Comprehensive Evaluation of Utilization of Organic Wastes as Resources Based on Cognitive Behavioral Science

Qingsheng Zhou[1], Yao Wang[2], Xinzheng Li[2]*, Yichuan Zhang[2]

ABSTRACT

Based on the theory of cognitive behavior, this article designs a brain evoked potential experiment and selects 30 livestock husbandry farmers from six provinces in East China as objects to verify the influence of cognitive attitude, subjective behavior and code of conduct on their willingness to utilize organic wastes as resources, and to draw the portraits of those farmers who utilize organic wastes as resources, which can provide theoretical basis and scientific reference for the government to formulate relevant policies on utilization of rural organic wastes as resources in later period. The results are as follows: (1) The farmer's cognition attitude, subjective behavior and code of conduct all have positive effect on their willingness to utilize organic wastes as resources, in which their cognitive attitude shows the strongest influence. The three influencing factors, including farmers' cognitive attitude, subjective behavior, and code of conduct, are the most closely related to each other. (2) Farmers' willingness to use organic wastes as resources has a significant effect on their behavior of utilizing organic wastes as resources, and there is a positive correlation between them. (3) Farmers' leisure time, household income, and technical skills also have a significant impact on the farmers' behavior in utilizing organic wastes as resources.

Key Words: Cognitive Behavioral Science, Organic Waste, Comprehensive Evaluation, Brain Evoked Potential Experiment

DOI Number: 10.14704/nq.2018.16.5.1386 **NeuroQuantology 2018; 16(5):574-579**

Introduction

The organic wastes of animal husbandry have gradually become the main source of pollution of agricultural ecological environment. By the end of December 2017, the amount of annual organic wastes of animal husbandry in China has increased to 5 billion tons, but their treatment rate is only 38%, which is far less than 78% of the utilization rate of straw. Compared with the large-scale operation in the developed countries of Europe and America, the animal husbandry in China is characterized by punctiform and dispersion, Therefore, the utilization of organic waste as resources requires the participation of the majority of farmers. Based on cognitive behavioral science, this paper studies how farmers participate in the utilization of organic wastes as resources, which is of great practical significance.

At present, there are few studies on the relationship between the behavior of farmers and the utilization of agricultural organic wastes as resources, most of the researches focus on how to "turn waste into treasure" to realize utilization of agricultural organic wastes as resources, including the formulation of subsidy policies for compensation, resource utilization methods and means (Dugas and Robichaud, 2007; Wang, 2016). In the aspect of organic waste treatment and pollution control of animal husbandry, the scale of

Corresponding author: Xinzheng Li
Address: [1] School of Resources and Environment, Henan Institute of Science and Technology, Xinxiang 453003, China; [2] School of Horticulture and Landscape Architecture, Henan Institute of Science and Technology, Xinxiang 453003, China
e-mail ✉ 894118758@qq.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 4 April 2018; **Accepted:** 1 May 2018

animal husbandry, the operation mode of land, the economy of pollution control and government supervision and subsidy all have an influence on the behavior and willingness of harmless treatment of organic wastes. At the same time, the annual income level, breeding scale, and academic qualifications of farmers will also have an impact on whether they are to recycle organic wastes. The recycling of organic wastes requires the active participation of farmers and subsidies for the farmers' environmental expenditures, which needs government support. If the rural organic wastes can be utilized as resources, it will greatly change the current energy structure. Although the proportion of rural organic waste in China's energy structure is still relatively low, its proportion in rural energy structure is relatively higher. On the one hand, it can optimize the rural ecological environment; on the other hand it can increase the family income of farmers (Herbert *et al*., 2013; Semache *et al*., 2015; Zhou *et al*., 2014). At present, the evaluation of rural organic wastes focuses on the evaluation of environmental pollution, the evaluation of the recycling of organic wastes, the evaluation of the factors influencing the reuse of organic wastes and the international comparison of the resource utilization of organic wastes. The evaluation methods are divided into three types: qualitative, quantitative and comprehensive evaluation, for example, the Delphi method which belongs to qualitative research method, data envelopment analysis which belongs to quantitative research method, and Analytic Hierarchy Process (AHP) which belongs to comprehensive evaluation method. Choosing the appropriate evaluation method can scientifically evaluate the level of resource utilization of rural organic wastes, and guide the evaluation of practical activities (Shadel, 2014).

The researches on cognitive behavior in the developed countries of Europe and America originated in the 1950s, and became mature in the 1970s (Simons *et al*., 2013). From the perspective of cognitive behavioral science, human is a complex system of information processing, in which the human body needs to constantly process the perceived information. With the development of information technology, human cognitive behavioral science can be studied through eye tracker, myoelectric biofeedback apparatus, or event-related potentials. Event-related potentials (ERP) is the main technique for studying cognitive behavior, which is used to study the changes of brain potentials associated with mental activities of subjects (Dillies *et al*., 2013). If a particular stimulus is applied to the human brain, a series of changes in the brain potential occur either when the stimulus is given or when the stimulus is withdrawn. After years of scientific research, it has been found that human behavior, decision-making and memory are closely related to specific components of event-related potentials, including P1, P2, P3, N1, and N2. P represents a positive wave, N represents a negative wave, and P1 represents a positive brain wave that occurs within 100 ms after the brain is stimulated. Similarly, N1 represents the negative brainwaves that occur within 100ms after the brain is stimulated (Statnikov *et al*., 2005; Barkley *et al*., 1990; Song *et al*., 2011). By sorting out the relevant literature at home and abroad, it is found that the researches mainly focus on how to realize the utilization of agricultural organic wastes as resources in the aspects of the individual behaviors of households, the characteristics of family farming behaviors, and the surrounding environment, and few investigate the psychological activities of farmers in treating organic wastes based on cognitive behavioral theory (Pu *et al*., 2014; Tang and Zhou, 2015). In terms of research methods, multiple regression equation or structural equation model (SEM) is mainly used, but brain evoked potential experiment is seldom used. In addition, there are few studies on the behavior and willingness of farmers to utilize organic wastes as resources in animal husbandry (Kajii *et al*., 2007; Werth *et al*., 1996).

Based on the theory of cognitive behavior, this article designs a brain evoked potential experiment and selects 30 livestock husbandry farmers from six provinces in East China as objects to verify the influence of cognitive attitude, subjective behavior and code of conduct on their willingness to utilize organic wastes as resources, and to draw the portraits of those farmers who utilize organic wastes as resources, which can provide theoretical basis and scientific reference for the government to formulate relevant policies on utilization of rural organic wastes as resources in later period.

Research Hypothesis

The cognitive behavioral theory is a classic theory studying behavior in the field of social science. Many studies at home and abroad have verified the correctness and authority of the theory and

can well explain the individual's behavior. In that theory of cognitive behavior, cognitive attitude, subjective behavior and code of conduct are three variables that mainly influence willingness. The better the cognitive attitude is, the more active the subjective behavior, and the stronger the ability to regulate the behavior, then the stronger the individual's willingness to act, the greater the chance that the individual will take action. The willingness of farmers to utilize organic wastes as resources is the probability that farmers adopt ecologically friendly ecological behaviors. The farmers' cognition attitude, subjective behavior and code of conduct all have influence on their willingness to utilize organic wastes as resource, and then influence their eco-friendly behavior. Therefore, the stronger the willingness of farmers to utilize organic wastes as resources, the higher the probability of taking action. Therefore, this article proposes the following hypotheses:

Hypothesis 1: Farmers' cognitive attitude has a positive effect on their willingness to utilize organic wastes as resources;

Hypothesis 2: Farmers' subjective behavior has a positive effect on their willingness to utilize organic wastes as resources;

Hypothesis 3: Farmers' code of conduct has a positive effect on their willingness to utilize organic wastes as resources.

Evaluation Theory Analysis of Utilization of Rural Organic Wastes as Resources in Rural Areas

It is necessary to analyze the evaluation of utilization of rural organic wastes as resource on the basis of the following four principles: (1) The principle of comprehensiveness. When evaluating the research object, it is necessary to fully consider every aspect of the research topic. This article will systematically evaluate and analyze the utilization of rural organic wastes as resources from three aspects, including economic benefits, social benefits, and environmental transactions. (2) The principle of consistency. The principle of consistency requires that the evaluation targets, the establishment of evaluation models, and the construction of evaluation index systems must be consistent. (3) The principle of feasibility. In the process of evaluating the utilization of rural organic wastes as resources, it is necessary to take full account of the availability of the research data and the reliability of the subsequent evaluation method. (4) The principle of rationality. The design of the evaluation index system shall take into account the objective and actual conditions of the evaluation object and the evaluation process shall conform to the principle of rationality.

This paper uses Analytic Hierarchy Process (AHP) and data envelopment analysis (DEA) to evaluate the utilization level of rural organic wastes as resources from the aspects of economic and social benefits. It is a method proposed by Professor Saaty, an expert in operational research in the United States, to achieve multi-objective decision-making, which models complex problems, breaks down complex issues one by one in an orderly manner, and finally comprehensively evaluates research issues. It includes three layers: target layer; criteria layer; index layer. The steps of the AHP are: (1) constructing an analytic hierarchy diagram; (2) establishing a model judgment matrix; (3) calculating the index system weights; (4) carrying out consistency tests. Analytic Hierarchy Process concretizes traditional indexes that cannot be quantified to achieve quantitative evaluation of research objects. Data envelopment analysis (DEA) is proposed by three famous operational researchers, Charnes, Rhodes and Cooper, which suggest constructing the DEA model, putting forward the input and output indexes, and calculating the numerical validity of each decision unit so as to explain and the validity of decision efficiency from a deeper level.

Experimental Design on Evaluation of Utilization of Organic Wastes as Resources in Rural Areas

Subjects

This article selects 30 rural farmers from six provinces in East China to participate in the test, including 15 males and 15 females, of which 5 are from Jiangsu Province, 5 from Shandong Province, 5 from Zhejiang Province, 5 from Anhui Province, 5 from Jiangsu Province, and 5 from Fujian Province. Their naked or corrected visual acuity is all above 5.0, and all are right-handed and healthy without have any hearing, color blindness or other diseases. This study uses the Neurosacn system to analyze the brain evoked potential experiment record, with the reference sample frequency of 2000HZ and A3 as the reference electrode. The resistance of each electrode is reduced to below 4000Ω. The brain evoked potential experiment data are stratified, filtered, and screened to obtain superimposed brain evoked potential data.

(1) Analysis of P400 component data

After stimulation, the P400 component is successfully activated, and positive brain waves appear at 400 ms after stimulation, as shown in Figure 1. The electrodes in the C3, CZ, C4 regions of the central region activate the N400 cost.

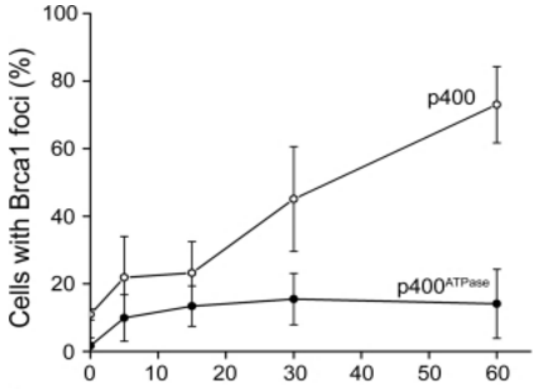

Figure 1. P400 electroencephalogram at 400ms after the onset of stimulation

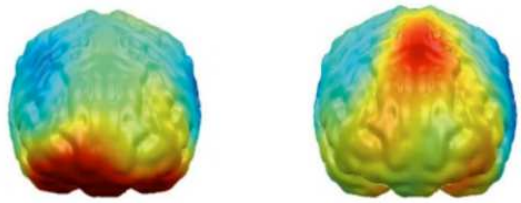

Figure 2. Changes in LPP component before stimulation to the brain

(2) LPP component analysis

Brown *et al*. suggest that LPP is closely related to people's willingness and behavior, and that the activity of the cerebral cortex is stimulated to produce ethylene changes in combination with mood. Figure 2 clearly shows the change in LPP component before the brain is stimulated. Due to the non-sphericity of the calculation results, this article uses Greenhouse-Geisser for correction.

Determination of the weight of the evaluation index system

Among the output indicators of the evaluation system, there are three indicators of economic benefits, including the number of households with gas supply (B_1), the size of the organic waste disposal pool (B_2), and the amount of the generated biogas energy (B_3). The judgment matrix is constructed by Delphi method, as shown in Table 1.

Table 1. Evaluation and judgment matrix of utilization of rural organic wastes as resources

	B_1	B_2	B_3
B_1	1	3	4
B_2	1/3	1	3
B_3	1/4	1/3	1

The indexes of the economic benefits of the evaluation indicator system are calculated using Analytic hierarchy process, which are substituted into the weight matrix, and then after the consistency check, it can be obtained as CI=0.004,CR=0.007<0.1, which shows that the consistency check of the judgment matrix is robust. The weight of each item in the indicator system can be further obtained. The weight of the number of households with gas supply (B_1) is 0.223, the weight of the size of the organic waste disposal pool (B_2) is 0.456, and the weight of the amount of the generated biogas energy (B_3) is 0.321, as shown in Table 2 below.

Table 2. Index weight and consistency check of economic benefits judgment matrix

Evaluation index	The number of households with gas supply (B_1)	The size of the organic waste disposal pool (B_2)	The amount of the generated biogas energy (B_3)
Index weight S(i)	0.223	0.456	0.321
Maximum characteristic root of the model	2.993		
CI	0.004		
CR	0.007		
CR is less than 0.1			

Table 3. Index weight and consistency check of social benefits judgment matrix

Evaluation index	Rural energy promotion and publicity agencies(C_1)	Number of farmers (C_2)	Growth rate of scientific and technological personnel (C_3)
Index weight S(i)	0.334	0.312	0.354
Maximum characteristic root of the model	2.883		
CI	0.006		
CR	0.009		
CR is less than 0.1			

Table 4. Index weight and consistency check of environmental benefits judgment matrix

Evaluation index	The number of upgraded toilets (D_1)	Agricultural emission of harmful gases (D_2)	Capacity of water purifying tank (D_3)
Index weight S(i)	0.334	0.312	0.354
Maximum characteristic root of the model	2.883		
CI	0.006		
CR	0.009		
CR is less than 0.1			

Table 5. Classification of utilization efficiency rate of rural organic wastes as resources in six provinces of East China

Regions	Efficiency value	Classification
Jiangsu	1.000	Efficient
Shandong	0.912	Mild
Zhejiang	1.000	Efficient
Anhui	0.845	Moderate
Jiangxi	0.718	Mild
Fujian	0.898	Mild

Table 6. The evaluation efficiency of resource utilization of rural organic wastes as resources in six provinces of East China in 2017

DEA efficiency value		Efficiency rate in 2017	
		Number	Rate
DEA Efficient	$\alpha=1$	2	33.33%
DEA mildly inefficient	$0.8\leq\alpha<1$	3	50%
DEA moderately inefficient	$0.6\leq\alpha<0.8$	1	16.67%
DEA severely inefficient	$\alpha<0.6$	0	0

Similarly, according to the above method of calculating the weight, the weight of the evaluation index in terms of social and environmental benefits can be calculated, as shown in Tables 3 and 4.

After the weights of the three output indexes of economic benefits, social benefits and economic benefits are determined, they are substituted into the data envelopment model for calculation, and the summary results are shown in Table 5.

The evaluation efficiency of resource utilization of rural organic wastes as resources in six provinces of East China in 2017 is further calculated, through which Table 6 is obtained.

Six provinces selected in East China are regions with relatively better economic development in China, which are typical and representative. In 2017, the effective utilization rate of organic wastes as resources in six provinces in East China reaches 33.33%, thus the overall situation of resource utilization rate is good, but it is not optimistic. The data show that only the efficiency values of Zhejiang and Jiangsu provinces are 1, which indicates that the decision-making units of both provinces are in the dominant position of data envelopment. The efficiency values of Shandong, Anhui and Fujian provinces lie between 0.8 and 1, which are mild DEA inefficiencies. The situation of Jiangxi is more serious among the six provinces in East China, which belongs to moderate DEA inefficiency, which needs to be paid attention to by the decision-making department of Jiangxi government to prevent it from sliding to the range of severe DEA inefficiency.

Conclusions

In this paper, 30 farmers from six provinces in East China are selected to conduct micro-data investigation, and based on cognitive behavioral science, three factors influencing farmers' willingness to utilize organic wastes as resources are analyzed, including cognitive attitude, subjective behavior and code of conduct. The conclusions are as follows: (1) The farmer's cognition attitude, subjective behavior and code of conduct all have positive effect on their willingness to utilize organic wastes as resources, in which their cognitive attitude shows the strongest influence. The three influencing factors, including farmers' cognitive attitude, subjective behavior, and code of conduct, are the most closely related to each other. (2) Farmers' willingness to use organic wastes as resources has a significant effect on their behavior of utilizing organic wastes as resources, and there is a positive correlation between them. (3) Farmers' leisure time, household income, and technical skills also have a significant impact on the farmers'

behavior in utilizing organic wastes as resources.

In order to enhance the willingness of farmers to use organic wastes as resources and to promote the active participation of farmers in the utilization of organic wastes as resources, the following suggestions are proposed: (1) we shall further increase the subsidy input in farmers' utilization of organic wastes as resources, share their cost and enhance their enthusiasm to participate in the utilization of organic wastes as resources; (2) Based on the needs of farmers in the utilization of organic wastes as resources, we shall increase investment in research and development of utilization of organic wastes as resources, and strengthen our efforts to popularize it, so as to achieve multi-disciplinary, multi-disciplinary and multi-level technological integration, providing technical support for utilization of organic wastes as resources. (3) We shall improve the technical skills of the farmers in utilizing organic wastes as resources, carry out relevant training on utilization of organic wastes as resources, cultivate their awareness of environmental protection and ecology, and guide them to develop towards intensive recycling.

Acknowledgements

This study was supported by the following scientific research projects: The Key Project of Science and Technology of Henan Province 2016 (Research on comprehensive utilization technology of urban green land rainwater resources, Grant No: 162102310088), The Key Project of Science and Technology of Henan Province 2017 (The application of simulation technology in ecological environment quality of outside urban communities, Grant No:172102310136), The Doctoral Foundation 2017 of Henan Institute of Science and Technology.

References

Barkley RA, Dupaul GJ, Mcmurray MB. Comprehensive evaluation of attention deficit disorder with and without hyperactivity as defined by research criteria. Journal of Consulting & Clinical Psychology 1990; 58(6): 775-89.

Dillies MA, Rau A, Aubert J, Hennequetantier C, Jeanmougin M, Servant N., Keime C, Marot G, Castel D, Estelle J, Guernec G, Jagla B, Journeau L, Laloe D, Le Gall C, Schaeffer B, Le Crom S, Guedj M, Jaffrezic F, French SC. A comprehensive evaluation of normalization methods for illumina high-throughput RNA sequencing data analysis. Briefings in Bioinformatics 2013; 14(6): 671-83.

Dugas MJ, Robichaud M. Cognitive-behavioral treatment for generalized anxiety disorder: from science to practice. Journal of Contemporary Psychotherapy 2007; 30(2): 149-61.

Herbert JD, Gaudiano BA, Forman EM. The importance of theory in cognitive behavior therapy: a perspective of contextual behavioral science. Behavior Therapy 2013; 44(4): 580-91.

Kajii H, Kawaki H, Nakahama Y, Fujiwara Y, Oshio T. P-112 influence of preference for beverages on α & β wave of electroencephalogram (eeg) and heart rate variation. Japanese Journal of Taste & Smell Research 2007; 14: 561-64.

Pu X, Liu T, Wu Q, Zhang R, Xu P, Li K, Xia Y, Yao D. Study on neurofeedback system based on electroencephalogram signals. Journal of Biomedical Engineering 2014; 31(4):894-98.

Semache A, Hamidat A, Benchatti A. Impact study of the solar energy on the energy performances of the rural housing in Algeria, International Journal of Heat and Technology 2015; 33(4): 229-36.

Shadel WG. Introduction to the special series what can personality science offer cognitive-behavioral therapy and research? Behavior Therapy 2004; 35(1): 101-11.

Simons AD, Rozek DC, Serrano JL. Wanted: reliable and valid measures for the science of cognitive behavioral therapy dissemination and implementation. Clinical Psychology Science & Practice 2013; 20(2): 181–94.

Song MJ, Shin H, Baek GJ, Kim HG, Kook C. A basic study on the characteristics of the electroencephalogram corresponded with the evaluating words of soundscape sound source. International Journal of the Korea Institute of Ecological Architecture & Environment 2011; 11(3): 49-56.

Statnikov A, Aliferis CF, Tsamardinos I, Hardin D, Levy S. A comprehensive evaluation of multicategory classification methods for microarray gene expression cancer diagnosis. Bioinformatics 2005; 21(5): 631-43.

Tang X, Zhou J. Electroencephalogram feature selection based on divergence analysis. Computer Engineering 2015; 41(5): 290-94.

Wang ZS. Research on the precision design of cat in the process of agricultural mechanization, Academic Journal of Manufacturing Engineering 2016; 14(2): 65-70.

Werth E, Dijk DJ, Achermann P, Borbély AA. Dynamics of the sleep eeg after an early evening nap: experimental data and simulations. American Journal of Physiology 1996; 271(2): 501-10.

Zhou ZH, Chen S, Xu F, Jiang HL, Xiao Y. Study on TFP of grain in Poyang Lake Ecological Economic Zone on DEA, Mathematical Modelling of Engineering Problems 2014; 1(2): 1-6.