2.

Table 3 gives the average values of indicators quantified using data collected through interviews, farm observations and soil and water analysis in WP and BAU farmers in the study villages. The numbers in parentheses against each group in the table indicate the number of households surveyed.[7]

Ecological indicators measured higher in WP farms compared to BAU, except for water quality in Mysore. In three study districts, adopting WP farming practices has helped farmers to improve net income and also to escape defaulting on loan repayments. However, food consumption from their own farms is less in WP farms (compared to BAU) in three districts, which is poorer among the study sites. Collective activities are higher in WP than in BAU (in four districts), whereas distribution of assets is often less equal in WP than in BAU (in three districts).

Though the comparison of present situation is useful, it needs to be verified for the nearby future[8] to be more prescriptive about corresponding policy drivers. Thus, we attempt a short-term projection of these patterns in indicators found in 2009, using MCA based on weightages attributed by stakeholders.

3.4 Inclusion of community preferences

In the deliberative traditions of MCA, stakeholders' preferences for important LUFs were an integral part in this MCA exercise. The method used follows a cardinal form of deliberative multicriteria evaluation (Zendehdel et al. 2008) that integrates results of deliberation and stakeholder interaction towards consensus building into the MCA. We draw upon information from Participatory Impact Assessment (PIA) workshops organized in the study sites where stakeholders were asked to attribute weightage to the selected LUFs to signify their importance. On an average, across the five districts, higher weights were attributed to the ecological and economic LUFs than to the socio-cultural LUFs (Fig. 2). PIA workshop in Bijapur (the poorest of the study districts) ranked provision of food as the most important function of their land, and participants from Udupi (the most developed of the study districts) ranked water quality and soil fertility as most important.

[7] Comparison of mean values of other key variables for WP and BAU groups is presented in "Appendix 1".

[8] Especially since it was not feasible to get enough sample farms following strictly the selected practices for a comparable time period.

Table 3 Mean indicator values (in 2009) for sample households

Indicator	Bijapur		Chitradurga		Chikballapur		Mysore		Udupi	
	WP (30)[@]	BAU (15)[&]	WP (33)	BAU (10)	WP (63)	BAU (35)	WP (29)	BAU (14)	WP (23)	BAU (8)
Soil organic carbon (%)[a]	*1.18*	1.00	*0.49*	0.44	*0.51*	0.39	*0.73*	0.60	0.49	*0.50*
Water quality (inverse of EC)[b] $(dS/m)^{-1}$	*1.38*	0.91	*0.79*	0.62	0.57	*0.58*	1.34	*3.98*	*2.55*	1.83
Agro-biodiversity (species/acre)	*3.68*	3.19	*1.19*	0.66	*2.03*	1.30	*2.54*	2.00	*2.61*	2.34
Net cash income (INR/acre/year)	*11,935*	−1,992	*34,536*	7,197	*1,648*	1,416	2,633	*5,835*	*26,149*	20,455
Net Income (with shadow price for organic inputs) (INR/acre/year)	*9,997*	(−5,831)	*27,708*	6,589	(−13,350)	*(−9,839)*	(−3,886)	*(−464)*	*(−7,393)*	(−10,627)
No overdue loans (probability)	*0.95*	0.95	0.44	*0.55*	0.23	*0.25*	*0.70*	0.43	*0.55*	0.44
Food from farm (kg/capita/year)	420	*511*	925	*1145*	354	*519*	*885*	388	*1071*	653
Collective activities (number)	*0.50*	0.33	*0.88*	0.80	*0.68*	0.66	0.07	*0.14*	*1.30*	1.13
Asset distribution (inverse of range between average high and low village asset indices)	1.17	*1.73*	1.27	*1.51*	*0.95*	0.91	*1.70*	1.06	1.61	*1.68*

Higher values italicized

n (WP) = 178 and n (BAU) = 82

[a] threshold: minimum of 0.5%; [b] threshold: maximum of 2 $(dS/m)^{-1}$

[@] *WP* 'with policy' applying 70% or more of total nutrients as organic matter; [&] *BAU* 'business as usual', farms applying less than 70% of total nutrients as organic matter

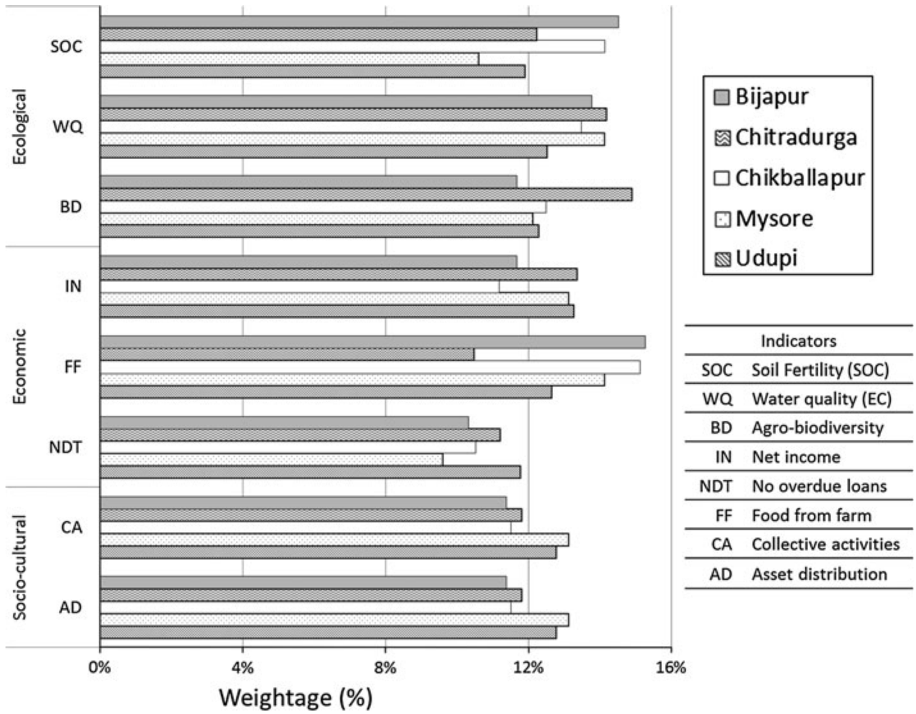

Fig. 2 Preference for LUFs from PIA

3.5 Projecting the impact of practices in different scenarios

Assessment of multidimensional sustainability is instrumental in evaluating the varied benefits and drawbacks of any target policy, so that mitigation strategies for possible negative impacts can be prepared while implementing the policy for different target locations and groups. Quantitative scenario descriptions allow the assessment of change in indicators in different policy/practice scenarios from the baseline situation. We opted for a target year (2015) that was 5 years from the assessment year (2009–2010) for scenario development, considering the turnover period of policies in line with the tenure of a government and the period for national planning (both 5 year) in India.

The scenarios used for the MCA analysis were based on expert knowledge, past trends in the state, stakeholders' views from PIA workshops and past trends in policies. "Appendix 2" provides the assumptions on all variables in the two scenarios. The major difference between the scenarios is the relative quantity of different inputs used. For example, in the WP scenario, it was learnt reasonable to assume 40% increase in the quantity of organic inputs and 20% decrease in the quantity of chemical inputs for all districts in line with stated policy goals. Similarly, in the BAU scenario, it is assumed that the quantity of inorganic inputs used would increase by 30%, and organic inputs would decrease by 30%. Among the soil and water parameters, soil organic carbon was assumed to change because of the policy emphasis on organic inputs and because of the current levels of soil carbon in WP and BAU farms (Table 3). Variables like 'extent of commercial crops', 'irrigated area' and 'cropping intensity' were expected to change, but depending on

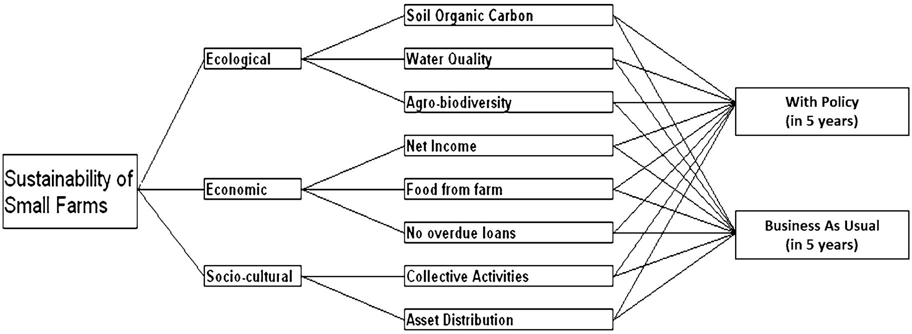

Fig. 3 Framework of hierarchical process for impact assessment

the public investments in irrigation projects and infrastructure like road networks and markets. Landholding size and rainfall are assumed to be largely unaffected during the period till 2015. The values of the indicators were projected to 2015, using regressions and expected changes in explanatory variables in the two scenarios.

Ordinary least square regression was used to identify the causal relationships between the selected LUF indicators and the economic, environmental, social and institutional dimensions of the prevailing situation in the district as also to project the values of the indicators in 2015.[9] Independent variables used in the regression equations were tested for multicollinearity and modified as explained above for the scenarios WP and BAU before predicting the value of dependent variables for 2015.

3.6 MCA for comparing the scenarios

The software *Criterium Decision Plus* (CDP) was used to carry out the multicriteria analysis by comparing the projected impact of the two scenarios based on indicator values (as in Sect. 3.5) and weights acquired from PIA (as in Sect. 3.4). The projected values of indicators using the regression with the two scenarios (equations in "Appendix 3") and LUF weights (as in Fig. 2) are entered in CDP. CDP uses a decision tree (Fig. 3) to normalize indicator values and attribute weights to indicators.

In CDP, threshold values and ranges are objectively set for all indicators, in order to normalize values of indicators, so that they can be compared, as these thresholds[10] affect the overall score of sustainability.

4 Results and discussion

The comparative performance of indicator scores between WP and BAU after a 5-year period across the study districts is depicted in Table 4 (not to be compared among the districts, but between the scenarios for each district). Figure 4 compares small and big landholdings, and Fig. 5 compares rain-fed and irrigated farmers. All the three sets of

[9] Regression equations determining indicators values are provided in "Appendix 3".

[10] For most indicators, the threshold is given by the minimum and maximum values in the data, so that they can be normalized and compared. SOC and WQ were normalized using standard threshold levels of 0.5–2 and 2–0 respectively.

Table 4 Impact on selected indicators in two scenarios across study sites

Indicators	WP better than BAU	WP same as BAU	WP worse than BAU
Soil organic carbon	Mysore, Chitradurga, Chikballapur, Bijapur, Udupi	None	None
Water quality	Bijapur, Chitradurga, Mysore, Udupi	Chikballapur	None
Biodiversity	Chitradurga, Bijapur, Mysore. Chikballapur, Udupi	None	None
Net income	Bijapur, Chitradurga, Mysore, Chikballapur, Udupi	None	None
Net income (with shadow price for organic inputs)	Chitradurga, Bijapur, Udupi, Mysore, Chikballapur	None	None
No overdue loans	Bijapur, Mysore, Chitradurga, Udupi, Chikballapur	None	None
Food from farm	Udupi, Chikballapur, Mysore, Bijapur, Chitradurga	None	None
Collective activities	Chitradurga, Bijapur	Udupi	Chikballapur, Mysore
Asset distribution	Chikballapur, Udupi, Mysore	Bijapur	Chitradurga

The actual projected values are in "Appendix 4", and the difference in values between the scenarios from CDP are in "Appendix 5"

results use two variants of the indicator 'net income' (IN), with and without the shadow price for additional organic inputs expected to be used in the coming years in WP. The rationale here is the uncertainty about self-sufficiency in sourcing these organic inputs from own farms, given the current levels of biomass and livestock in the farm holdings.

Altogether, the only trade-off in WP in the run up to 2015 (from 2009) was found to be only in socio-cultural indicators for three districts (Mysore, Chikballapur and Chitradurga). Otherwise, no indicator was adversely impacted in any district in WP.

Despite the districts having different physical and social characteristics, most of the selected indicators perform better even in the short term, with policies favouring organic inputs going against the arguments in literature for adverse impacts on crop yields (e.g. Bhattacharyya and Chakraborty 2005; Ramesh et al. 2010) affecting farm household economy. In other evaluations like Gómez-Limón and Sanchez-Fernandez (2010), private environmental benefits from reduced use of artificial fertilizers emerge greater than the increase in profits obtained from their use. Apart from the private benefits considered here, the use of organic inputs (instead of chemical fertilizers) statedly has potential for mitigating greenhouse gas emissions from avoided production and application of fossil fuel-based fertilizers and soil carbon sequestration (Tirado et al. 2010). Imbalanced use of fertilizers and pesticides, leading to deterioration in soil and water quality and pesticide resistance, could add to financial burden, thus linking agricultural practices and financial viability. Unlike the already cited literature on adverse impacts on income and crop yield with organic farming, the adverse trade-off in WP here was unexpectedly on socio-cultural indicators in three of the five study districts. Such disaggregated results provide pointers as to where and how to anticipate varied potential impacts of policies.

Despite not attaching price-premium for organic produce, net income in WP is projected to be higher than in BAU for the study districts. This economic advantage with organic practices in terms of cost savings is also found in Padel and Lampkin (1994) and Offermann and Nieberg (1999). Thus, we differ with the arguments for premium price for organic products as precondition for the success of organic farming (Ramesh et al. 2005) and also point towards the need to transform prevailing institutions and collective activities around the use of capital intensive inputs like credit and fertilizer cooperatives, into local networks around production and use of organic inputs.

Districtwise analysis does not give us insights into disaggregated relative impact of practices on small and big farms or on rain-fed and irrigated farms. Thus, we pool the data across districts to compare WP and BAU for small (up to 2 ha) and big farms as well as rain-fed (irrigated area less than or equal to 20% of total landholding) and irrigated farms.

Figure 4 shows the results for the impacts of a change from BAU to WP for farms of different holding size. Important revelations are as follows: a) most indicators exhibit similar directions of change in WP across big and small holdings (except collective activities that is worse off in small farms and water quality that shows improvement in small farms compared to big farms); b) WP helps both big and small farmers to move away from indebtedness; and c) household consumption of own farm produce in small and big farms does not improve significantly with WP, implying that more organic inputs do not necessarily mean less area under commercial crops.

Our analysis also proves that harnessing the complete economic advantage of WP depends on in situ generation of inputs, and hence, if the government intends to support organic inputs (see Fig. 4 for the difference between WP and BAU with and without shadow price for additional organic inputs), the incentive should be to produce them in situ rather than for an industrial scale production and marketing (as followed currently for mineral fertilizers). Cost savings mean non-requirement of large credit for small farmers, thus reducing financial risks at times of crop failures, often a cause of indebtedness among farmers (Sidhu and Gill 2006). The results of reduction in accumulated debts and income gains (see the 'no overdue loans' in Table 4 and Fig. 4) indicate that policies (that favour BAU-style practices) towards industrial agriculture and large mechanized farms (Gulati et al. 2008; Mani and Sinha 2010) may be unwarranted, even from an economic point of view. Some of these observations resonate with the results of rain-fed *vs* irrigated farms as the average size of irrigated farms (4 acres) is almost half of the rain-fed farms (7.68 acres).

Figures 4 and 5 show that the overall incremental changes from BAU to WP are better for small holdings and rain-fed farms. This is comparable to other studies showing relative benefits of organic farming in rain-fed farms *vis-a-vis* intensively cultivated areas (e.g.

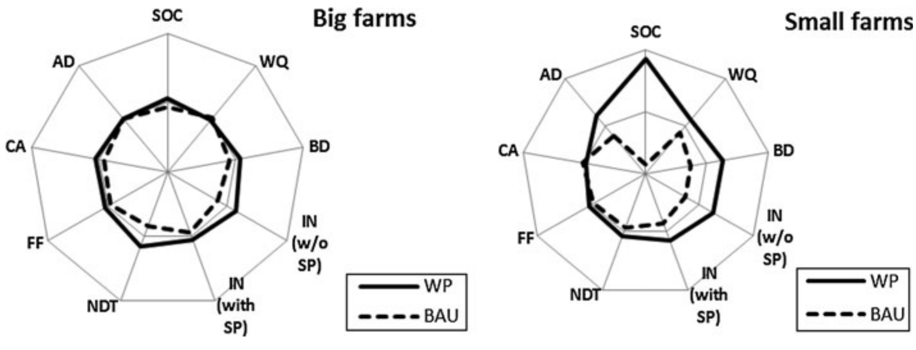

Fig. 4 Impact on indicators in two scenarios for different holdings. *Note*: Big farms ($n = 101$): more than 2 ha; Small farms ($n = 159$): ≤ 2 ha

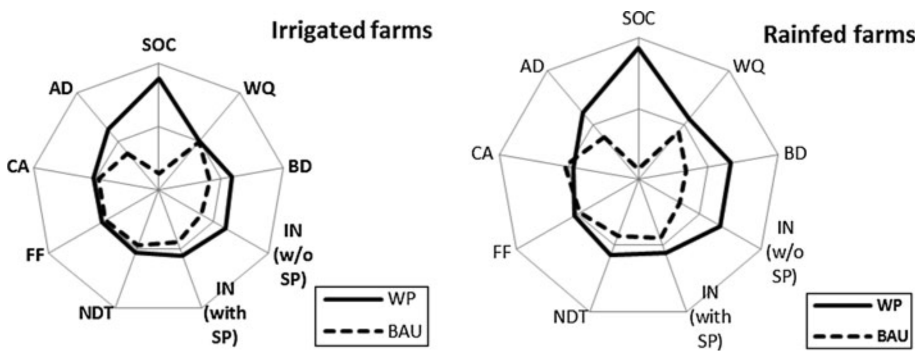

Fig. 5 Impact on indicators in two scenarios for rain-fed and irrigated farms. *Note*: Rain-fed ($n = 92$): Irrigated area ≤20% of the total land holding; Irrigated ($n = 168$): irrigated area more than 20%

Ramesh et al. 2005). Surprisingly again, the Fig. 5 also shows that WP does not aid rain-fed farmers in deriving more food for subsistence from land; in fact, it does not vary much across big, small, rain-fed or irrigated farms. This indicator is influenced by the access of households to the public distribution system (PDS) (as stated also in Purushothaman 2005) and wherever PDS performs well with assured and cheaper access to food grains for the family, farmers grow crops for the market. Nevertheless, in WP, they could be reaping additional benefits in terms of other indicators, though WP by itself is not enough to make them grow coarse grains/food crops.

The adverse trend in collective action in small and rain-fed farms implies the need to revive and revitalize village social platforms for farmers to interact on the techniques and practices involving organic inputs as current institutional mechanisms are mostly around fertilizer and credit cooperatives and dominated by large farmers. Adverse performance of asset distribution in irrigated WP is less explainable but could be attributed to the correlation of small holdings with irrigation as also the currently less mechanized operations in small farms following organic practices.

Although this study makes an attempt to trace a range of indicators to evaluate sustainability, we concede that these indicators do not cover the entire spectrum of factors affecting sustainability of small farms.

5 Concluding remarks

At a time when there are apparent attempts to wean small farmers from their occupation given the expected economies of scale from consolidation of farm land in corporate farming (Gulati et al. 2008), amidst a widely discussed agrarian crisis and the ironic coexistence of food price inflation and farmers' suicides, it is critical to look at the prospects of small-scale agriculture in India, given the negative effects of conventional agriculture on soil, water and health as well as challenges posed by climate change, water scarcity, decline of biodiversity, socio-economic problems. The objective of the study was to compare the impact of recently incentivized sustainable farm practices (WP) with that of conventional non-organic practices (BAU) on small farms using deliberative but cardinal MCA.

The economic benefits in terms of freedom from indebtedness and income gains, slight reduction in collective action and almost no impact on land-based subsistence (in both rain-fed and small farms) are the emerging short-term prospects with policies supporting organic inputs. Although WP emerges better with respect to income, benefits are better if inputs are generated in situ. Though WP does not improve the food sourced from own land and involvement in collective activities, the ecological and economic benefits make the case for support for in situ production of organic manures and fertilizers, along with catalysing the emerging institutions for weaving collective activities around these practices.

The largest projected benefits from policies favouring sustainable agriculture among the study sites in Karnataka were seen in Bijapur and Chitradurga, where ecological and economic indicators benefit significantly. Results in these drier and underdeveloped districts indicate that such policies (promoting sustainable agriculture) have a good potential in resource-poor areas. Given the weightages elicited from PIA, it appears that WP is in line with what farmers want, except for food raised from own farms, that is often valued as the most important use of one's land (e.g. in Bijapur).

The MCA results show that implementation or continuation of policies that favour organic farming practices can help small farming sustain as an occupation though the nature and extent of impact on ecological, economic or socio-cultural criteria differ across districts. The paper also illustrates the potential application of MCA with participatory and quantitative processes, in a disaggregate analysis of multidimensional impacts of farm policies.

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Appendix 1

See Table 5

Table 5 Mean values of key variables in WP and BAU for 2009

Variables	Bijapur		Chitradurga		Chikballapur		Mysore		Udupi	
	WP (30)	BAU (15)	WP (33)	BAU (10)	WP (63)	BAU (35)	WP (29)	BAU (14)	WP (23)	BAU (8)
Landholding (acre)	2.25	2.80	10	17	4.89	4.9	3.41	6.3	4.32	3.99
Education (number of years of schooling)	4	6	10	10	7	8	4	7	5	3
Food crop yield (kg/acre)	1,600	917	1,790	1,538	750	734	1,100	1,088	2,200	1,000
Commercial crop yield (kg/acre)	4,560	2,390	1,313	2,368	3,700	2,690	1,569	1,400	400	600
Livestock (number/acre)	4	3	1	1	2	1	3	2	2	1
Organic input (kg/acre)	11,965	409	5,663	1,097	4,756	1,984	2,771	1,588	7,523	5,961
Inorganic input (kg/acre)	0	177	26	230	40	152	11	162	0	290
Extent of Irrigation (%)	76	78	22	7	62	47	51	45	38	29
Cropping intensity (%)	172	194	107	79	77	59	136	157	114	85
Commercialization (%)	46	42	85	90	44	58	38	63	66	61

Mean values for 2009

Values enter regression equations in "Appendix 3"; Mean values for LUF indicators are in Table 3

Appendix 2

See Table 6

Table 6 Scenario assumptions for projecting indicator variables to 2015

Variable	Acronym used in "Appendix 3"	With policy (WP)	Business as usual (BAU)
Livestock (number/acre)	ANC	(+)10%	(−)10%
Agro-biodiversity (number of species/acre)	BD	(+)10%	(−)10%
Collective action (number)	CA	(+)10%	(−)10°%
Commercial crop ratio (%)	CC	No change	(+)10%
Home grown food consumption (kg/person/acre)	FF	(+)10%	(−)10%
Cropping intensity (%)	CI	(+)10%	(+)10%
Crop species (number)	CrSP	(+)10%	(−)10%
Cultivated land holding (acres)	CULH	(+)10%	(+)10%
No overdue loans (probability)	NDT	(+)10%	(−)10%
Ground water level (feet)	GRW	(−)10%	(−)10%
Chemical fertilizer (kg/acre)	CFZ	(−)30%	(+)30%
Net income (INR/acre/year)	IN	No change	No change
Organic fertilizer (kg/acre)	OFZ	(+)40%	(−)20%
Extent of irrigation (%)	IRLPR	(+)10%	(+)10%
Land holding (acre)	LH	No change	No change
Plantation crop species (number)	PlSP	(+)5%	(+)10%
Soil organic carbon (%)	SOC	(+)10%	(−)10%
Tree species (number)	TrSP	(+)10%	(−)10%
Water quality (inverse of EC)	WQ	No change	No change

These variables also include selected indicators as they often influence one another

Appendix 3

See Table 7

Table 7 Regression equations determining indicator values for 2009

Indicator	Bijapur	Chitradurga	Chikballapur	Mysore	Udupi
SOC	−CULH**, −IRLPR**, +CrSP**, +ANC*, +CFZ* (49%)	−IRLRP**, +GRW*, +BD*, −PlSP**, +CC** (30%)	−CULH**, +CI**, −CFZ** (45%)	−CI**, −CFZ**, +BD* (39%)	+IRLPR*, +CFZ*, −CC*, +WQ*, +BD**, −ANC** (49%)
WQ	−CFZ*, +BD*, +CrSP** (64%)	+IRLPR*, +CI*, +OFZ** (57%)	−IRLPR**, +CC**, +CrSP**, −PlSP** (70%)	+CULH**, +IRLPR*, +OFZ**, +GRW**, +CrSP** (78%)	+CC*, −CrSP**, +IRLPR*, −CFZ* (42%)
BD	+CI**, +NDT**, +FC**, +FF**, +ANC** (79%)	+IRLPR**, +CI**, +OFZ**, +ANC** (72%)	+IRLPR*, +CI**, +OFZ*, +ANC** (40%)	+IRLRP**, +CI**, +OFZ**, +ANC** (75%)	−CULH**, +IRLPR**, +NDT*, +CFZ**, +PlSP**, +SOC** (81%)
IN	−CULH**, +OFZ**, −CrSP**, +PlSP** (73%)	−CULH**, −IRLPR**, +OFZ**, +CC* (57%)	+CI**, −CrSP**, +BD*, −CFZ** (61%)	+WQ**, −CULH**, −IRLPR**, +CA** (68%)	−CULH**, −CFZ**, +CC*, −CrSP** (34%)
NDT	+IRLPR**, −CI**, +CrSP**, +BD* (60%)	+IRLPR**, −CI*, +OFZ**, +CFZ*, +CC* (63%)	+CULH**, +OFZ**, −CC**, +CrSP** (72%)	−CC**, +BD**, +PlSP**, −CrSP** (68%)	−CULH**, −CFZ*, −CC*, +FF** (59%)
FF	+IRLRP**, +CA**, −OFZ**, −PlSP**, +BD** (63%)	+CULH**, +NDT*, +OFZ*, −CC** (40%)	−IRLPR**, −CI**, +CFZ**, −CC**, +CrSP*, +SOC** (57%)	−CI*, −CFZ**, +CrSP** (40%)	+CULH**, +ANC**, +CrSP*, −PlSP* (76%)
CA	+CC**, +CrSP*, +PlSP** (48%)	+CrSP**, +ANC*, +BD*, −NDT* (56%)	−PlSP**, +ANC*, −CC* (71%)	−CULH**, −IRLPR**, +CFZ**, −ANC* (49%)	−CULH**, −CC*, +IRLPR*, −NDT* (61%)
AD	−CI*, +NDT*, +CC*, +IN* (59%)	+OFZ**, +CrSP**, −PlSP** (64%)	+IRLPR**, +CrSP**, +SOC**, −CA** (91%)	−CI**, −PlSP*, −ANC**, −CA** (77%)	+CA**, +NDT**, +PlSP**, +CI** (62%)

Acronyms explained in Table 6 (Appendix 2)

* Significant at 95% level; ** significant at 99% level; Numbers in parenthesis indicates R^2 of each regression equation in each district

Appendix 4

See Table 8

Table 8 Projected mean values of indicators (in 2015)

Criteria	Indicators	Bijapur		Chitradurga		Chikballapur		Mysore		Udupi	
		WP	BAU	WP	BAU	WP	BAU	WP	BAU	WP	BAU
Ecological	Soil organic carbon	*1.13*	0.79	*0.50*	0.46	*0.49*	0.46	*0.80*	0.50	*0.51*	0.48
	Water quality	*1.61*	0.88	*0.80*	0.71	*0.57*	0.58	*2.39*	2.37	*2.61*	2.22
	Biodiversity	*4.36*	3.02	*1.24*	0.59	*2.27*	1.87	*2.73*	2.23	*2.73*	2.44
Economic	Net income	*11,935*	−1,992	*34,536*	7,197	*1,648*	1,416	*2,633*	5,835	*26,149*	20,455
	Net income (with shadow price for organic inputs)	*12,866*	−8,290	*3,652*	−18,614	*−12,208*	−12,508	*−3,864*	−9,855	*−7,612*	−11,289
	No overdue loans	*0.97*	0.93	*0.72*	0.57	*0.23*	0.22	0.73	0.41	*0.47*	0.44
	Food from farm	*476*	468	*1,235*	1,127	*531*	99	*933*	865	*1,474*	1,016
Socio-cultural	Collective activities	*0.46*	0.45	*0.88*	0.81	0.64	*0.69*	0.11	*0.18*	*1.24*	1.24
	Asset distribution	*1.37*	1.37	1.35	*1.44*	*0.95*	0.91	*0.84*	0.45	*1.69*	1.62

Higher values italicized

Projected values of other key variables are assumptions made for scenarios as listed in "Appendix 2"

Appendix 5

See Table 9

Table 9 Difference in CDP values between WP and BAU

Indicators	WP better than BAU	WP same as BAU	WP worse than BAU
Soil organic carbon	0.71, 0.67, 0.60, 0.37, 0.33	None	None
Water quality	0.49, 0.19, 0.16, 0.02	0	None
Biodiversity	0.60, 0.25, 0.17, 0.10, 0.07	None	None
Net income	0.37, 0.19, 0.06, 0.03, 0.01	None	None
Net income (with shadow price for organic inputs)	0.45, 0.37, 0.17, 0.05, 0.01	None	None
No overdue loans	0.33, 0.27, 0.27, 0.04	None	None
Food from farm	0.44, 0.21, 0.15, 0.05, 0.01	None	None
Collective activities	0.14, 0.02	0	(−0.06, −0.29)
Asset distribution	0.26, 0.11, 0.02	0	(−0.26)

Values appear in the same order of districts as in Table 4

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