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Agri-environmental attitudes of Chinese farmers – The impact of social and cognitive determinants

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Abstract
Chinas' succcessfully increased food production during the last 30 years has caused significant negative external impacts and subsequent escalating environmental costs (Ash and Edmonds, 1998). This dilemma has recently become a popular issue and the government attaches great importance towards a more sustainable agricultural production (UNDP, 2006). The challenge is to enhance well-grounded approaches that accomplish of effective agricultural trainings, encouraging farmers to adopt optimized practices. According to recent decision-making theories, a successful implementation is also closely related to the target group's social and cognitive preferences. In order to get more information about farmers' inherent decision-making factors an explorative quantitative survey of 394 farmers was conducted in Shandong Province. Next to descriptive economic and agronomic analyses, a structural equation model gave evidence that beside farmers' economic reasons, values and *guānxi*-relationships indeed show an influence on the extracted agri-environmental attitude factors as well as on manifest behaviour variables. Concluding results reveal the farmers varying preferences and give explanations out of the social and cognitive paths to explain why they behave different or have other focussed attitudes. Finally, recommendations for more effective training methods are given that consider the farmers' individual motivations.

Keywords: China; agri-environmental attitudes; guānxi; SEM; values

1 Introduction

Within the last 30 years, China's agriculture is driven by a success story. At the end of the 1970s, Deng Xiaoping's reforms of the market mechanisms and the renunciation of peoples' collectives effected an increased production of in average 5 percent annually, especially for grains in the fertile north and eastern plains. Arable land was reallocated to the households and agricultural inputs inter alia the production of mineral Nitrogen fertilizers, was subsidised heavily (Hoering, 2010). Today, agriculture in China contributes in a remarkable manner to environmental problems. Next to inadequate pesticide use and irrigation practices, the application of contaminated effluents and organic fertilizers from intensive animal husbandry as well as overfertilization with mineral nitrogen fertilizers are very common problems in China and lead for instance to total loss rates of nitrogen between 45-50 percent followed by nitrate and heavy metal leaching into aquatic systems, causing groundwater pollution (Ju *et al.,* 2004). Thus, a premium and secure sustainable agricultural production and rural development is gradually more endangered due to land and water scarcity, environmental pollution and its resulting problems as well as an emerging emigration of rural workers due to income security problems and increased consumer demands.

These economic and agri-environmental transformations are accompanied by rising hedonistic values, displacing the traditional way of life (Kwong, 1994). According to Harris (2004), this would have the consequence that ecological values in China are subsumed by economic objectives, except when there are immediate and painful consequences of environmental damage that affect economic prosperity. Particularly among poorly educated people in rural areas Qing and Vermeer (1999) stated, that there is low public awareness of the environment because people first of all tend to aspire towards a modern life-style. This is not to say that there are no environmental values in China at all, but they would be generally associated with personal well-being rather than protection of nature per se in an altruistic sense (Harris, 2004). Nevertheless, nothing was found from literature regarding the farmers' fundamental values or impact of their social relationship networks on their agri-environmental behaviour, not to mention the environmental attitudes they hold on or dispositions towards their agricultural decision-making. The conducted explorative research therefore attempts to develop a model that fits to the farmers' special situation. This is quite an innovative approach and should be regarded as a first examination that needs to be improved in further steps.

Thus, in order to promote mitigation and adoption options for sustainable and resource saving food production in rural agricultural systems of developing and emerging countries, the farmers' behaviour and their production decisions are crucial. But the mental processes are

complex and decision-making must be regarded from several sides. From a psychological perspective, it is necessary to examine individual decisions out of values and resulting preferences in the context of a set of needs. The cognitive decision making process must be regarded as a continuous process integrated in the interaction with the environment (peer pressure, group-thinking, social norms). From a normative perspective, the analysis of individual decisions is concerned with the logic of decision making, the individual's rationality and the invariant choice it leads to (Kahneman and Tversky, 2000). Emanating from these assumptions, an intensive literature review was accomplished first, in particular taking into account the cultural context of Chinese farmers with special regard to the scientific observations of their behaviour in agri-environmental issues (esp. the exorbitant fertilization behaviours). Based on this information, an advanced model of individual decision-making was developed under the assumptions of the neoclassical economic theory. The theoretical construct aims to be an orientation for the structural equation modelling which at least consists of a dataset resulting from a quantitative household survey (n=394) of selected farmers in Shandong Province conducted in 2009.

2 Research conception

In standard neoclassical economic theory, it is assumed that decision-making is guided by extrinsic motivation. In recent years the influence of intrinsic factors (e.g. social and cognitive aspects as well as surrounding social conditions) has been recognized. A range of innovative economic studies have shown that decisions are not only linked to rational and monetary incentives but also to a wide range of other inherent determinants (Simon, 1959; Becker, 1976; Gasson, 1973; Deci and Ryan, 1985; Kahneman and Tversky, 2000). Based on the fact that decision-makers are faced with several considerations regarding economic, social and cognitive variables, this research model leans on a theoretical multicriteria approach (Fig. 1). The farmer (with its socio-demographic starting condition) states preferences for an intended and particular utility-oriented agri-environmental production decision under the condition of offensive restrictions. Focussing on the socio-psychological approach of Fulton *et al.* (1996), the model considers the cognitive hierarchy concept, with fundamental value positions as a basis for general beliefs, specific attitudes and social norms that in turn influence the preference of an intended and finally manifest behaviour.

This approach in particular focuses on agri-environmental attitudes, the impact of fundamental values and the Chinese relationship network *guānxi* as leading decisive social norm in China. Values are crucial because they predict attitudes and choices as well as

preferences and even, attributed to others, a particular behaviour (Strack *et al.*, 2008). For this reason *guānxi* is regarded, which is an indispensable Chinese social concept describing the personalized networks of influence (Dunning and Changsu, 2007). Both, the cognitive psychological and social approach combined, establish a basis to guide culturally adapted development projects in an agent-based approach.

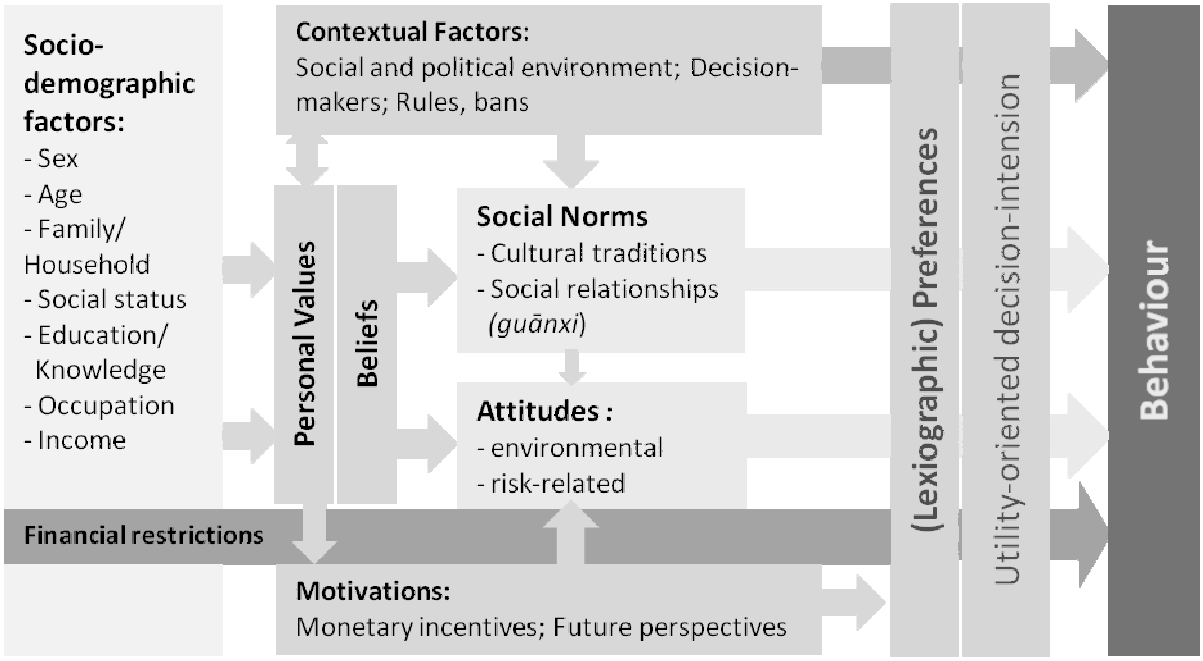


Fig. 1: Research model of agri-environmental decision-making with special regard to cognitive and social aspects (Author's illustration)

2.1 Guānxi

The social concept of *guānxi* is a major dynamic within the Chinese society. "It describes the basic force of the complex nature of personalized networks and social relationships." (Dunning and Changsu, 2007) *Guānxi* is deeply rooted in the Confucian doctrine. Interpersonal and harmonious relationships are valued and sought after (Dunning and Changsu, 2007) and individuals are exhorted to respect patriarchs and elders. Such respect is extended to authority of all kinds (Alston, 1989), which explains the practiced hierarchical order. Thus, *guānxi* has a cultural dimension, too, leading to the fact the collectivism as culture shaping social institution has to be mentioned as an important attribute as well (Hofstede, 1991). A recent comprehensive description of *guānxi* is offered by Luo (2000) as well as Dunning and Changsu (2007). According to their research, utilitarian attributes are of central meaning, thus relationships in the first are fixed by an exchange of favours rather than through sentiments, which implies perpetual reciprocal obligations and includes also transfer of *guānxi* relationships to recommended persons, if one feels satisfied with these persons.

This is given by trust, honesty, reciprocity, respect and social status (Davies *et al.*, 1995) and explains why interpersonal loyalty is often more important than organisational affiliation or legal status in Chinese society. Furthermore *guānxi* is regarded as relational capital which is to be conserved or augmented in times of abundance and plenty, but drawn upon in times of need, thus, the relationships are long-term oriented, informal and intangible (Dunning and Changsu, 2007). If disregarding the pillars of *guānxi*, it can seriously damage one's respectability and social standings, which in turn explains its function as a social norm in this theoretical approach and enforces its importance in individual decision-making processes.

2.2 Fundamental values

Values are imparted to societal members through daily exposure to customs, laws, norms, scripts and organisational practices that are shaped by and express the prevailing cultural value priorities (Schwartz, 1999; Bourdieu, 1972). But next to the cultural level, there are also intrinsic value priorities at an individual level reflecting the psychological dynamics of conflict and compatibility that a person experiences in its daily life and society (Schwartz, 1994). According to Schwartz (1994), this so called universal value is defined as "a belief pertaining to desirable end states or modes of conduct that transcends specific situations, guides selections or evaluation of behaviour, people, and events, and is ordered by importance relative to other values to form a system of value priorities" (Schwartz, 1994). Based on that assumption, he developed a cross-culturally validated value model out of ten incorporating universal values that are organized into a system of four types of higher-order values: openness-to-change (self-direction, stimulation), conservation (conformity, security, tradition), self-enhancement (achievement, hedonism, power) and self-transcendence (benevolence, universalism) (Schwartz, 1994). Openness-to-change values relate to the importance of personal autonomy and independence, variety, excitement and challenge. Conservative and traditional values relate to the importance of self-control, safety and stability in societal and personal relationships, and respecting cultural traditions. Self-enhanced egocentric values relate to achieving personal success through demonstrated competence, attaining social status and prestige, and control over others. Universal self-transcendent values relate to protecting and enhancing the well-being of those with whom one has close contact, as well as the welfare of all people and nature. According to these criteria for evaluating the self of people, value priorities can be located in a universal value cycle and used as central position "able to unify the apparently diverse interests of all the sciences concerned with human behavior" (Rockeach, 1973; Schwartz, 1994).

3 Empirical approach

In September and November 2009 a quantitative farmers survey was conducted via personal interviews in Huimin and Shouguang County of Shandong Province, both intensive agricultural areas of the North China Plains (n=394)[1]. The study areas were mainly selected according to agro-economic criteria referring to the overall project objectives, such as a similar crop-rotation, high grade of agricultural intensity and the existence of agricultural extension systems. Furthermore we paid attention to include different economic strata. As such, the sample was systematically selected and does not fulfil the criteria of representativeness; nevertheless, it draws conclusions to the general assumption that social and cognitive determinants have or do not have an impact on the farmers' definite behaviour.

3.1 Study area

The research area is characterised by intensive winter wheat and summer maize double crop rotation systems as well as vegetable production units. Overfertilization due to too high and inadequate mineral nitrogen application rates for different plant stages and crops of annually more than 580 kg/ha as well as the farmers' lack of knowledge and instructions are descriptive elements of the local agricultural practice (Zhang *et al.*, 2004; Bergmann and Weber, 2010). In addition Ju *et al.* (2004) stated a certain recalcitrance regarding the farmers' fertilization behaviour, since they have experienced almost doubled grain yields since the late 1970s, when nitrogen manufacturing was heavily subsidised. Thus, the prices got affordable for the bulk of farmers. But due to less effective agricultural extension services (Huang, *et al.*, 1999) increasing nitrogen losses cause serious pollution of ground and surface waters with reactive nitrogen (Zhang *et al.*, 2004). In some rice areas, recent studies have already investigated an estimated loss of net farm income due to the overuse of mineral fertilizers and consequential decreased yields at as much as 15 percent (Buresh *et al.*, 2004). Thus, crop production increasingly becomes less profitable (Bergmann and Weber, 2010).

3.2 Research question

Emerging questions are why farmers do not apply less nitrogen and recognize the environmental harms out of their behaviour. This research therefore focuses on reasons why

[1] The project "Innovative nitrogen technologies to improve agricultural production and environmental protection in intensive agriculture" is funded by the German Federal Ministry of Education and Research (BMBF), project number 0330800A-F and the Chinese Ministry of Science and Technology (MOST), grant number 2007DFA30850. For further information see http://www.nitrogen-management.org/. The author likes to acknowledge her colleague Dr. Holger Bergmann for the fruitful discussions on the topic and the Chinese counterparts from Chinese Center for Agricultural Policy (CCAP) for their organizational and scientific support; moreover, Dr. Marco Roelcke for his invaluable guidance, unless the research would not have been possible.

farmers might not relate their behaviour to the increased soil and groundwater pollution, although the production becomes less profitable and what influences the inherent determinants have on their agri-environmental decision-making. These are the addressed questions that this paper attempts to give an answer to. Focussing on cognitive and social aspects referring to the introduced consciousness of environmental issues in China (see introduction) societal dynamics should be recognized within the decision-process as well. Do farmers with a particular value orientation or a varying social embeddedness behave different, e.g. could they be distinguished according to their amount of applied nitrogen fertilizers? Or, vice versa, what inherent factors lead farmers to pro-environmental attitudes or a willingness to pay for environmental goods? Those are just some of the questions that could be related to the modelling approach. But moreover another central question is: Do these results fit for better adapted agricultural training approaches that influence the farmers' agri-environmental behaviour in a more sustainable way by convincing them strategically based on their inherent decision-making factors?

3.3 Statistical methodology

Methodologically, an overall framework was designed to provide an integrated approach in order to derive first, information about the farmers' situation and second, preferences from collecting data of structural variables (farm size, farm type, land type, location, etc.), agro-economics (yields, farm inputs/ outputs, etc.), socio-demographics (age, gender, household composition) and the farmers' environmental and risk-related attitudes[2]. Besides, fundamental values were interrogated as well as data of social relationships as a factor of the contextual conditions that are in particular hypothesized to affect the decision-making. Guided by the literature reviewed, social and cognitive variables were selected out of various contents. Multi-sited and semantic differential items were interrogated by Likert scales to describe the farmers' varying agri-environmental attitudes (16 items), their *guānxi* specifications (13 items) and their fundamental value positions (21 items) (see Vogel, 1996; Dunning and Changsu, 2007; World Values Survey, 2007; Schwartz, 2001, 2006)[3].

[2] For detailed information related to the agroeconomic part, selected results were already published in Bergmann and Weber (2010).

[3] The questionnaire design of the fundamental values is the identical Chinese version of Schwartz' universal values survey (Schwartz, 2001) in order to follow the psychological ensured statistical approach. Furthermore, for comparison of the methodological approach, the items of Dunning and Changsu (2007) were carried over as well. In addition, some environmental items were selected out of the World Values Survey (2007) since they fit perfectly to our research purpose. Detailed results on the Chinese farmer's fundamental values and their *guānxi* performance should be published in Weber (2011).

The preceding descriptive analyses of especially the structural and agro-economic variables as well as the socio-demographics are consisting of conducted frequency analyses and calculations of mean values, Standard Gross Margins (SGM) and the apparent Nitrogen Use Efficiencies (aNUE) for the planted crops. The accomplished results give an overview about the respondents and farm characteristics as well as the efficiency of their agricultural production. Thus, they aim at grading and underpinning the interpretation of the Structural Equation Model (SEM), since the farm practice especially regarding the application of agricultural inputs is equally crucial like the farmers' social condition.

Afterwards, in order to capture the latent variables for the multivariate path modelling, a factor analysis of the *guānxi* items and the items of the environmental attitudes was examined. In order to generate factors for the fundamental values, Strack's (2010) formula was used since it facilitated an attribution of the two antagonistic value axes according to the psychological approach of Schwartz' value cycle (see Strack, 2010). The two value axis ('universal/ self-enhanced value axis' and 'traditional/ self-determination value axis') deem as a starting construct of the path model. It is assumed, that values are influenced by socio-demographics and household income. Since household income is regarded as fundamental restrictive, it is assumed that it influences the social structure as well. The interrelated measured directives of the farmers' social relationship orientations, consisting of two factor constructs (describing utilitarian versus intrinsic/moral orientations on the one side and collectivism versus individualism orientations on the other side), are in turn affected by the fundamental values. They conceptualize together with the farmers' value positions the tripartite factor construct of environmental attitudes, that at least, amongst other attitudes and lexiographic preferences that were not investigated in this model, are hypothesised to have an impact on the farmers' decision-making. In this case, the different constructs are supposed to operate on the amount of applied nitrogen fertilizers and on the willingness-to-pay (WTP) for clean drinking water[4].

In order to avoid double loading and non-loading at the model construction, minor modifications have been accomplished, so that the item measurements demonstrate acceptable levels of fit and reliability. The afterwards detected causal relationships of the construct will then be able to explain and test the interdependencies between the different value positions, various *guānxi* traits and distinguishing agri-environmental attitudes. The causal SEM was conducted by the partial least squares (PLS) method that combines path, principal component

[4] For detailed description on the measurement items belonging to the factors of one construct, the single statements are attached in the appendix (Table I).

and regression analysis in a single operation in order to examine the relationships among the latent constructs (Albersmeier *et al.*, 2009). The analysis is then conducted in two stages with SmartPLS Version 2.0 (M3)[5]. First, the measurement model is evaluated regarding the reliability and validity of the measurement instruments. Afterwards, the structural model of the relationships between the constructs is tested according to the quality criteria. PLS was selected because it fits especially for very complex and explorative studies and has minimal requirements to residual distributions and sample size (Chin, 1998).

4 Results of the empirical study

4.1 Sample description

In order to understand and arrange the results of the empirical model, a brief sample description and selected frequency analyses and calculations will give an overview about the farmers' social and economic situation.

Table 4-1 shows some of the respondent and farm characteristics. In total, the two counties have similar results; nevertheless, differences refer to different local preconditions, like soil qualities, climate as well as off-farm labour opportunities.

Table 4-1 Sample description (n=394) (Author's calculations)

Respondent characteristics	Huimin (n=206)	Shouguang (n=188)
Gender (% male)	64.2	76.2
Education (in years)	5.7	6.7
Age (in years)	47	46
Full labour time on farm (in %)	89.9	80.1
Farm characteristics		
Household members (figure)	4.2	3.4
Household income (Yuan/year)	16000	20500
Agricultural income (% of total household income)	54.5	57.5
Farm size (in mǔ[6])	7.9	6.4
Size of the biggest plot (in mǔ)	2.5 (=0.16 ha)	3.2 (=0.21 ha)
Production characteristics		
Winter wheat		
Average yields (t/ha)	6.0	7.3
Applied mineral Nitrogen amount (kg/ha)	370.4	307.3
SGM (€/ha)	321	661
Sommer maize		
Average yields (t/ha)	5.4	7.3
Applied mineral Nitrogen amount (kg/ha)	276.3	189.1
SGM (€/ha)	937	1456
aNUE (anually for both crops in %)	18	19

[5] SmartPLS 2.0 (M3) was developed by the Institute of Operations Management and Organization of the University of Hamburg (Germany) (Ringle *et al.*, 2005)

[6] The unit "*mǔ*" describes a Chinese area unit. One mu is 1/15th hectare (~67m²).

According to the data, a remarkable part of the respondents were female, in average of advanced age, educated and work between 80 and 90 percent on their farms. Detailed analysis shows that 30 percent of the respondents in Huimin and nearly 18 percent in Shouguang went less than 5 years to school (no education at all: 16.9% Huimin; 6% Shouguang). To conclude, a remarkable share of uneducated household heads, the average age more than 46 years, and the fact that agricultural income is only just under 60 percent of the average household income, points out that agricultural activities are to a great extent performed by the older generations.

Regarding the farm characteristics, small nuclear families obtain a quite decent household income for Chinese farmers. Nevertheless, Shouguang is better well-off than Huimin, even though the farm sizes are smaller. The income differences derive from the bigger plot sizes for especially wheat and maize crop-rotation and the better agricultural outputs reached in Shouguang (see yields as well as SGMs, Table 4-1). Furthermore, the more farmers work off-farm and younger people are more likely to seek a job in the manufacturing industry or wholesale, the more small farm sizes do not allow a suitable financial outcome due to emigration of human capital. Land itself is contracted from the village committee to each *Hùkǒu*[7] registered inhabitant according to an officially defined size. It cannot be sold easily and serves as well as a retirement arrangement. Nevertheless, the production of wheat and maize shows in average quite decent yields. Although the average yields were lower in Huimin than in Shouguang, most farmers are able to reach at least annually yields of about 6 t/ha in wheat and 5.4 t/ha in maize. Compared to Huimin, the stated amounts of fertilizers in Shouguang show less use of mineral nitrogen for both crops, which is also reflected in better Standard Gross Margins (SGM)[8]. Referring to the higher aNUE in Shouguang it can be assumed that amongst others an application of less fertilizer could increase the aNUE. Nevertheless, the question remain, what are the determinants that influence the farmers' behaviour and how could their decision-making be changed towards better adapted fertilizer applications?

Additional descriptive analyses on the farmers' annual production show that beside the farmers' own farming experiences and the basic production conditions, neighbours do play a role in the farmers' decisions (11.8%). Extension services only have a neglecting influence

[7] The *Hùkǒu* system is the officially system of residence in China that rules the public administration. The registred status is used to control the movement of people between rural and urban area, because it bounds people to their birth of origin. People who live and work outside their *Hùkǒu* registration (regional boundary) do not qualify for fixed social services, education, health care, employer-provided housing, etc.
[8] For detailed interpretation and analysis see Bergmann and Weber (2010).

(1.3%). Concerning the environment sensitive decision-making on fertilization (see Fig. 2), 61.2 percent of the respondents stated that their fertilizer management bases on established habits and traditions. The remaining got their support from private providers (10.9%) and extension staff (7.9%). Again, interestingly, 7.1 percent rely on relatives and friends and 5.9 percent on information from media.

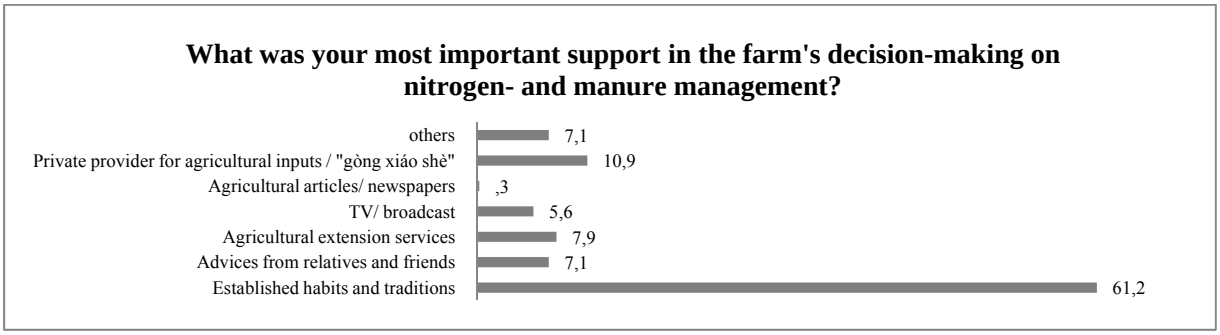


Fig. 2 Frequency analysis (in %) (Author's calculation)

This shows clearly, that informal information systems and personal networks of decision-making support are widespread and need to be analysed in detail, under consideration that existing professional trainings are not available or were not accepted by the local population. Moreover, the results provide an indication of the farmer's basic value positions. Most of them still seem to think in very traditional categories and rely on traditional practices. Nevertheless, some are open for new ideas and willed to adapt their production according to new influencing information. In the following, it will be investigated, how these value orientations are related to the farmers' final decision behaviour.

4.2 Evaluation of the measurement model

The measurement model reflects the relationship between manifest and latent variables. It is evaluated by examining in particular the individual item reliabilities, internal consistency and discriminant validity of the measurements.

In this model, there is evidence of item reliability as all factor loadings of the items on their respective constructs exceed at least the critical value of 0.6 which means that in general more than 60% of variance could be explained (Hair, 1998) (see Appendix, Table I). The calculated internal consistency shows the reliability of the construct. The figures of the reliability of all indicator items belonging to a latent variable show moderate results, since the Cronbach's Alpha should reach at least 0.6 (see Table 4-2). A plausible explanation for the low quality is the small number of items in the constructs on which the Cronbach's Alpha is greatly

depending. Before the background of an insufficient number of items, internal consistency is still given, especially knowing that the individual item reliability as well as the figures for the composite reliability, that measures the reliability of the indicator construct loading on a latent variable, reach quite good values of more than 0.7 (Fornell and Larcker, 1981). Finally, discriminant validity is evaluated by the average variance extracted from the contracts (AVE). The results show satisfactory values of an AVE in nearly all cases higher than 0.5, meaning that the average variance shared between a construct and its items contain less than 50% error variance (Chin, 1998).

Table 4-2 Assessment of measurement model (Author's calculation)

Code	Item	Number of items	AVE	Composite Reliability	Cronbach's Alpha
ED	Environmental disinterest and neglegt of responsibility	2	0.59	0.73	0.34
AN	Applied nitrogen amount	1	1.00	1.00	1.00
CIR	Collectivist vs. individualistic oriented relationships	2	0.67	0.80	0.53
ES	Fertilizers secure the agricultural outcome	2	0.66	0.80	0.50
EA	Environmental problem awareness and responsibility	1	1.00	1.00	1.00
HI	Household income	1	1.00	1.00	1.00
SD	Socio-demographic factors	3	0.99	1.00	1.00
TOV	Traditional vs. open-to-change value positions	1	1.00	1.00	1.00
USV	Universal vs. self-enhanced value positions	1	1.00	1.00	1.00
UMR	Utilitarian vs. intrisic/ moral motivated relationships	2	0.77	0.87	0.70
WTP	WTP for clean drinking water	1	1.00	1.00	1.00

4.3 Evaluation of the structural model

Whereas the measurement model reflects the internal consistency between latent and manifest variables, the structural model describes causal relationships between the individual latent variables. According to Götz (2004), path coefficients are standardized regression coefficients that could be evaluated like beta weights (β), showing the direct effect of an independent on a dependent variable in the model. They should reach at least 0.1 (Sellin, 1994). Bootstrapping method is applied to evaluate its significance. Reliable results are presented in Fig. 3.

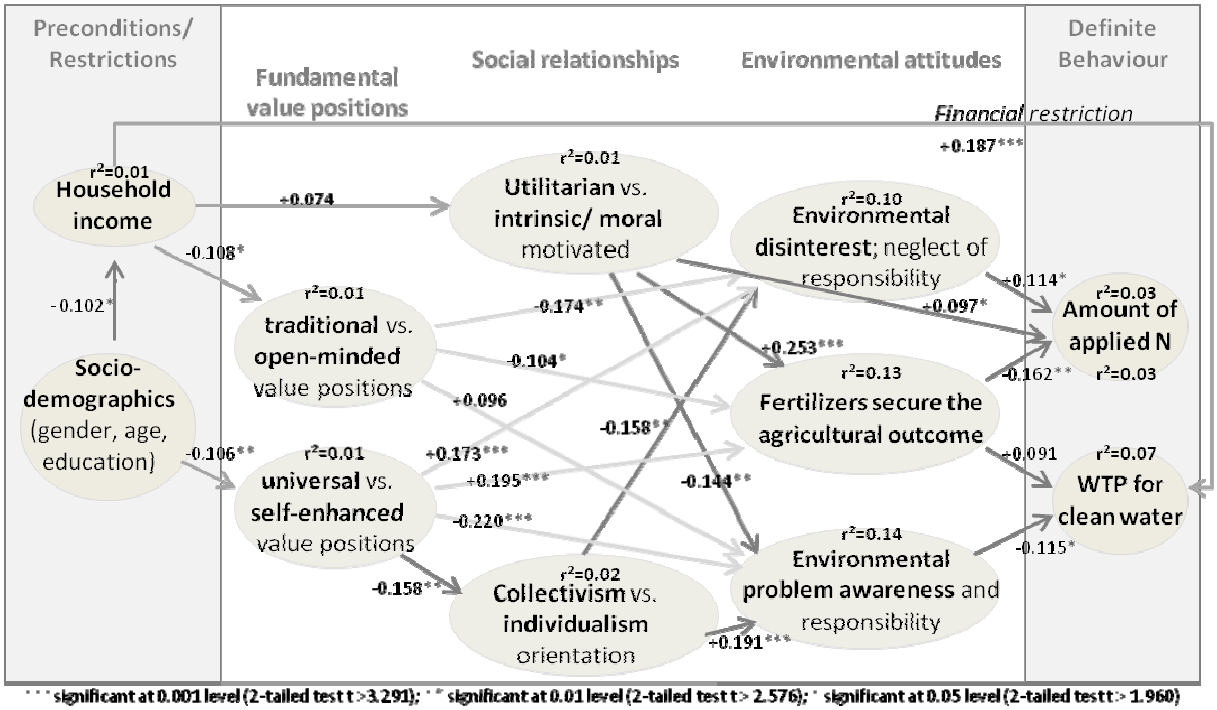
The R square values show the goodness of fit of the extracted endogen latent variables (Backhaus *et al.,* 2000). Since the share of total explained variance is very weak ($r^2 < 0.19$) (Chin, 1998), this indicates a very low linear relationship but this does not mean that there is no other causal relationship. It just shows that the influence of the selected items is low. Regarding the impact of the exogenous variables on the endogen variables, thus the significance of the substantial construct, the effect size (f^2) is tested in addition. It measures the R square values with and without the influence of exogenous latent variables (total effects) according to the formula $f^2 = \frac{R^2\text{included} - R^2\text{excluded}}{1 - R^2\text{included}}$.

The results show that the substantial constructs of the environmental attitudes are significant with each endogen variable measuring $f^2 > 0.02$ (Appendix, Table II). Thus, this explorative structural model aims to shows reliable tendencies out of the investigated data. The causal analysis shows that some paths, suggested in the theoretical research model, can be confirmed but need to be extended in further studies by better explaining items and variables.

To sum it up, the explorative model shows that cognitive and social factors have a direct influence on the farmers' environmental attitudes and as well finally – in accordance to the economic theory of humans decision-making – on the definite behaviour that follows out of the preferences. Initial results show promising tendencies and thus allow carefully drawn conclusions that might be helpful for recommendations, challenging the current agricultural paradigm of an increased food production in China towards a more sustainable development.

4.4 Concluding results on the farmers' agri-environmental attitudes

Regarding the agri-environmental attitudes, the majority of the suggested factors have an impact on attitudes focussing ***environmental problem awareness and responsibility***. The most important effect on this variable is observed from fundamental values, in particular from *universal positions* (-0.220***); *open-minded* values slightly confirm a tendency (+0.096). *Collectivist* (+0.191***) and *intrinsic/ moral guided social interactions* (-0.144**) are further decisive constructs that in addition reflect the high involvement of societal topics before the



background of Confucian doctrines. Socio-demographic factors as well as the household's income act as indirect independent variables so that especially *female farmers* who are in addition *less educated*, *younger* and/or *more affluent* than the sample average (see descriptive analysis Table 4-1) are more likely to apply to the just described construct and thus tend to agree to pro-environmental statements.

Important determinants of the attitude construct ***fertilizers secure the agricultural outcome*** are *self-enhanced* (+0.195***) and by trend *traditional value positions* (-0.104*). Regarding the influence of the social environment, there is a strong path dependency from *utilitarian aligned societal interactions* (+0.253***), so that it seems that farmers whose preferences are guided by utilitarian issues focus more upon their agricultural outcome than farmers whose decision-making is intrinsic and moral motivated. The financial background of utilitarian and self-enhanced guided farmers, who are – according to the socio-demographic data – expected to be *male*, in average *older* and/ or additionally *better educated*, is slightly determined by a *worse income* situation. Thus, traditional value positions include as well a strong importance of the family and its security, which has priority above all in critical monetary situations.

The third agri-environmental construct describing ***environmental disinterest*** combined with a ***neglect of any responsibility*** regarding negative environmental effects due to overfertilization is also directly influenced by *self-enhanced* (+0.173***) and *traditional* fundamental values (-0.174**), thus the socio-demographic preconditions of the respondents tend to be similar to the construct just described before (*older male, better educated* farmers of *lower income*). But regarding the social component, *individualists* are more likely to agree to such attitudes than collectivist thinking respondents (-0.158**).

Subsuming in a first step, pro-environmental attitudes are stated of intrinsic motivated farmers with mainly universal value positions or of farmers that think in very traditional and conservative categories and that like to act in line with the collective's and family's aims. Thus, both extreme groups have a kind of altruistic and intrinsic motivation for environmental issues and do not first of all think upon their own individual interest. In contrast, self-enhanced and egocentric thinking respondents focus more on their own benefit. They favour especially the *guānxi's* utilitarian traits in order to reach their goals, thus the path analysis gave evidence that this leads towards a very one-sided and shortened disposition for agro-chemicals ignoring its environmental harms. Another path shows that farmers who are torn between environmental issues and their responsibility for the family's financial security, are driven by traditional and conservative family centred values and a strong maintenance of

guānxi relationships which seems to be an area of internal conflict between the pursuit of group harmony and general demand for a proper environment and the increasing individualized economic pressure on the household's financial outcome. Traditional conservative values and social relationships in the rural areas are increasingly influenced by dynamic societal forces, pushed by urban pull factors and changed values from migrant workers, not knowing to which direction the farmers' value system will develop in future.

4.5 Concluding results on the farmers' fertilization behaviour

Referring to the observed fertilization behaviour, the model shows significant influences on the ***amount of applied mineral nitrogen fertilizers*** from attitudes stating that the application of fertilizers secures the agricultural outcome. Thus, the more farmers were afraid of decreased harvest outputs, the more they would apply fertilizers (-0.162**) (see Fig. 3).

This could mean that those farmers who already have decreased yields due to fertilizer overusage and who are, due to their scarce knowledge in agricultural inputs, more concerned about a sufficient fertilization, tend to use even more nitrogen fertilizers than required. Leaving this at that, it will end into a vicious circle, damaging the nature and the farmers' agricultural income in the same way. Thus, since those farmers already belong to the older, general quite educated population, they miss at least convincing trainings, in order to get out of this dilemma. To wit, they need to know that an optimized fertilization pays off, since it leads to higher yields and less financial input for the expensive fertilizers and causes on top a better economic and environmental situation.

Furthermore, individually and self-enhanced driven farmers without environmental sensibility, that just do their work on the farm and do not feel responsible for the environmental burden resulting out of nitrogen surpluses, put comparatively less amounts of mineral fertilizers on their fields (+0.114*).

They tend also to be older male, better educated farmers of lower income regarding their socio-demographic background, but it seems that they do not only regard the amount of yields, respectively the financial outcome, but in addition the fertilizer costs, which is in fact around two third of the production costs (see Bergmann and Weber, 2010). Hence, it seems to be that their cognitive and social setting results in a weight up between costs and benefits. Their most important target is to do their work in a reasonable way and it seems that they adapt their fertilization better than those farmers who are only concerned about their farm income, measured at the harvested amount of yields. Nevertheless, they have in average a lower

income, which could result from the fact that they were not well established in the social community (see Fig. 3). No correlation is found with *guānxi*-relationships which might hamper the exchange of useful information regarding adapted practices of an agricultural production. This goes along with the already described results in chapter 4.1 that decision-making also depends on the social community.

As a consequence one has to think about the importance of social networks and the farmers' household security, when giving recommendations and setting incentives. The results show tendencies, that due to the low agricultural education in chemical inputs and its impact on the environment and thus finally on the farmers' household income, farmers tend to adopt new agricultural technologies without reflecting, just assuming like experienced during the last decades or based on their information from family members and neighbours that a plus will improve their yields.

Contrarily to these two paths running to the fertilization behaviour, the results show also that there is no significant relationship with farmers who stated for attitudes of environmental problem awareness and responsibility. In general, this construct was more supported by universal and very open-minded persons and their socio-demographic background is vice versa to that of the other constructs. Nevertheless, these findings show that even younger and good networked people with intrinsic social relationships do not have the knowledge to realize how their cognitive disposition could be related to their behaviour.

This supports as well the assumptions resulting from the preceding paths' analyses that farmers of different values and varying social and financial justifications in general, value environmental goods positive, but do not connect that with their own agricultural behaviour.

4.6 Concluding results on the farmers' WTP for environmental goods

These preceding findings are supported by the results of the contingent valuation variable, describing the farmers' **willingness-to-pay for clean drinking water** (see Fig. 3). Of course, this construct shows highly significant effects from the farmers' income situation (+0.187***). The higher the income the higher the respondents' WTP for the added value out of an environmental good.

Lower payments might by trend be promised by heads of farm households who think in the first about their family's financial security and possible negative consequences out of a

changed behaviour – in this case a reduced fertilization (+0.091). Higher payments are stated by farmers of a more distinctive environmental understanding (-0.115*).

No correlation was found between attitudes of environmental disinterest and neglect of responsibilities and WTP. Taking into account the findings of the preceding causal analysis, this group is indifferent between farmers having a higher WTP, because they evaluate the added value out of their payment and farmers who are the opinion that their drinking water is clean and, according to this assumption, do not have any understanding of environmental harms of residues from agricultural and municipal origin at all.

5 Conclusion and outlook

Closing, in accordance with the socio-psychological theory, the results give evidence that, next to socio-demographic and economic preconditions and restrictions, personal value positions as well as the Chinese social concept of *guānxi* social shape the farmers' agri-environmental preferences. Both are relevant determinants for farmers' decisions and have to be regarded for optimized projects aiming at increasing the apparent nitrogen use efficiency. Thus, for an intended behaviour change, there is a need for individually adapted incentives that go along with the emerging dynamic societal demands.

The results of *guānxi* and the farmers' information sources revealed the necessity to address and exploit the existing *guānxi* networks via systematic infiltration of persuasive agricultural information by carefully selected and trained contact persons. In order to meet the challenge to enhance a sustainable agricultural production, it is indispensable for future policy recommendations (measures and instruments), to reveal the determinants of agri-environmental decision-making.

There is evidence that wealthier and younger people are more likely to change their behaviour. The more open and the better farmers are embedded into a social network, the more agricultural trainings of an advanced knowledge transfer will be enforced by their relational capital. The declared social group and especially the mentioned kind of behaviour type promise at least a structural change from the current agricultural paradigm towards better balanced and more sustainable solutions.

Furthermore, self-enhanced and better educated farmers of worse financial conditions could be convinced by trainings that focus on resulting added values. Although most of them already belong to the older generation, they have the positive attitude trying to act cute

according to their families' economic benefits. Presuming the trainings had been effective, an increased aNUE, hence less applied mineral nitrogen fertilizers, would first show them the positive effects on their soil and water condition and second an improved agricultural income, since they have less costs for fertilization and thus safe a remarkable part of their agricultural expenses (Bergmann and Weber, 2010).

In addition, urban demands have found their way into the farm households, too and have already evoked a change of conservative and traditional values in a part. Self-enhanced individual oriented farmers will increase and they will not only focus on cross-linking with others. They are also driven to do everything for their own benefit. Hence, even their training method has to focus on the added value from the positive-environmental effects, but moreover also on the benefit of multifunctional services in agriculture. So creative rural development ideas have to be promoted and subsidised in order to give incentives for such services from farmers that might already have the independence and courage for an open way of thinking, thus, a motivation that enables a new form of agricultural services.

Finally, the results explain why farmers behave different from each other and that most of them rely to a great extent on uncertain agricultural information sources, which is also a problem of the collapsed extension system in some regions. Hence, extension people should be reliable persons who are well established in the farmers' community and who serve farmers full-time (see also Hu *et al.*, 2009). Since this is given, the most important recommendation for effective training methods bases on the fact that farmers act as individuals and should be treated like that. If the extension people could convince them by arguments that fit to their individual situation and motivation, they will rather change their behaviour than if they can not link the optimized treatments to their individual prefernces, because for most of the farmers it pays-off. It is only a problem of knowledge transfer.

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Appendix

Table I - Appendix: Descriptive measurement items (Author's calculation)

Item code	Statements	Ø	δ	r
SD_1	Age group (1=young; 7=old)	5.27	1	0.998
SD_2	Gender (0=female;1=male)	0.70	0.458	0.996
SD_3	Education (1=low; 9=high)	6.22	3.287	0.995
HI	Income (metric scale)	18,104	14,761	1
TOV	Open-to change (=1) vs. Traditional values (=6)	0.32	0.73	1
USV	Self-enhanced (=1) vs. Universal values (=6)	-0.03	0.91	1
UMR_1	It is fair that people can gain benefits by depending on their network of contacts (utilitarian=1 vs. intrinsic motivated relationships=5)	3.55	1.381	0.913
UMR_2	It is natural that I give favours to and receive favours from my network of contact (utilitarian=1 vs. intrinsic motivated relationships=5)	2.99	1.255	0.839
CIR_1	I put group harmony above my own opinion. (collectivist=1 vs. individualist oriented relationships=5)	1.78	0.891	0.916
CIR_2	Related to work alone I like to work in a group (collectivist=1 vs. individualist oriented relationships=5)	1.95	1.165	0.704
ED_1	The groundwater burden resulting from the washing out of fertilizers is not so worse than many people imagine. (1=totally agree; 5=totally disagree)	2.88	0.932	0.592
ED_2	I don't think about environmenal aspect, I just do my work on the farm.(1=totally agree; 5=totally disagree)	3.06	1.325	0.907
ES_1	If I put more fertilizers, I will definitely have more yields. (1=totally agree; 5=totally disagree)	3.28	1.277	0.734
ES_2	Only people, who can't afford buying fertilizers, forbear from using fertilizers.(1=totally agree; 5=totally disagree)	2.94	1.303	0.885
ER	It is important to think upon environmental issues. (1=totally agree; 5=totally disagree)	1.80	0.932	1
WTP	WTP for clean drinking water (1=low 6=hig)	2.85	1.441	1
AN	Total amount of applied fertilizers (metric scale; calculated)	334.1	274.7	1

Scales in brackets; Ø = mean; δ = standard deviation; r = factor loading; Item code see Table 2

Table II – Appendix: Effect size (f^2)

Code		Socio-demographics	Income	Traditional value axis	Universal value axis	Utilitarian	Collective
ED	Environmental disinterest and neglect of responsibility	0,00	0,00	**0,03**	**0,03**	0,00	**0,02**
AN	Applied nitrogen amount	0,00	0,00	0,00	0,00	**0,01**	0,00
CIR	Collectivist vs. individualistic oriented relationships	0,00	0,00	0,00	**0,03**	0,00	**0,03**
ES	Fertilizers secure the agricultural outcome	0,00	0,00	**0,01**	**0,04**	**0,07**	0,00
EA	Environmental problem awareness and responsibility	0,00	0,00	**0,01**	**0,05**	**0,02**	**0,04**
HI	Household income	**0,01**	**0,01**	0,00	0,00	0,00	0,00
TOV	Traditional vs. open-to-change value positions	0,00	**0,01**	**0,01**	0,00	0,00	0,00
USV	Universal vs. self-enhanced value positions	**0,01**	0,00	0,00	**0,01**	0,00	0,00
UMR	Utilitarian vs. intrisic/ moral motivated relationships	0,00	**0,01**	0,00	0,00	**0,01**	0,00
WTP	WTP for clean drinking water	0,00	**0,04**	0,00	0,00	0,00	0,00