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(**5) Materials and Methods**.

(**6) Results**.

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Contents

Farmers' Sustained Adoption Decision Behaviors of Maize/Cassava Intercrop Technology in Imo State: Lessons for Extension Policy Development

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Abstract: Various variables influence farmers' sustained adoption decision behaviors. Thus the rate of sustained adoption of maize/cassava intercrop technology, reasons for the sustenance and the determinants were empirically investigated in Orlu zone of Imo State with a view to drawing lessons for extension policy development. Data were collected from 115 randomly selected crop farmers using structured questionnaire. These were analyzed with percentage counts, frequency tables and logit regression model at 0.05 level of significance. The farmers' sustained the adoption of the technology by 88.7% with reasons ranging from environmental friendliness to full utilization/maximization of agricultural land. The farmers' age, family size, education, farming experience, social organization membership, farm size, and annual farm income as well as number of technological information sources used determined their sustained adoption decision behaviors. It was recommended that extension education sensitization campaign be intensified using multi-media as well as extension intervention strategies being guided by the socio – economic attributes of the farmers.
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Key words: sustained adoption; decision behaviors; intercrop technology

1. Introduction

In Imo State, household food security is of major concern. Increasing population and alterative demands for land has exacerbated this. As a panacea, innovative technologies that favour farm level production from research stations are disseminated by the State Agricultural Development Programme (ADP) to farmers for use. One of such technologies is maize/cassava intercrop.

The maize/cassava intercrop technology is the growing of maize and cassava in proximity as their period of overlap is long enough to include the vegetative stages (Gowez and Gowez, 1983). The technology is a risk management strategy that attempts to hedge against the vagaries of market, rainfall \and pest attack (Mutsaers *et al* 1993; Vandermeer, 1989). Here, cassava, a semi - perennial crop is associated with an early maturing crop, maize in such a way that the maize is harvested 3-4 months and the cassava harvest may start 9 months after planting. The bulk of the cassava is harvested after 12-35 months (Mutsaers et al, 1993). There is reduction in pest attack as a non-host plant is included in the field (Dessimond and Hindorf, 1990; Vandermeer, 1989).

The maize/cassava intercrop technology is of paramount importance in the state. First, maize and cassava are the most commonly cultivated carbohydrate staples of cereal and root/tuber crops origin respectively. Both are food security crops and there are no cultural barriers in their consumption. According to Ngoka (1997) maize is grown in almost all the states of the federation and about one million tones of it are produced annually. It is consumed boiled, roasted, fried or processed into flakes, pap, flour, etc. It is used in producing industrial starch, livestock feed, alcohol and for making hay and silage. Cassava on the other hand is a valuable source of 40 percent of the calorie consumed in Africa (Nwajiuba, 1995) and 70 percent of the daily calorie intake of more than 50million Nigerians (Ugwu et al, 1989). It is consumed as fou-fou, garri, flour, tapioca, cake, wet-extract starch, etc. It is a raw material in the livestock feed industry, industrial starch production and brewing industry. The leaves serve as forage and vegetable.

It is however unfortunate that in spite of the contributions of the crops to household food security and livelihood and the obvious advantages of the technology, empirical data on the sustained adoption decision behaviors of the technology does not exist. There are no data on the rate at which the technology is sustained. There is no information on the dynamics of the farmers' sustained adoption decision behaviours. Also the reasons behind the sustained adoption decision behaviours are unknown. Previous studies have treated maize/cassava intercrop as one of the technologies meant for farmers' adoption without in depth analyses of the farmers' sustenance of the technology (Nnadi and Akwiwu, 2005).

It was against the background that this study set out to assess the sustained adoption decision behaviors of maize/cassava intercrop in Imo State with a view to drawing lessons for extension policy development.

1.1 Objective of the study

The broad objective of the study is to assess rural farmers' sustained adoption decision behaviours of maize/cassava intercrop technology in Imo State with a view to proffering policy recommendations. The specific objectives include: (1) to determine the rate at which the farmers sustained the adoption of maize/cassava intercrop technology; (2) to ascertain reasons for the sustained adoption decision behaviours; (3) to analyze the determinants of the sustained adoption decision behaviours.

1.2 Hypothesis

The farmers' socio – economic factors do not determine their sustained adoption decision behaviours of maize-cassava intercrop technology.

2. Methodology

The study was conducted in Orlu agricultural zone of Imo State, Nigeria between December 2006 and April 2007. Orlu agricultural zone is one of the three agricultural zones in Imo State. It is made up of 10 Local government areas. The major economic activity of the people is farming. The crops cultivated include cassava, yam, maize, cocoyam, oil palm, pineapple, banana, plantain and different types of vegetables. The animals reared include poultry, goat, sheep, pig, cattle, snail, grass cutter and fishery. There are two major seasons, rainy and diry, which range from April to October and November to March respectively. The rainfall ranges from 1500 to 2000mm (Onu, 2005) while the temperature is between 26 and 28^0C with relative humidity of 80-90 % (Ugwu and Lekwa, 1988).

Three local government areas were randomly sampled for the study-Oru East, Orsu and Ideato South. Two communities were randomly sampled from each local government area. From each community, 25 farmers were randomly sampled. These provided data for the study.

The instrument used for data collection was semi-structured questionnaire validated by experts and professionals in Agricultural extension and Rural sociology. The questions revolved around the objectives and hypothesis. These were tested for internal consistency using 25 farmers from Oru West L.G.A. with test – re – test method. A coefficient 'r' of 0.75 was got at 0.05 level of significance. A set of 150 copies of the questionnaire was administered while 115 copies were valid for use on retrieval.

The analytical tools comprised descriptive and inferential tools. For objectives 1 and 2, percentage counts were used while objective 3 and the hypothesis utilized logit regression model

$$Y = Ln\ (P/1\text{-}P) \quad (1)$$

$$Ln\ (P/1\text{-}P) = b_o + b_1 x_1 + b_2 x_2 \ldots b_{12}\ x_{12} + e \quad (2)$$

Where:

Y = Dependent binary variable (Sustained the adoption = 1, Did not sustain the adoption = 0)

P = Probability of sustaining the adoption

Ln = Natural logarithm function

bo = constant

$b_1 - b_{12}$ = Regression coefficients

$x_1 - x_{12}$ = Explanatory variables, x_1 –Age, (years) x_2 – Sex (Male = 1, female = 0), x_3 Education (number of years of formal schooling), x_4 – Marital status (married=1, single = 0), x_5 – Family size (number of persons' in a household), x_6 – Nature of Farming (fulltime = 1, part time = 0) x_7 = Farming experience (number of years of farming), x_8 – Social organization membership (member = 1, non number = 0)

x_9 – Farm size (hectare), x_{10} Credit opportunity (obtained credit = 1, has not obtained credit = 0)

x_{11} – Annual farm income (Naira), x_{12}- Number of technology information sources

(P/1-P)- Odd ratio (odds in favour of sustained adoption)

Chi – square was used in place of R^2 to measure goodness of fit (Gujarati, 1988):

$$\sum_{i=1}^{m} \frac{Ni\ (p_1^0 - p^*)^2}{P_1^*(-p_1^*)} \quad (3)$$

Where:

N = Number of observations in ith cell
P_1^o = Actual probability of event occurring
P_1^* = estimated probability
M = Number of Cells

For the large sample size, the Chi – square was distributed according to the chi-squre distribution with M – K degree of freedom, where K is the number in the estimating model (K<M) .

3. Results and discussion

3.1 Rate of sustained adoption of maize – cassava intercrop technology

The rates of adoption of a technology and participation in a programme were measured as the percentage of the farmers' that adopted the technology or participated in the programme (Nnadi and Akwiwu, 2008; Nkonya et al, 1997). Following these, the percentage count of the farmers who sustained the adoption of maize – cassava intercrop was calculated in Table 1. The result shows that about 89 percent of the farmers sustained the adoption of maize – cassava intercrop technology while 11.30 percent did not. The high sustenance rating could be attributed to the superiority of the technology over the traditional, obvious gains from the use and concerted extension efforts. On further probing the farmers, 80.40 percent indicated sustaining the adoption for more than 5 years and 19.60 percent otherwise. On the technology attributes that favored the sustenance, 69.91 percent indicated that the technology is inexpensive, 73.53 percent favored specificity, 98. 04 percent indicated for profitability while 82.35 percent identified with simplicity. These underscore the relevance of technological attributes being wholesome for farmers to sustain adoption.

Table1. Farmers' classification by rate of sustained adoption of maize – cassava intercrop technology

Sustained doption	Frequency	Percentage
Yes	102	88.70
No	13	11.30
Total	115	100.00

Source: Field survey data, 2007.

3.2 Reasons for the farmers' sustained adoption decision behaviours:

Six reasons were adduced for the sustained adoption decision behaviours of the farmers (Table 2). The item, the land is fully used in a growing season ranked first with 56.52 percent while the item, the technology is similar to the existing traditional practice but for a few modifications had 54.78 percent to rank second. Whereas the item, the farmer does not lose all at the event of failure of one crop had 52.17 percent to rank third, the item, the technology is easy to apply had 44. 35 percent to rank fourth. The item, technology does not involve much money and the technology is friendly with the environment had 29.57 percent (5th) and 21.74 percent (6th) respectively.

Table 2. Farmers' distribution by reasons for sustaining the adoption of maize – cassava intercrop technology

Reasons	*Frequency	Percentage	Rank
The land is fully used in a growing season	65	56.52	1st
The technology is similar to the existing traditional practice but for a few modifications	63	54.78	2nd
The farmers do not lose all at the failure of one crop	60	52.17	3rd
Technology is easy to apply	51	44.35	4th
Technology does not involve much money	34	29.57	5th
The technology is friendly with the environment	25	21.74	6th

*Multiple responses
Field survey data, 2007.

The various reasons given by the farmers indicate proper understanding of the obvious advantages of the technology. These corroborated the objectives of the technology (Mutsaers *et al* 1995; Vandemeer, 1989). The reasons further laid credence to the need to consider the farmers' socio–economic situations for technological design and dissemination.

3.3 Socio – economic determinants of the farmers' sustained adoption decision behaviors of maize/cassava intercrop technology

The logistic regression equation had a chi-square of 61.2297. Eight variables (66.72) were statistically significant at 0.05 levels. These included age, education, family size, farming experience, social organization membership, farm size, annual farm income, and number of technological information, sources. There determined the farmers' sustained adoption decision behaviors:

Age (Xi) – The coefficient was – 0.0318 while the t-value was–3.074, significant at 0.05 level. The relationship was inverse. The result implies that a unit increase in age resulted to 3 percent reduction in sustenance of maize – cassava intercrop technology. This shows that young farmers sustained the adoption of the technology more than old farmers. Old age is associated with weakness and skepticism while youth hood is associated with virility and venturesome ness. The finding agrees with Nnadi and Akwiwu (2005) and disagrees with Matthews-Njoku (2005).

Education (X_2) – The coefficient of education was 0.1926 while the t-value was 2.5992. The positively significant relationship implies that a unit increase in years of formal schooling increased the probability of the sustained adoption decision behaviour by 19 percent. Educated farmers are analytical and observe easily the obvious advantages of new technologies. The studies of Nnadi and Akwiwu (2008) and Ohajianya and Onu (2005) associated education with increased participation/adoption of agricultural technologies.

Family size (X_5) – The coefficient and t – value of family size were – 0.0337 and – 2.9052 respectively. The inverse relationship implies that a unit increase in the family size resulted to about 3 percent reduction in the probability of the adoption decision behaviours of maize-cassava intercrop technology. This could be explained by the high social and food security responsibilities of large families that could derail the use of farm capital. The result contradicted Nnadi and Akwiwu (2006) that large families sizes predisposed adoption of innovations.

Farming experience (X_7) – The number of years put into farming had a coefficient of 0.0513 and t-value of 2.5909. The result implies that each additional year to the farmers experience resulted to 5 percent increase in the probability of sustained adoption decision behaviour of maize cassava intercrop technology.

Increased years of farming experience just like education furnished more knowledge that increased the farmers' rationality in the use of innovations. The work of Nnadi and Amaechi (2007) explained increased years of farming experience as a valuable asset in adoption decision-making.

Social organization membership (X_8): The coefficient and t-value of farmers' membership of social organization were 0.0847 and 3.3086 respectively. The result implies that a unit increase in farmers' membership of social organization increased the probability of sustained adoption of maize – cassava intercrop by 8 percent. Social organization membership provided the social needs of the farmers, enhanced diffusion and facilitated collective solutions to problems. The result is in consonance with Nnadi and Akwiwu (2006) in which women who belonged to social organizations adopted more soil management practices.

Farm size (X_9): Farm size had a coefficient of 0.0961 and a t-value of 3.0315. The result implies that a unit increase in hectare of farm size cultivated resulted in 9 percent increase in the probability of the sustained adoption decision behaviours. This could be explained by the fact that large farm size pre-supposes large farm asset. Thus, farmers who had more assets had more dispositions to sustain technologies than those who had less. A similar result was reported by Nkonya *et al* (1997).

Annual farm income (X_{11}) – The coefficient and t-value of annual farm income were 0.0219 and 3.3692 respectively. The result implies that a unit increase in Naira from annual farm income resulted to 2 percent increase in the probability of the sustained adoption decision behaviour of maize/cassava intercrop. Increased annual farm income increased a farmer's capital base. This predisposed to sourcing agricultural information, purchasing farm input, employing farm staff and paying wages. The result is in consonance with that of Karki and Bauer (2004).

Number of technology information source (X_{12}) :

The number of technology information sources available to a farmer had coefficient of 0.0856 and t-value of 3.0681. The result implies that a unit increase in the sources of information available sustained adoption decision behaviours by about 9 percent. More sources of information furnished more facts, cleared doubts and clarified misconceptions. The study of Nnadi (2007) revealed positive relationship between the number of information source available to farmers and their adoption of improved poultry technologies in urban and peri-urban areas of Imo State.

The variables: sex, marital status, nature of farming and credit opportunity were not significant. They do not determine the farmers' sustained adoption decision behaviours and as such should not be considered in designing extension intervention strategies.

Table 3. Logistic regression determinants of farmers' sustained adoption of maize/cassava intercrops technology.

Explanatory variables	Coefficients	T-values
Age	-0.0318	-3.0874*
Sex	-0.714	1.1609
Education	0.1926	2.5992*
Marital status	0.0841	1.1169
Family size	-0.0337	-2.9052*
Nature of farming	0.1167	0.9419
Farming experience	0.0513	2.5909*
Social organization membership	0.0847	3.3086*
Farm size	0.0961	3.0315*
Credit opportunity	0.1022	0.8989
Annual farm income	0.0219	3.3692*
Number of technology information source	0.0856	3.0681*

Constant	-18.3266
N	115
Degree of freedom	58
Model Chi-square	61.2297

*Significant at 0.05 levels

Source: Field survey data, 2007

4. Conclusion and policy implications

The adoption of maize – cassava intercrop technology was sustained by 88.7 percent of the farmers. The reasons ranged from the technology being friendly with the environment to the land being fully used in a growing season. The determinants of the farmers' sustained use decision behaviours include age, education, family size, farm size, annual farm income and number of information sources available. These underscore the importance of the farmers' socio-economic factors, technological attributes and communication related variables in designing extension intervention strategies:

Participatory approaches like the farmer field school should be utilized in designing and disseminating technologies so as to incorporate farmers' socio-economic conditions and expectations for sustained adoption.

Extension education campaign should utilize multi-media for increased awareness, clarification and reinforcement of extension agents' efforts.

Extension enlightenment campaign by the state Agricultural Development. Programme should be intensified to sensitize and motivate farmers towards enlisting in farmers' co-operative societies.

Farmers' socio-economic factors should be considered fundamental in designing extension intervention strategies.

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Quality Control Assessment of Unskinned-dried Tadpole Meal Supplemented Fish Feeds

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Abstract: The hike in the price of fish feed due to that of fish meal called for researches into suitable supplement for this essential animal protein which will be use to produce feeds with high nutrient and preserved quality. Unskinned-dried tadpole meal was used to supplement fish meal at inclusion levels of 0% (control diet) , 25%, 50%, 75% and 100% of Unskinned-dried tadpole meal coded Tdp1 to Tdp5. The feeds were divided into two first parts were preserved in a refrigerator at 8°C while the other at 28-30°C for 70 days. Routine checking was done bimonthly for the physical, biochemical and microbial evaluations for duration of 10 weeks. The results of the experiment showed that the highest Hedonic scale, 7 was Mould appearance of all unskinned-dried tadpole meal diets stored in refrigerator while lowest value, 2 was for colour in 75% and 100% unskinned-dried tadpole meal diets stored in room temperature diets stored in room temperature at 28-30°C. There was significant different ($p<0.05$) between the final lipid stored at the two temperatures. High significant correlations $r=0.885$ and $r=0.990$, $p<0.05$ existed between the final proteins and lipids respectively of the diets stored at the two different temperatures. The microbial evaluation for unskinned-dried tadpole meal ranged from 16.73x107cfu/mol - 41.73x107cfu/mol with highest from 100% unskinned-dried tadpole meal stored at room temperature and lowest from the control diet stored in refrigerator. Based on the results from this study 50% unskinned-dried tadpole meal diet stored in refrigerator at 8°C is recommended as a better way of feed storage for sustainable aquaculture and improving fish food security. [World Rural Observations 2009;1(1):7-16]. ISSN: 1944-6543 (print); ISSN: 1944-6551 (online).

Key words: dried–unskinned tadpole meal; fish meal; preservation quality; temperature

1. Introduction

The future growth of the aquaculture industry in Nigeria and other country's of the world depends upon the availability of suitable and economical feeds. Information on the type, quality, quantity, seasonality and cost of fish feeds is important in determining the appropriate production strategy. Enhancement of aquaculture practice in Nigeria has tendency to proffer solution to problem of malnutrition in providing fish (which is a cheap and reliable animal protein source) on every table at each meal (Adegbola, 1999; Falayi et al., 2003 ; Sogbesan et al., 2006). For aquaculture to supply the population's growing demand of 1.84Million tonnes of fish as food in the 2009 and to fill the gap of 1.22Million tonnes deficiet in declining yield from capture fisheries (Federal Department of Fisheries, 2003); basic but critical information should be available especially as regards feeds that are less competitive and of low cost value. These should have replaceable capacity for fishmeals with the aim of making fish to attain table size at reduced culture time and minimum production cost.

Quality assurance investigates all aspects capable of influencing the end products and it is aimed at ensuring that the initial quality is maintained so as to reduce incidence of quality shortcomings (Eyo, 2001). Fish diet must have the correct appearance (ie. size, shape and colour), texture (ie. hard, soft, moist, dry, rough or smooth), density (buoyancy) and attractiveness (ie. smell or taste) to elicit an optimal feeding response (appetite) by the fish fed (Mackie and Mitchell, 1985). Quality assurance in feeds must have hazard analysis critical control points plan (HACCP) and adhere to it (Tacon, 1994), hence the need for proper processing and preservation methods.

The presences of toxins, inhibitors and anti-growth factors in feeds and feed ingredients have a problem that limits their maximum utilization and inclusion as supplementary non-conventional ingredients to the conventional ones. In the choice of feed ingredient, the easiness in processing and preservation of ingredients and prepared feeds shelf life remains important factors apart from availability, nutrient composition, easy accessibility and lack of competition with other consumers. Processing methods embarked upon during most feed preparation are aimed at detoxification of toxins in the ingredient either by boiling/cooking, fermenting with/without enzymes/soaking, heating, roasting, blanching, extruding among other methods (Akpodiete and Okagbare, 1999; Isikwenu and Bratte, 1999; Obun et al., 2005).

2. Materials and methods

2.1 Formulation of experimental diets

Ingredients used in compounding the diets such as fish (clupeid) meal, yellow maize, groundnut cake, soybean, blood meal, cassava starch and bone meal were purchased from Monday Market in New-Bussa while vitamin/mineral premix was purchased from Hope Farms Ltd, Ibadan. Tadpole meal was from the cultured and processed tadpole (Sogbesan et al., 2007 and 2008). Soybean was dehulled and toasted before use while cow blood collected from abbatoir was boiled and congealed. The congealed blood was sun-dried and ground into powder. Cassava starch was used as a binder at a rate of 1%.

A completely randomized design was used in the designing the diets which were formulated using Algebraic Method along with Least Cost Formulae (LCF). Unskinned –dried tadpole meal was used to replace fishmeal as animal protein source at 0% (control), 25%, 50%, 75% and 100%. All diets were isonitrogenous at 42.5% crude protein, isocaloric at calculated 1900kJ/100g with the same protein to gross energy ratio (P: GE) of 44.7mgprotein/kJ/100g. The percentage composition of the ingredients in the experimental diet is shown in Table 1.

Table 1. Percentage composition of ingredients (g/100g diets) in unskinned-dried tadpole meal diets for the feeding trial

Ingredients	Tpd1 (control)	Tpd2	Tpd3	Tpd4	Tpd5
Fishmeal	30.0	22.5	15.0	7.5	0.0
Unskinned-dried tadpole meal	0.0	7.5	15.0	22.5	30.0
Yellow maize	28.7	21.1	15.2	8.9	1.3
Groundnut cake	11.7	17.3	20.9	24.6	25.0
Soy bean meal	12.6	14.6	16.9	19.5	25.2
Blood meal	10.0	10.0	10.0	10.0	10.0
Chromic oxide	0.5	0.5	0.5	0.5	0.5
Vitamin/minerals premix	2.0	2.0	2.0	2.0	2.0
Palm oil	2.0	2.0	2.0	2.0	2.0
Common salt	0.5	0.5	0.5	0.5	0.5
Bone	1.0	1.0	1.0	1.0	1.0
Cassava starch (binder)	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0
Calculated crude protein (%)	42.5	42.5	42.5	42.5	42.5
Calculated gross energy kJ/100g	1900	1900	1900	1900	1900

P :GE mg of protein/kJ/100g	44.7	44.7	44.7	44.7	44.7
Inclusion of unskinned-dried tadpole meal %	0.0	25.0	50.0	75.0	100.0

Tpd= Unskinned-dried tadpole meal
P = crude protein content
GE= gross energy value

2.2 Preparation of experimental diets

After formulation, the ingredients were measured using electric sensitive weighing balance (OHAUS- LS 2000 Model), milled into fine particles (commonly practised for fish feed preparation) (Falayi, 2003) using a combined grinder and mixer (ASEFAC Prototype 1989). The dry ingredients were thoroughly mixed for 30 minutes to ensure homogeneity of the ingredients. Starch was prepared with hot water and added after thorough mixing of all the other ingredients. The dough was pelleted wet using hand pelleting machine (Kitchen Hand Cranker Pelletizer). The pelleted dough was collected in flat trays and sun-dried to constant weight after which the feeds were crushed into crumbs with pestle and mortar (for easy ingestion by the fish). They were packed in plastic bowls with covers labelled and stored at room temperature in the laboratory.

2.3 Determination of shelf life of the experimental diets

5g of each of the experimental diet was put in corked bottle labelled according to each of the diet code. One set was stored in a refrigerator at 8^0C and coded A while the other set was stored under ambient room temperature of 28-31^0C in the laboratory and coded B. Routine checking was done bimonthly for the physical, biochemical and microbial evaluations for a duration of 10 weeks. The duration choice was based on 1-2 months recommendation by DeSilva and Anderson (1995) for storing fish feed in the tropical region.

(1) Physical and sensory evaluation

A 10-member evaluation panel comprising of experienced and qualified fish nutritionist from NIFFR, Federal College of Freshwater Fisheries Technology, and Federal College of Forestry and Wildlife all in New-Bussa were constituted. The quality attributes assessed included colour, mould appearance, odour/ flavour (rancidity) and texture (Eyo, 2001). A 7-point Hedonic Scale of Tiamiyu et al. (2004) adopted for the evaluation were 7=excellent, 6=very good, 5= good, 4= fairly good, 3=fair, 2=poor and 1=very poor). Each member of the panel evaluated each quality attribute.

(2) Chemical evaluation

Each of the experimental diet was analysed for proximate composition in triplicate on bi-monthly bases and the mean was recorded. The parameters considered were crude protein, crude lipid and crude fibre according to (AOAC, 2000) Methods.

(3) Microbial evaluation

The microbial analysis of the stored feeds was carried out in triplicate in the Biological Laboratory of NIFFR following Tiamiyu et al. (2004) Methods.

(4) Colony forming unit (cfu)

The colony forming unit (cfu) was determine by serial dilution of the preserved experimental feeds using 1.0g of feed to prepare 10 fold serial dilution with sterile distilled water.

(5) Agar preparation

Potato dextrose agar (PDA) (Oxoid Industry, England) was prepared according to the manufacturer's instruction and autoclaved at 120^0C for 15 minutes. This was allowed to cool to 37^0C before 1% streptomycin was added to prevent bacteria contamination of the agar (Adriau and Dehant, 1979). All glasswares used for the experiment were sterilized in the oven at 105^0C for 2 hours.

(6) Inoculation with experimental diets

1ml of each fold dilution was incorporated into 16ml of sterilized molten potato dextrose agar, mixed clockwise and anticlockwise for 1 minute, and incubated at 27^0C for 24hours in an incubator.

(7) Fungal counts

This was done quantitatively using colony count on pour plate technique according to the method of Adriau and Dehant (1979). 24hours old culture was used for this determination.

3. Results

The lowest crude protein, 43.39% was in 100% unskinned-dried tadpole meal diet while the highest value, 43.53% was in the control diet (Table 2). Crude protein content in all the diets were not significantly different ($p>0.05$). The lipid content increased as tadpole meal inclusion increased with the values ranging from 10.63% to 16.07% which were significantly different ($p<0.05$) except between 50% and 75% inclusion levels. There was no significant difference ($p>0.05$) in the gross energy content in all the diets. Highest potassium, 0.78g/100g was in 100% diet while lowest 0.72g/100g was in control and the values were not significantly different ($p>0.05$) between all the diets.

Table 2. Proximate and energy composition (% dry matter) of the unskinned dried tadpole meal diets

Composition	**Experimental diets**				
	Tpd1 (control)	**Tpd2**	**Tpd3**	**Tpd4**	**Tpd5**
Inclusion levels of unskinned-dried tadpole meal (%)	0	25	50	75	100
Crude protein %	43.53	43.51	43.48	43.46	43.39
Crude lipid %	10.63[e]	11.62[d]	13.10[c]	14.66[b]	16.07[a]
Crude fibre %	3.36	3.58	3.74	3.92	3.99
Ash %	8.41	9.98	11.44	12.62	13.77
Nitrogen free extract %	18.33[a]	15.92[b]	13.11[c]	10.51[d]	6.87[e]
Dry matter %	84.28	84.61	84.87	85.16	84.09
Sodium (g/100g)	0.53	0.52	0.48	0.45	0.43
Calcium (g/100g)	1.47[a]	1.23[b]	1.14[b]	1.10[bc]	1.04[bc]
Potassium (g/100g)	0.72	0.73	0.77	0.74	0.78
Phosphorus (g/100g)	0.95[a]	0.89[a]	0.77[ab]	0.65[bc]	0.55[c]
Magnesium (g/100g)	0.10	0.11	0.21	0.26	0.32
Gross energy kJ/100g	1776	1766	1777	1788	1777
Metabolizable energy kJ/100g	1332	1324	1333	1341	1332
Digestible energy kJ/100g	1439.2	1451.3	1476.5	1499.4	1509.7

All values on the same row with the different superscripts are significantly different ($p<0.05$).
Data without superscript are insignificantly different ($p>0.05$)
Tpd: Unskinned-dried tadpole meal

Lowest hedonic scale, 2 was for color in 75% and 100% unskinned-dried tadpole meal diets stored in room temperature (Figure 1). There was mould appearance in all unskinned-dried tadpole meal diets stored in refrigerator with hedonic scale, 7. There was significant difference ($p<0.05$) between colour, odour and texture of unskinned–dried tadpole meal diets stored at the two temperatures.

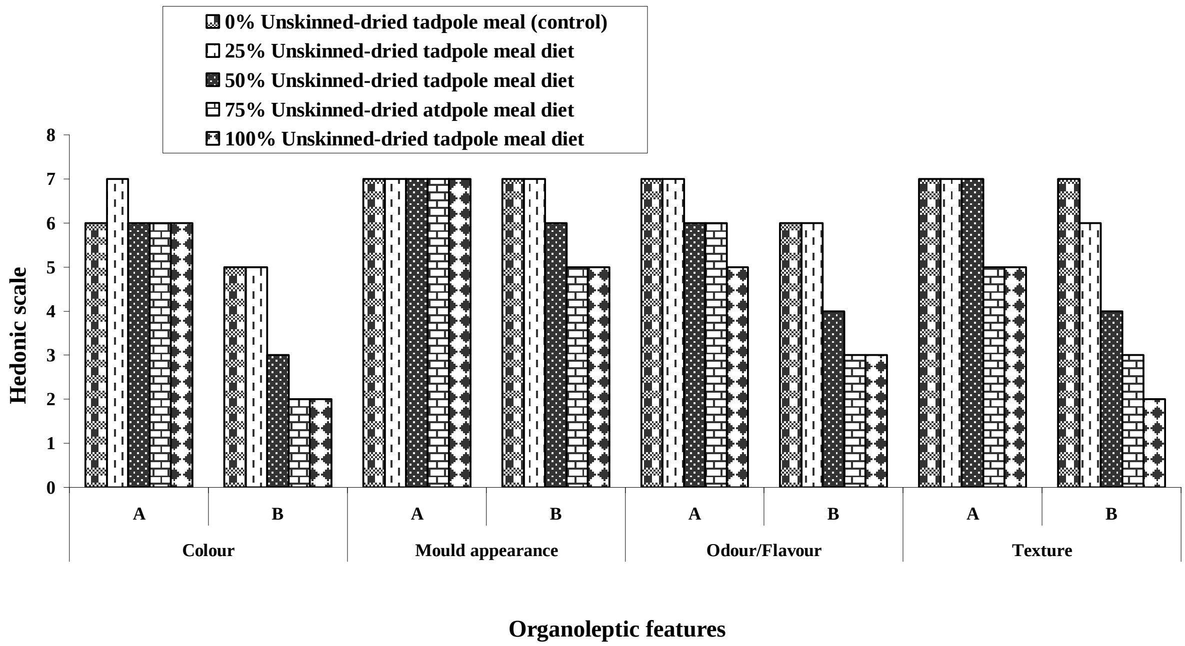

Figure 1. Physical evaluation of unskinned-dried tadpole meal diets preserved in refrigerator, 8°C (A) and under room temperature, 28-30°C (B) for 84 days

Final crude protein ranged from 41.93% to 43.21% in stored unskinned-dried tadpole meal with highest from 25% diet stored at 8°C while lowest from 100% diet stored at room temperature (Table 3). Lowest lipid, 10.55% was in the control stored at room temperature while highest, 15.88% was from 100% unskinned-dried tadpole meal diet stored at 8°C. There was significant different ($p<0.05$) between the final lipid stored at the two temperatures. High significant correlations $r=0.885$ and $r=0.990$, $p<0.05$ existed between the final proteins and lipids respectively of the diets stored at the two different temperatures.

Table 3. Proximate composition of the unskinned-dried tadpole meal diets before and after storage at the two different storage temperatures (8^{o}C and room temperature 28-30^{o}C)

Nutrient	**Storage temperatures**	**Experimental diets**				
		Tpd1 (control)	**Tpd2**	**Tpd3**	**Tpd4**	**Tpd5**
Inclusion levels of unskinned-dried tadpole meal		0%	25%	50%	75%	100%
	Initial	43.53	43.51	43.48	43.46	43.39

Crude p...		42.60^{b}
		41.93^{c}
Crude li...		16.07^{d}
		15.88^{d}
		15.69^{d}
Crude fi...		3.99^{c}
		3.90^{b}
		3.83^{b}
Ash (%...		13.27^{e}
		13.10^{d}
		12.68^{e}

For eac... ...ntly difference $p<0.05$.

For each nutrient data without superscript are insignificantly different ($p>0.05$)

Tpd= Unskinned–dried tadpole meal

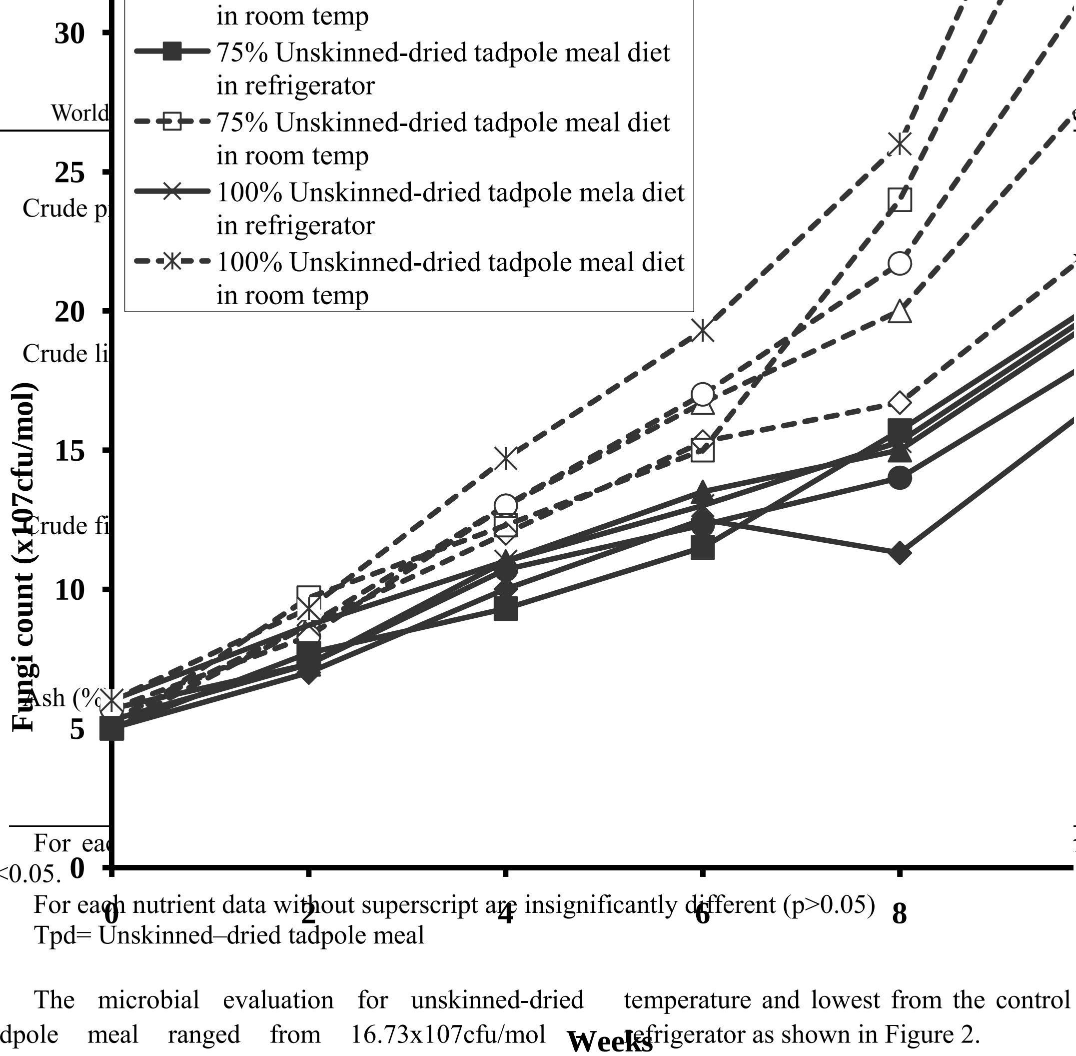

Figure 2. Weekly fungi growth in unskinned-dried tadpole meal diets stored under different temperature for 70 days

The microbial evaluation for unskinned-dried tadpole meal ranged from 16.73x107cfu/mol – 41.73x107cfu/mol with highest from 100% unskinned-dried tadpole meal stored at room temperature and lowest from the control diet stored in refrigerator as shown in Figure 2.

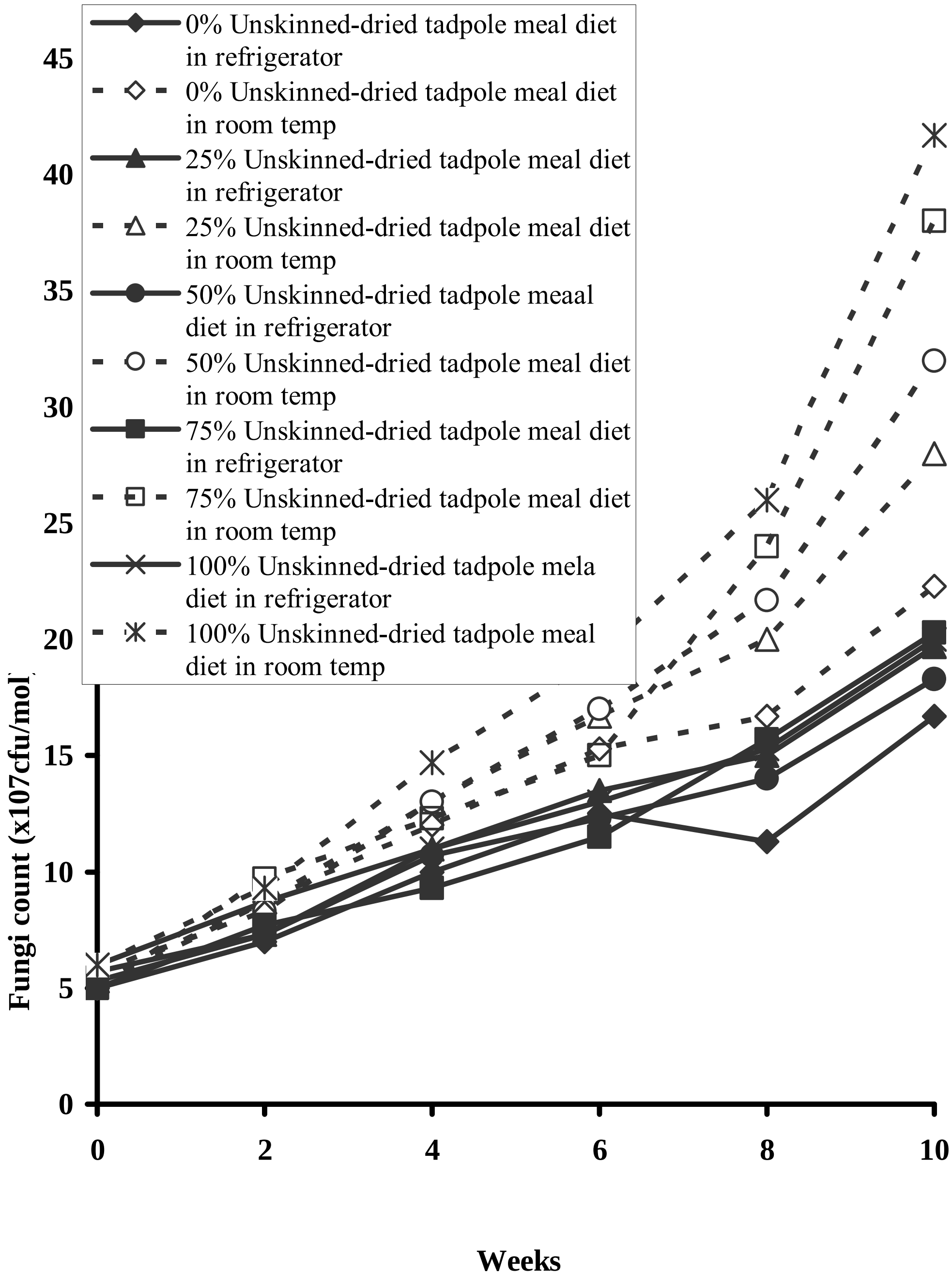

Figure 2. Weekly fungi growth in unskinned-dried tadpole meal diets stored under different temperature for 70 days

4. Discussion

The basic nutrient that cannot be compromised in the choice of ingredients for feed formulation and preparation is protein (Zeitler et al., 1984) and since each of the experimental diet supplied the optimum required amount they were adequately utilization by the fish. The lipid content of each experimental diet increased with increase in the proportion of their tested animal protein supplements (See Table 2). This lipid increase may have had a sparing effect on the dietary protein and complement its utilization (Okoye et al., 2001). This observation corroborate with that of NRC (1993), that practical diets should be formulated not only to meet the optimum ratio of protein to energy but also the adequate amount of lipid needed by the fish. Dietary lipids also provide essential polyunsaturated fatty acid for normal growth and development of cells and tissues (Sargent et al., 1995) .

Among the experimental diets studied, unskinned-dried tadpole meal diets were rancid ealier and more microbial growths at both 8°C and room temperature (28-30°C) storage temperatures than the other diets. The reason for this would have been their high lipid concents compared to the other diets. This agrees with the report of Tacon (1987) that the major problem faced by animal feed compounders is the susceptibility of individual ingredients and formulated diets having high lipid and moisture to oxidative damage or oxidative rancidity and microbial attack. Despite the fact that the studied diets were dried which eliminate high moisture; deterioration were recorded from physical, chemical and microbial studies which showed that moisture was not a major factor in feed spoilage (DeSilva and Anderson, 1995; Effiong and Eyo, 2003 and Tiamiyu et al., 2004).

The reduction in lipid and protein composition from all the experimental diets at the end of the experimetal period corroborate the reports of DeSilva and Anderson (1995) and Hodari-Okae et al. (1998) that within a period of 2-4months feeds are prone to reduction in their major nutrient composition. Reduction of nutrient content from each diet at the end of the experiment could have been as a result of increase in activity and microbial population, solubilization of minerals into weak acids, other oxides, temperature and humidity fluctuation as also reported by (Eyo, 2001).

The result of the microbiological analysis showed that the method of storage had effect on microbial growth though lower microbial load were recorded from 8°C compared to those preserved at room temperature. Wilson (1991) and Tiamiyu et al (2004) documented that cold storage is the most effective way of preserving raw and processed offal meal. The microbes recorded from the lower temperature could have resulted from water crystals in feed, which could lead to rapid microbial spoilage and destruction of moisture-sensitive vitamins like vitamin C (FAO, 1983 and Wilson, 1991) due to of moisture and low temperature and high humidity. Decrease in Vitamin E, which could result from high rancidity of feed, has been associated with mould appearance in meals because of fungal destruction of α – tocopherols (Aletor, 1990 and Hodari-Okae et al., 1998). Some of the inconsistent trends in microbial growth and nutrient depression in feed can possibly be due to the interactions taking place between chemicals present in the feed, processing methods, preservation technique and resistance of the organisms as reported by Aletor (1990).

The fact that microbial growth was reported all diets studied despite their compositions and place of storage corroborate with the report of Osho et al. (2007) that no feed was completely free of fungi contamination.

The occurrence of Aspergillus is significant in public health. A niger and A. flavus had been reported (Osho et al., 2007) as the common agents of food spoilage most especially in the tropics where their spores are widely distributed. Some species of are known to secrete toxins known as aflatoxin which cause food poisoning and are carcinogenic to man; when ingested affect the liver and no effective therapeutic treatment has yet been known. Aspergillus spp caused “Aspergillosis” (a disease of the lungs) (Okaeme, 1999). Many human and animal diseases such as mycotic abortion, aflatoxin poisoning, allergic reaction, systemic infections are attributed to mould and fungi ingestion (Okaeme, 1999). Penicillum spp and Fusarium spp are also capable of secreting toxins like ichra toxins and penicillic acid that are dangerous to human health. Various lung diseases in farmers are associated with mould and grain dust. Aflatoxins, even at diminutive dietary levels have been established to decrease growth rate and feed conversion efficiency (Aletor, 1990) in animals fed such feed.

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Performances of Dutch Claries Juvenile Stocked at Different Densities in Out-door Happas

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Abstract: The differences in optimum stocking levels reflect differences in species culture condition and size of fish used in the studies. Hollandis fingerlings will be stocked at 5, 10, 15 and 20 per happas of sizes (1m X 1m X 1m) and coded T1, T2, T3 and T4 respectively. They were fed 5% body weight of 45% crude protein diet for ten weeks. The results of the experiment showed that Happa stocked at 10 hollandis juvenile had the highest specific growth rate of 0.89%/day while those stocked at 20 Juvenile per m^2 had the lowest specific growth rate of 0.26%/day. These were significantly different ($p<0.05$) to each other. The survival and condition factors were also significantly different ($p<0.05$) between T2 and T4. The condition factors for fish stocked above 15Juvenile/m^2 of happas were below 1.00 while those from fish stocked below 15Juvenile/m^2 were above 1.00. The Feed conversion rate ranged between 1.23 to 2.04. The best from T1 and the worst from T4. There were no significant difference between feed conversion rate in T2 and T3. From this study and foregoing, Hollandis can still be stocked at 10 Juvenile per m^2 for sustainability of aquaculture.

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Key words: growth; feed conversion rate; survival; Hollandis; stocking density

1. Introduction

In spite of remarkable success reported on the induced breeding of Dutch *Clarias*. It's still beset with survival during the fry and fingerlings stage. This is attributed to lack of proper awareness and technical "know-how" about principles of hatchery management. Studies on the effect of stocking densities and feeding frequency of other aquaculture species have yielded different results. Optimum stocking for which fish density was reported as 60 fish/m^3 for estuary grouper, (maximum weight of 15.2g) (Teng and Chua, 1978), 150 fish/m^3 for rainbow trout *Oncorhynchus mykiss* (Trzebiatowski *et al*., 1981); 100 fish/m^3 for *Clarias anguillarias* (2.5g) (Madu, 1989). The differences in optimum stocking levels reflect differences in species culture condition and size of fish used in the studies.

There is currently very scanty information on the optimum stocking density and feeding frequency of Dutch *Clarias gariepinus* "Hollandis" juveniles. According to Viveen *et al.* (1986) optimum stocking density for effective hapa management of fry must be established since the performances in confinement are largely influenced by stocking density. In view of this, there is a clear need to look at the space requirement for optimum performance for dutch *Clarias gariepinus* juvenile.

2.Materials and methods

(1) Study area

The research was carried out in the Fisheries Farm of Federal University of Technology Yola, Adamawa State between September to December, 2008.

The research area is located within the Sudan Savannah and lies between latitude 7^0 and 11^0 North of the equator and between longitude 11^0 and 14^0 East of the Greenwich Meridian. The mean annual rainfall is about 1000mm and the average minimum temperature is 40^0c (Adebayo, 1999).

(2) Methods and materials for the construction of hapas

Fishing Net of mesh size, Fishing Twine, Needle, Scissors, and Meter Rule. (Plate 1.0.). Twelve hapas net of sizes 1m X 1m X 1m were constructed as described by Otubusin (1985) and Otubusin and Opeloye (1985) in order to determine the stocking densities of Dutch Clarias. The net hapas were attached to the concrete tank on the floating culture system (see plate 1).

Plate 1. Experimental happas in the out-door concrete tank

(3) Experimental fish

200 Juveniles of Dutch domesticated strain of *Clarias gariepinus* produced by artificial spawning of the domesticated broodstock of average weight 15.40±3.24g were purchased from Gessedaddo Farms Limited Km 11 Yola, Numan Road, Adamawa State. These were also acclimatized in outdoor concrete tanks at the Research farm of Department of Fisheries, Federal University of Technology, Yola.

(4) Feed ingredients and formulation

The Dutch *Clarias* will be fed on mainly essential nutrient of complete diet purchased from the market. The materials for the composition of the fish feeds ingredients are as follows. Maize, Groundnut cake (GNC), Soya beans, Groundnut oil, Fish meal, Vitamin and mineral premix, Salt and Starch were purchased from Fish feed store in Yola, Adamawa. They were used to formulate 45% crude protein pelleted feeds as shown in Table 1 and fed to the fish.

Table 1. Experimental diet (DM/100g) and Proximate composition of the feed

Ingredients	**compositions**
Groundnut cake	17.00
Fish meal	32.00
Soybeans	14.00
Yellow maize	34.00
Starch	3.00
Salt	0.4
Vitamin and Mineral premix	1.6
Palm oil	1.00

Total	**100.00**
Calculated crude protein (%)	40.00
Proximate composition	
Dry matter	87.89%
Crude protein	40.20%
Crude lipid	14.45%
Crude fibre	4.57%
Ash	11.20%
Nitrogen free extract	17.47%

(5) Acclimatation of the fish and experimental set-up

C. gariepinus fingerlings will be randomly assigned to each of the eight experimental Hapas at different stocking densities and feeding frequency. The stocking density and feeding frequency of fingerlings per (m^3). A 45% dietary crude protein prepared according to Eyo (2003).

(6) Stocking density

Hollandis juveniles were stocked at 5, 10, 15 and 20 per hapas of sizes (1m X 1m X 1m) and fed 5% body weight of 45% crude protein diet for eight (8) weeks

(7) Water quality and temperature

The temperature, dissolve oxygen, nitrite and pH will be determined using Boyd, (1992) methods.

(8) Monitoring

The fish were monitored for survival by removing the dead fish and recording their numbers.

Each experimental set-up will be monitored for weekly weight by recording the fish using OHAUS weighing balance. The new weekly weighed will be used to adjust the quantity of the ration given to the fish.

(9) Data collection

The weight and quantity of feed given per each setting will be recorded on weekly basis.

(10) Chemical analysis

Feed formulated shall be analyzed for the proximate composition using AOAC, (2002) methods.

(11) Growth and feed relation parameters

The following parameter shall be determined using the weekly weight, length and quantity of feed fed. Weight gain (g/fish, Specific growth rate (%/day), Relative weight gain (%), Condition factors, Feed Supplied, Feed conversion ratio, Protein efficiency ratio, Survival

(12) Data analysis

The data collected will be subjected to one way analysis of variance and differences among means will be deleted with least significant. Difference multiple range test at 0.5% probability to accept or reject the level (Sokal and Rohlf, 1981). Graphically, the weekly weight and feeds fed shall be represented.

3. Result

The feed proximate composition shows that the protein content was 40.20% and lipid was 14.45% as shown on Table 1.

The result of the data collected in respect of the research into the stocking densities and growth performance of Dutch Claris (Hollandis) reared in happas at different stocking rates in outdoor concrete tank is presented in Figure 1 as well as graphical depiction. There was significant different in the mean weight gain obtained in all the four treatments. Table 3 shows the survival rate of Dutch Clarias juvenile in the outdoor concrete tanks during the experimental period. Fish survival was between 80% and 90%. Details of number of Dutch Clarias juvenile that survivals during the experiment are shown in table.

Table2. Growth performances of Hollandis raised in Happas at different stoking densities

Parameter	**T1**	**T2**	**T3**	**T4**
Stocking densities	5/m^3	10/m^3	15/m^3	20/m^3
Initial mean weight (g/Fish)	18.12	15.00	13.62	14.84
Final mean weight (g/fish)	27.48	22.14	21.34	20.08
Mean weight gain (g/fish)	9.36	7.14	7.72	5.24
Relative weight gain (%/fish)	51.66^a	47.60^a	56.68^a	35.31^b
Specific growth rate (%/fish)	0.32^a	0.30^a	0.35^a	0.23^b
Food conversion ratio	0.06^b	0.08^{ab}	0.13^a	0.17^a
Protein efficiency rate	0.14^b	0.19^b	0.33^a	0.45^a
Feed intake	158.16^a	93.92^b	58.24^c	29.11^d
Condition factor K1	0.72	0.80	0.71	0.68
Condition factor K2	0.59	0.65	0.66	0.63
Initial length (cm)	13.62	12.34	12.42	12.98
Final length (cm)	16.72	15.06	14.82	14.74
Length gain (cm)	3.10	2.72	2.40	1.76

All data with different superscripts are significantly different ($p<0.05$)

Table 3. Cost analysis of Hollandis Stocked at different densities and raised in Happas for 56days

Cost (₦)	**T1**	**T2**	**T3**	**T4**
Mean Cost of feeding	596.18	540.31	514.62	438.99
Mean Cost of Juvenile	80	80	80	80
Cost of construction of Happas	1200	1200	1200	1200
Miscellaneous	200	200	200	200

Expenditure	2076.18	2020.31	1994.62	1918.99
Value of Fish	125.73	130.00	116.08	147.19
Net profit/loss	-1950.45	-1890.31	-1878.54	-1771.8
Incidence of cost	154.9	157.4	212.6	156.1
Profit index	0.211	0.241	0.226	0.335
Cost benefit ratio	0.0605	0.0643	0.05819	0.0767

The specific growth rates were also significantly different amongst treatment ($p<0.05$). Treatment 1 with the least stocking densities (5fish/M^2) had a SGR of 0.53 while treatment 3 with (15fish/M^3) stocking density had the least specific growth rate of 0.29. Although there were variation in the mean gain in length. The lengths of the juvenile were not significantly different $p>0.05$.

The mean weight gain per day for juvenile was found to be highest (1.12g/day) in treatment 1 followed by juvenile in treatment 2 (1.1g/day), treatment 4 with (1.1g/day) and treatment 3 (0.81g/day), respectively.

This means that treatment 3 had the least mean weight gain of 0.81g/day. The mean number of fast growers was found to be highest in treatment 1 with stocking density of (5fish/m^2) while lowest stocking density. Highest stocking density (15fish/m^2) gave rise to fewer but bigger jumpers. Water quality parameter measured varied as followed; temperature 28^{0}C to 28.5^{0}C, dissolved oxygen, 4.68 to 5.73 mg/l, pH, 7.40 to 7.52.

4. Discussion

Result of this study showed that stoking density affect the growth and survival of Hollandis under happas management system (see fig 1). Similar results were found in other mudfish: *C. gariepinus*, maintained at a density of 100fry per m^3 grew significantly faster than when maintained at 50/m^3 (Madu, 1989). Fish stocked at higher densities (values) showed a significant increase in the mean fish weight, weight-gain per fish, specific growth rate as well as survival, compared to those at the lower stocking densities. The specific growth rate was highest in treatment A with the lower stocking densities and lowest in treatment D with the highest stocking density. This conforms to the findings of Haylor (1992) who stated that specific growth rate deceases with increase density. The increase in the development of "Jumpers" as the stocking levels increased, further support the effect of overcrowding. Growth and production of fish are to a certain extent dependent on the population density (Siddiqui *et al*, 1989). In the present study, the harmful effects that higher stocking density had on the rearing of juvenile were reduction in growth and lowering of survival.

A similar trend was reported by Ita *et al*, (1989) for the fry of *C. anguillaris* under outdoor hatchery management system. Higher stocking density (Value) gave rise to fewer but bigger "jumpers". Mortality of fish during the study might have resulted mainly from cannibalism and space effects. The dissolved (DO), pH and Temperature (T^{0}C) estimated during the experiment were within the acceptable range for warm water fish culture (Boyd, 1981).

When all these are considered, the best option that can guarantee highest revenue, largest turnover and a reduced production cost will be the tank with 20 Juvenile/m^3 (Table 3). The study carried out on the utilization of happas in raising fish as been practised in cage culture may not be economically viable based on the fact that the cost of producing happas is higher than either an earthen pond or a concrete pond if aquaculture is to be practised as a sustainable venture. The study is recommending a stocking density that will be as high as 20Juvenile /m^3 for dutch Clarias which will turn out as economically viable. This is against the conventional 5Juvenile/m^3. This could have been as a result of the fact that the fish studied (Dutch clarias) is an improved variety of a naturally hardy fish of the family Clariidae.

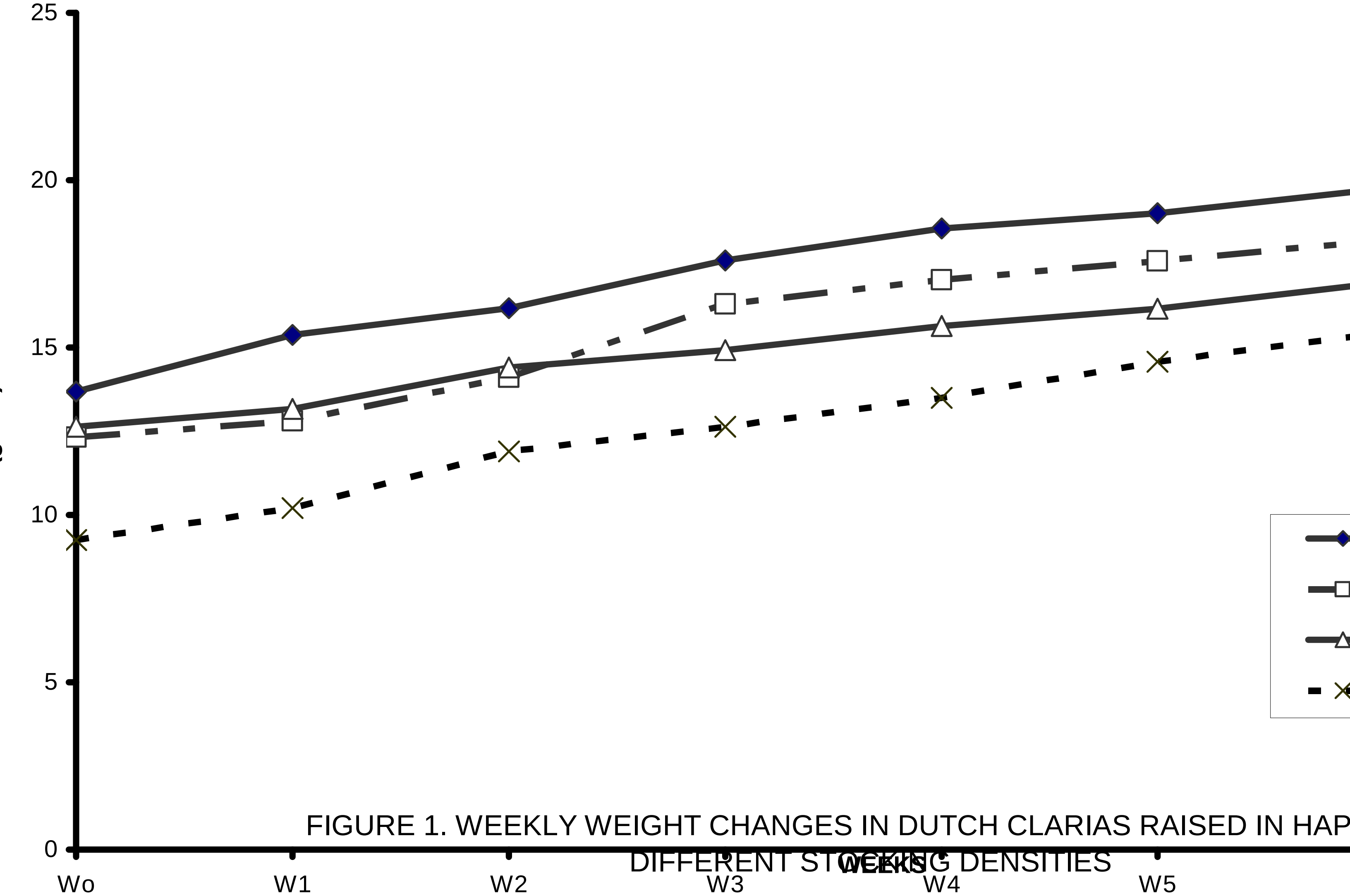

FIGURE 1. WEEKLY WEIGHT CHANGES IN DUTCH CLARIAS RAISED IN HAP
DIFFERENT STOCKING DENSITIES

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Situation of Rural Ecological Environment and Management system Innovation in Northeast Major Grain Producing Areas

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Abstract: This article investigated 36 administrative villages in Heilongjiang Province, Jilin Province and Liaoning Province. The questionnaires ask about the issuance of local rural sanitation, solid waste, chemical fertilizers, pesticides, the use of plastic film and environmental protection activities. Statistics based on the questionnaires are as follows: Organic Waste is the major part of rural solid waste in Northeast Major Grain Producing Areas. The average amount of chemical fertilizer of the three northeastern provinces is 61.62、93.12、80.49t/km^2 respectively, which exceeds the safety limit set by developed countries to protect the environment. This article sets out the rural ecological environment problems, institutional innovate on management of the rural ecological environment according to the actual situation of Northeast Major Grain Producing Areas. Management system innovation includes legal system innovation, organizational innovation and Organization management innovation.
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Key words: rural ecological environment; management system innovation; Northeast Major Grain Producing Areas

1. Introduction

With 18% of the country's total arable land, Northeast Major Grain Producing Areas is one of the important commodity grain production bases, which made a significant contribution to the country's economic development. However, with the rural economic development, rural eco-environmental issues especially the problems of environmental pollution in rural areas are increasingly prominent, which make fragile rural ecological environment face tremendous pressure.

Figure1. Pollution in rural areas of three provinces in Northeast China

The survey about rural eco-environmental problems in Northeast Major Grain Producing Areas was carried out in July, 2009. The effective number of questionnaire is 498 in a total of 700, of which 193 in Heilongjiang Province, 174 in Jilin Province, 131 in Liaoning Province. The survey was conducted on residents of towns and administrative villages. Contents include rural health, waste, environmental protection activities and so on, with the way of releasing questionnaires and asking.

2. Situation of rural ecological environment in Northeast Major Grain Producing Areas

2.1 Solid waste and sewage pollution

There are no perfect environmental infrastructure constructions, waste disposal sites and agencies, so garbage which hasn't been dealt with is open-air dumped everywhere. The questionnaire divides all the solid wastes into 4 main types. The first category is organic waste, including leftovers, plant stalks, animal carcasses, etc.; the second one is recyclable garbage, including paper, plastics, metals and textiles, etc.; the third one is inorganic refuse, including discarded bricks, cement, tiles, etc.; the fourth one is hazardous waste.

Most of the sewage is not treated, according to the statistics based on the questionnaire. The proportion of sewage directly discharged or deposited into rivers is 68.5%. The one which is thrown at random around villages is 26.9%. The one deposited into farmland is 3.5%. And the rest one is 1.1%. Gray water takes account for 50%, black water accounts for20%, and other sewage accounts for 30% out of all the Discharged wastewater. The sewage washed into rivers by rain finally causes pollution to the source of drinking water.

Table 1 Classification and proportion of solid waste in Northeast Major Grain Producing Areas

Kinds	Organic Waste	Recyclable rubbish	Inorganic refuse	Hazardous Waste
Proportion	50%～60%	25%～30%	5%～10%	＜5%

2.2 Pollution from agricultural production

Pollution generated in the agricultural production process is serious in villages in Northeast Major Grain Producing Areas. Excessive application of chemical fertilizer and pesticide, and improper using of plastic film lead to soil compaction and deterioration of water quality of groundwater resources. Use of chemical fertilizers per unit effective area of arable land can be calculated according to the questionnaires. Three-year average of Heilongjiang Province, Jilin Province and Liaoning Province, respectively is 61.62、93.12、80.49t/km^2, which far exceeds the maximum safety , 22.5t/km^2, set by developed countries to prevent soil and water contaminated by chemical fertilizers. As a result, soil organic matter content reduces and fertility declines. At the same time, a considerable number of chemical fertilizers directly flow into water resources without been fully utilized.

Table 2 Chemical fertilizer Application situation in Northeast Major Grain Producing Areas

year / kinds	2004			2005			2007		
	Heilongjiang	Jilin	Liaoning	Heilongjiang	Jilin	Liaoning	Heilongjiang	Jilin	Liaoning
Effective irrigation area (1000 km2)	22.82	15.95	15.20	23.94	16.13	15.27	29.50	164.06	14.91
Nitrogen (m t)	57.12	88.44	64.42	57.5	61.30	64.0	65.92	62.71	65.42
Phosphate (mt)	33.66	7.08	11.44	33.8	6.20	11.4	39.31	6.51	11.45
Potash (m t)	15.78	9.73	9.05	17.70	10.00	9.60	22.72	11.06	10.88
Compound Fertilizer (m t)	37.25	53.84	32.94	42.00	60.70	34.9	47.25	74.12	39.72
Total (m t)	143.81	159.09	117.85	150.90	138.10	119.90	175.20	154.39	127.47

Source: 2005, 2006, 2008 "China Statistical Yearbook"

Pesticide pollution is also very serious in rural areas. Farmers increase the use of pesticides in order to improve crop productions and control pests. There are upward trends of application of dose and kinds of pesticides year by year according to the questionnaires. A number of toxic substances of pesticide causes ecological environment polluted, even threat to people's health, which infiltrate in water, soil and agricultural products.

Greenhouse and the plastic film used widely in rural areas can promote crop growth, but with low recovery rate, plastic film is another kind of pollution. According to the questionnaires, the recovery rate is less than 80%. This means that a large number of non-degradable plastic film remains in the soil. Absolutely, plastic film has destructive influence on soil and hinders crops growth.

2.3 Pollution from livestock and poultry breeding industry

Phenomenon of livestock and poultry manure misplacing huddle exists everywhere in villages in Northeast Major Grain Producing Areas. Livestock manure releases smelly gas which contain ammonia, sulphide, methane and other harmful ingredients to pollute environment and threat to people's health. Massive livestock and poultry manure which is directly discharged into the ditch without treatment make local water resources deteriorate, even spread certain diseases. Soil quality has been affected by high concentration sewage irrigated. Livestock and poultry manure without fermentation processing applies directly to the soil. As a result, many harmful bacteria and parasites cause pollution to the soil and crops.

2.4 Pollution caused by urban and rural enterprises

The fact that industrial urban pollution transferred to rural areas exacerbates deterioration of ecological environment in villages. Wastewater discharged by some polluting industries such as electroplating, paper, plastics, etc, contains heavy metals. The wastewater is deposited into farmland irrigation river in the main protected areas without thoroughly dealt with. Emissions of cement plants and brick factories pollute atmosphere and destruct the rural environment that decline the quality of agricultural products and seriously affected the normal life of residents.

3. Cause analysis about deterioration of rural ecological environment

3.1 Unsound legal system of ecological environment protection in rural areas

There are many China's existing laws relating to the protection of agriculture ecological environment. But those laws without consideration of environmental pollution special status in rural areas can not adapt to the needs of rural development. Phenomenon of not full enforcement complying with the law is being. Related management systems exist in name only. Most law enforcement events of environmental protection departments are ex post facto punishment. The prevention of environmental pollution has not been attention to. Phenomenon of duplicate construction and decentralized funds often leads a organic management program to local operation of each department, even if the implementation of environmental protection projects in rural areas. Environmental protection effect is poor.

3.2 Insufficient funds of the ecological environment management in rural areas

Most funds of China's pollution prevention and control are invested in the industrial and urban areas for a long time. Urban environmental pollution has been transferred into rural areas, but the rural areas have little access to funds of pollution control and environmental management capacity-building from national financial channels.

The construction of residents living environment infrastructure does not enter the public service system which evaluates local officials' political achievements. So local government usually does not allocate special funds to control ecological environment in rural areas, even problems are in adverse conditions.

3.3 Farmers' weak environmental protection awareness

The actions of waste separation use organic fertilizers and non-use highly toxic pesticides are seldom in Northeast Major Grain Producing Areas, according to the questionnaires. Because of lower level of rural residents' education, weak environmental moral sense and lack of legal education and publicity, farmers pursue short-term effects of economic development in the agricultural production process and neglect the rural eco-environmental polluted by the large-scale use of pesticide and chemical fertilizer. 70% of farmers, who know litter about scientific application and balanced fertilization, always increase the dose of pesticide and blindly application chemical fertilizer. As a result, chemical fertilizer with low utilization rate, pollute the ecological environment, even affect the normal life of residents.

4. Mode research and system innovation on rural

ecological environment management

4.1 Mode research in rural ecological environment

Traditional and modern waste disposal techniques are combined. Pollutants are classified by composition, processing methods and the construction of treatment facilities.

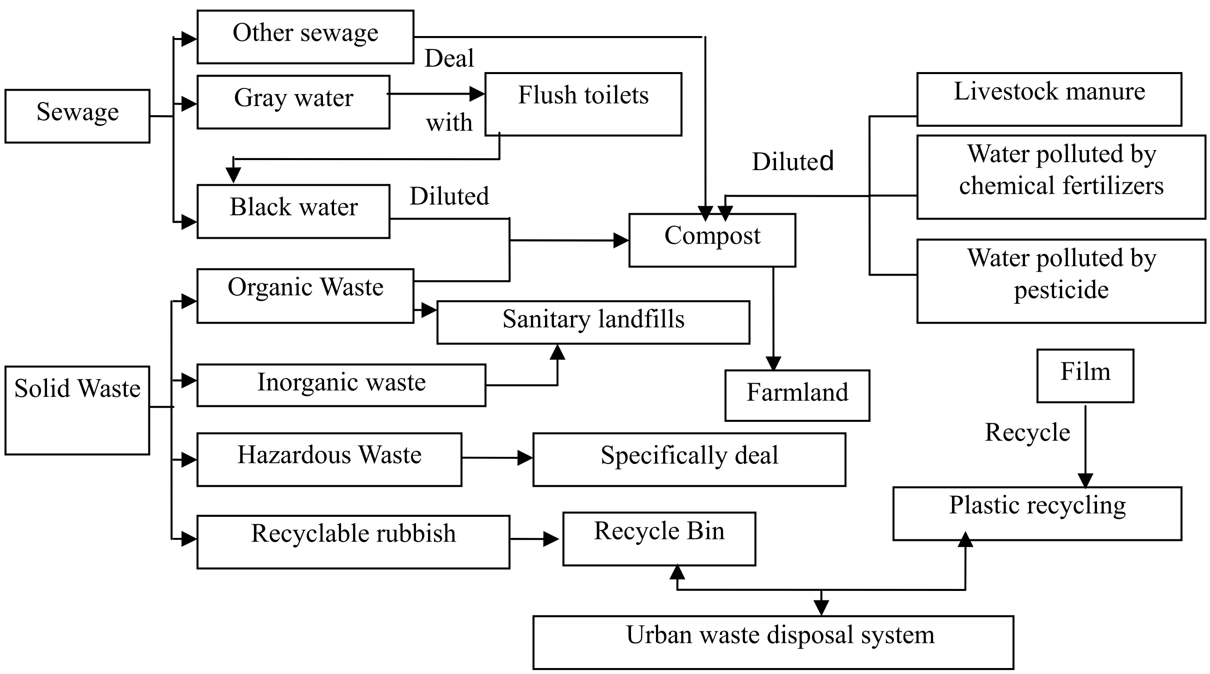

Figure 2.Pollutant processing mode in rural ecological environment

4.2 Management system innovation in rural ecological environment

4.2.1 Legal system innovation

It is necessary to establish a rural eco-environmental protection law based on the current status and characteristics of pollution of rural ecological environment. Make the rural ecological environment protection and construction into the country's legal management system. In the course of law enforcement, it is necessary to correctly handle the relationship between the rural economy development and environmental protection. Achieve rural economic development should not be established on the expense of the environment, each law enforcement agencies must strictly comply with the law requirements in the course of law enforcement. Environmental protection departments must be "There are law, and lawbreakers must be dealt", "prevention first, combining prevention, monitoring the entire process."

4.2.2 Organizational innovation

Organizational innovation means that an independent new government organization should be established in Northeast Major Grain Producing Areas, which is different from urban and industrial ecological environment protection organizations. The new government is in charge of rural ecological problems.

Regions with rural ecological environment problems should be designated as a specific region, according to the characteristics of administrative divisions in Northeast Major Grain Producing Areas. These regions have to be geographical approaches, similar socio-economic development situation and similar pollution.

In the part of government institutions, the optimized allocation of administrative resources is set on the principle of "streamlined, unified and efficient", to avoid the phenomenon of redundant construction and decentralized funds. The staff have to comply with the social morality and professional ethics, honesty and diligent.

In another part of personnel allocation, traditional personnel administration has to transform to the direction of modern human resources management. Improve the government personnel's cultural level and specialized quality who work at the new organization.

4.2.3 Organization management innovation

Organization management innovation is reflected in two aspects. On one hand, legal means are the main management methods; on the other hand, macro-management and direct management are the main part. So management approach including administrative, legal methods and methods of ideological work must be innovative. At present, the new rural construction is in a crucial stage. It is difficult to adapt and accept the loss of interest probably brought by the implementation of the rural ecological environment management for farmers who firmly hold old ideas and concepts. This requires matching use of the above methods. Governmental organizations should have good ideological and political education to change there ideological and moral values, to enhance their environmental awareness.

At the same time, the large-scale use of modern, high-tech facilities, technology, achieve modern、high-tech and network management and effectively reduce the operating costs and improve efficiency.

5. Conclusion

The new management system which is close cooperation at all levels of the main power, coordinated operation，management efficiency，is established in Northeast Major Grain Producing Areas, through creating a new governmental organization and the above institutional innovation. The stuff must clarify their positions; effectively contact the local situation when they work on ecological environment. That can achieve the process of comprehensive institutional innovation smoothly, and improve the ecological environment in villages in Northeast Major Grain Producing Areas.

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Study on Rural Drinking Water Safety and Measures in Heilongjiang Province

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Abstract: According to the current situation of drinking water security in rural areas in Heilongjiang Province, the overall distribution feature and the spatial distribution characteristics of population drinking unsafe water in rural areas, the cause of different drinking water security issues and the main factors of impacting the drinking water safety are analyzed. In view of the distribution feature of rural drinking water safety and the existed problems, some measures are presented such as strictly control point source and non-point source pollution, strengthen the protection of water sources, select project model in line with local conditions and steadily promote the reform of rural water and the electricity price adjustment to ensure the engineering construction of rural drinking water safety and healthy operation. [World Rural Observations 2009; 1(1):29-34]. ISSN: 1944-6543 (print); ISSN: 1944-6551 (online).

Key words: rural drinking water safety; exceeding water quality standard; Heilongjiang Province; water resources protection

1. Introduction

The main performances of urban-rural difference are transportation, water supply and education. And water supply has become the key issue that needs to be solved urgently in the modernization of rural areas in China. Recently, the nation pays high attraction to rural drinking water safety issue and carries out water safety management measure and a series of projects such as “the difficulty solution of rural drinking water”, “rural drinking water safety” and “Demonstration County of rural drinking water safety”. Many protection projects of rural drinking water safety have been established, which solved many drinking water security issues of some rural residents. But there are also many other rural drinking water problems in Heilongjiang province such as water shortage, the water quality endemic illness, water inconvenience and the low guarantee rate of water supply, which are a serious threat to people's health.

2. Rural drinking water safety and the overall situation of Heilongjiang Province

2.1 The concept of rural drinking water safety

The drinking water safety is a kind of social state that means everyone can obtain water that meets the requirements of clean and healthy timely, convenient, and economically [1-2]. According to the development status of rural economic in China and the basic requirements of drinking water safety at home and abroad, Ministry of Water Resources and Ministry of Health work out the evaluation index system of rural drinking water safety and health, in which rural drinking water is divided into two grades, safety and basic safety. Water quality, water quantity, convenience degree and guarantee rate four indicators are evaluated. As long as one of the four indexes is under the safe or basic safe value, the water is unsafe.

2.2 The overall situation of rural drinking water safety in Heilongjiang province

The main problems of rural drinking water safety are the shortage of water and drinking water quality exceeding standard. Drinking water quality exceeding standard includes two types. The one is natural water quality exceeding standard which is that some materials such as F, Fe, Mn exceed standards and some like Se and I are lower than the standards, and the other is caused by artificial pollution which contains surface water and groundwater exceeding standards. Some villages, located at the front of mountains or gentle hilly region, are often in the conditions of water stress throughout the year in drought season because of the small water of drinking wells, and even exists various endemic at the same time.

At the end of 2008, the total number of rural population (including state farms and forest and industry) in Heilongjiang Province is 21.36 million. Among them the total population of the centralized water supply and decentralized water supply is 12.65

million (account for 59.2%) and 8.71 million (account for 40.8%) respectively. The popular rate of tap water is 45%.The population drinking unsafe water in rural is 9.5 million, accounting for 44.5%. It is estimated that the standard-reaching rate of water quality of the rural water resource is 85% in 2010, in 2020 is 95% and in 2030 is 100%.

3. The distribution characteristic of different drinking water safety problems and its analysis

3.1The distribution characteristic of drinking water safety problems

3.1.1 The population drinking fluoride content exceeding water

The upper limit value of fluoride content in standard drinking water is 1.0mg/L. If fluoride content is higher than 1.0mg/L, then the water is high fluoride water. If people drink high fluoride water for a long time, they will have endemic fluorosis, which will threat people's health directly. In Heilongjiang Province the rural population drinking high fluoride water is up to 1.33 million, accounting for 14% of drinking unsafe water and 87% of drinking high fluoride, which mainly distributed in Songnei Low Plain area and mostly distributed in some counties of Suihua, Daqing and Qiqihar. What's more, the ration in Zhaozhou County and Zhaoyuan County of Daqing city is more than 40% and the ration in Zhaodong of Suihua city is even more than 70%.

3.1.2 The population drinking iron and Mn content exceeding water

Fe and Mn are the essential elements of human body. The health standards for drinking water in China regulate that Fe content should not higher than 0.3mg/L and Mn content should not higher than 0.1mg/L. It is said that daily edible food and vegetables can meet the needs of Fe and Mn. The more intakes of Fe and Mn will have chronicle poison role on the human body. If the concentration of Fe in body exceeds the binding capacity of Hemoglobin, deposition will be produced that lead to Metabolic acidosis, Hepatomegaly, Liver dysfunction and diabetes. Physiological toxicity of Mn is more than that of Fe. According to recent studies, more intakes of Fe and Mn also destroy artery wall and cardiac muscle and forms atherosclerotic plaque even coronary heart disease. The population drinking Fe and Mn content exceeding water is consistent with people drinking unsafe water in space. This indicates that the population drinking Fe and Mn content exceeding water is relative concentration, mainly in the Songnen Plain, Sanjiang Plain and mountain foot of Xiaoxing'anling, mostly in some counties of Harbin, Qiqihar, Suihua, Daqing, Yichun, Jiumusi and Qitaihe. The population drinking Fe and Mn content exceeding water is 3.79 million, accounting for 57% of water quality unsafe and 39.9% of drinking water unsafe. The Fe and Mn content in drinking water in Suiling and Qin'an counties of Suihua city is up to 100%.

3.1.3 The population drinking other water quality unsafety

The population drinking other water quality unsafety is 1.53 million, accounting for 23% of water quality unsafety and 16.1% of drinking water unsafety. This is mainly because of selenium and iodine deficiency and drinking contaminated water etc. Endemic goiter accounts for 1% of water quality unsafety; kashin-beck disease accounts for 2%; keshan disease accounts for 1%; drinking Ⅳ and ultra-Ⅳ contaminated surface water accounts for 1%; drinking bacteria content exceeding and untreated shallow groundwater accounts for 4%; drinking serious pollution and untreated groundwater accounts for 8%; and drinking other water with exceeded water quality accounts for 6%. Drinking contaminated water can seriously endanger human health. Except for some common illnesses, drinking water contaminated by heavy metals, nitrite and organic even can lead to cancer. This population drinking water unsafety distribute disparately in Heilongjiang Province.

3.1.4 The population lacking of water

Seasonal shortage of water and lack of drinking water cause great inconvenience to rural resident which limit the development of rural economy. The population drinking water unsafety brought by water quantity, guarantee rate and convenience degree is 2.85 million in country in Heilongjiang Province, accounting for 30% of drinking water unsafety. The population mainly distributes in Songnei High Plain, big and small xing'an ling and so on.

3.2 The analysis of main drinking water safety problems

3.2.1 The significant difference and complex cause of area drinking water safety problems

From the spatial distribution of rural drinking water safety issues in Heilongjiang Province, we can see that the significant difference of regional drinking water safety issues is caused by many reasons such as climate, water resources, economic development, topography, population distribution, hydro-geological conditions etc.

Water quality exceeding standard is the main problem of rural drinking water safety. High fluoride water area is closely related to characteristics of fluoride and hydro-geological conditions. Fluoride is an active element and easy to dissolve in water, widely distributes in the crustal rocks and mainly buried in shallow area. The dissolve of fluoride salt is the main reason for the formation of high fluoride groundwater in water system. The causes of Fe and Mn content exceeding water is mainly the common role of water back-irrigation, ancient geography, topography, climatic conditions, geological structure and salification. With the rapid development of economy and urbanization, a large number of untreated industrial effluent and domestic sewage is discharged. At the same time, a large number of pesticides and fertilizers, as well as the solid, gas emissions and other waste, results in serious point source and non-point source pollution in the agricultural production. The main reason of water deficiency and low guarantee rate is that less precipitation and uneven distribution, water source deficiency, scattered rural residents in mountain areas, economic backwardness and lack of water supply facilities.

3.2.2 Pollution is the leading factor to affect drinking water safety

The water quality grade of Songhua River, Neijiang River and Mudanjiang mainly belongs to Ⅳ in Heilongjiang Province in2008. In general, these rivers are polluted slightly, the rivers in Heilongjiang Province suffer different degree pollution, and the downstream of city and some tributary are polluted seriously. The status of surface water quality in Sanjiang Plain is well, which can meet Ⅳ grade water quality standards in water environment functional area in high-flow period, but the water quality is relatively poor in low-flow period and it belongs to Ⅴ grade. The water quality grade of Songnei Plain mostly belongs to Ⅲ and Ⅳ grade and some does not meet water quality standard in function area. Water pollution is not only from point source pollution, but also from non-point source pollution. Our province is in a period of rapid economic development, and then the water pollution pressure brought by development will show increasing tread. Therefore, pollution will be the leading factor to affect drinking water safety in the future.

3.2.3 Lack of drinking water safety monitoring, emergency and measures

Monitoring water supply process effectively and making response mechanism and preparedness of emergency are an important guarantee for drinking water safety. Many chemical plants distribute near the river in China, which is harmful to drinking water safety. Once emergency happens, a wide range of water pollution would be made. The event that chemical plant explosion of Jihua Company causes serious water pollution of the Songhua River Basin in 2005 is an emergency. Moreover, with the change of global climate, the occurring frequency of extreme weather increased, which leads to water shortage in some areas. After 1980s, the occurring frequency of extreme drought increased markedly in western region and northeast areas. This weather induces that some areas are seriously short of water resources in Heilongjiang, which is a serious threat to the drinking water safety. At present, short of necessary monitoring equipment and network results in poor supervision of drinking water quality in majority rural areas of Heilongjiang Province.

3.2.4 Rural water supply management service laging behind, as well as higher electricity price and the tax affect the construction and operation of drinking water project

Each relevant department is always lack of supervision to factory and rural drinking water project. In water quality detection, normal collection of water price and water resource protection, although there is a set of complete system, there is no place to monitor and implement. Recently, electricity price of rural water supply adopts electric power price that is very high and increase water supply cost. At the same time, tax also affects the cost in some degree. According to statistics, tax accounts for 6%-13% of construction costs, the average cost of each project is about 0.37 million yuan and the tax is about 25-65 thousand yuan [3].

4 Strategies and measures

4.1 Raise funds in various ways, increase investment and build water supply facilities

The drinking water safety and the construction of water source areas should be based on national input, but in order to solve rural drinking water safety problem, relevant policies of raising funds such as government guidance, user self-raise; government input, user management and government fully responsible for funding should be made. For relative developed regions, policy guidance should be adopted that local government raise funds to build and run supply water project. For most of undeveloped rural areas, central government and local government raise funds together to build. At the same time, aim at the status of lacking of water supply facilities in rural areas, the construction of rural drinking water infrastructure should intensify and the construction of rural water supply pipe network should enlarge in order to increase the proportion of concentrated water. Urban and rural water supply network should be built in some conditional areas in order to increase guarantee rate of rural supply water.

4.2 Control point and non-point source pollution strictly, enhance water sources protection

Water sources protection must be combined with water quality treatment, all levels' health, water conservancy and development and reform department should be closely with each other to improve drinking water monitoring system. Base on the current equipment water quality monitoring center should be improved and built and rely on large-scale concentrated water supply stations zonal monitoring points should be set up. Water quality testing and monitoring of water resource, water factory and pipe network tail should be strengthened for concentrated supply water projects and for scattered supply water projects water quality monitoring should be done periodically.

Control Point source pollution strictly and improve comprehensively, at the same time, intensify the harness force of non-point source pollution and follow the eco-agriculture path. Change the extensive economic growth mode and intensify the protection of rural water pollution in order to protect rural drinking water sources. Instruct peasant to implement the technique of balance fertilization and ecological Control rightly, control and reduce the total nitrogen content, promote high concentration compound fertilizer and crop-specific fertilizer, and adopt scientific fertilization and optimized farming system to carry out the integration of agricultural-materials and agricultural-technology. Speed up the construction of urban sewage treatment facilities and factory, make greater efforts to implement cleaner production technology for reducing pollution emissions and realize advanced wastewater treatment and recycling gradually. In water source protection area, contamination is prohibited to discharge and garbage is prohibited to pile up, industrial and mining enterprises is prohibited to develop.

Combined with Building a new socialist countryside, rural well-off environmental protection action plan is implemented. Rural non-point source pollution is controlled and peasants are led to adopt low toxicity, low-residue pesticide and utilize fertilizer rationally; Pollution-free, green, organic food is developed and black soil resource is protected in cold areas; Agricultural wastes such as the manure of livestock and poultry and straw are exploited reasonably. Some environmental issues such as a sweep of pollution made by small coking are checked and supervised strictly in order to prevent industrial pollution from transferring to rural areas.

4.3 select rural supply water mode in line with local conditions

Concentrated and large-scaled supply water system has irreplaceable advantages in water quality safety management and maintenance. It is difficult to build pipe network and promote concentrated supply water comprehensively because of scattered peasants. In view of the scattered, kind-wide, and pollution-complex of water sources, water quality exceeding standard, lower educational level and weak rural economic in the village of Heilongjiang Province, the choice of water supply mode must be in line with local conditions and not adopt high-running-cost and operation-complex equipment.

In the areas of supplying water for majority residents or plain the kind of *concentrated treatment, concentrated supply* should be recommended. This supply mode includes integration of urban and rural water supply model, self-building water supply station and water supply all day or time-sharing mode. In more developed-economy, relative concentrated-rural and lace of urban and village plain areas, advocate the first model; for scattered village, advocate the second mode; for the size of the population more than 1500, advocate the last mode. For extremely scattered rural households such as mountain area, recommend the kind of *distributed processing, local supply, namely,* household-based water supply. In fact developed countries such as America also adopt this mode in scattered areas.

4.4 Promote rural water price reform and electricity price adjustment smoothly in order to the construction and healthy operation of rural drinking water safety project

The low water price of rural drinking water projects is one important factors of constraining the normal operation of rural water supply project. Therefore, it is necessary to reform the current management policies. The policy of full charge and differential treatment to ensure base price, cost price and over water price should be implemented in order to realize paid water, self-sustainable water for drinking water project. It is important to implement the valuation mode of standardized scheme water, unbundling and ultra-use increasing, and establish and improve the hearing system monitoring of rural water price. Taking into account the water cost and reasonable profit of water factory and the bearing capacity of society, rural water reform should be promoted smoothly and reasonable rural water system should be gradually formed.

Appropriate price is helpful to healthy operation of rural drinking water safety project. The popular electricity price of rural drinking water project is 1.05～1.25 yuan/kwh. Electricity charge accounts for 60%～80% in running costs. Rural drinking water works are public, so relevant policies should be made to reduce the supply water electricity price that is suggested to consistent with electricity price of agricultural irrigation and drainage, namely, 0.346 ～ 0.396 yuan/kwh. Preferential electricity price can reduce running costs of rural drinking water project and alleviate peasants' burden, the project can play effectiveness for a long time. Therefore, aiming at the problem of applicable electricity price of rural drinking water safety project, the nation should make preferential policies unitedly.

4.5 Make emergency mechanism and preparedness, establish and perfect effective monitoring network

Managing emergencies of drinking water safety are brought into emergency management System, according to the demand in the State Council The overall national plans of public emergency, overall plan is made, specific measures include carrying out risk assessment to factories and enterprises that are threatening in water resource and according to the results to develop contingency plans, implementing risk design and improving emergency facilities. For the lack of drinking water sources incident under extreme climatic conditions, groundwater, which limits to overdraft and deep mining, should be as emergency water and back-up water.

Establish system monitoring network of the whole water supply process to dynamic monitor water quality and provide real-time for protection and management in water resource areas. Rural areas should be given priority to establish water quality monitoring network or build a local monitoring center in a place near which the kind of water samples for inspection is implemented in order to improve the monitoring level and network [4-8].

4.6 Raise the health consciousness of villagers and research drinking water safety problem actively

Gaining safe drinking water is human basic need, which relates to people's physical health and life safety and relates to the realization of building a new socialist countryside and comprehensive constructing well-off society. Therefore, local leadership is the core of rural water environmental protection, and people are the backbone of rural water environmental protection. It is impossible to solve rural drinking water safety question without great attention of local leadership and people. Therefore, bringing the rural drinking water safety into the agenda, establishing the executive leadership responsibility system, implementing effective measures, popularizing the science and legal knowledge of rural drinking water safety, enhancing the responsibility sense of rational utilization and protection rural water environment and mobilizing and right guiding people to participate in the decision-making of rural drinking water safety projects should be an important task to solve the current problems of rural drinking water safety. At the same time, we should carry out comprehensive investigation and research of rural drinking water systems actively and explore new mechanism of drinking water safety projects management and realizing healthy operation of rural drinking water projects in accordance with the requirements of the scientific concept of development.

5 Conclusion and suggestion

The most serious regions of rural drinking water safety is in the western Heilongjiang Province, Water quality exceeding standard caused by nature water quality pollution and Man-made pollution is ubiquity, which is the main problem of drinking water safety. The form and distribution of nature water quality exceeding standard are mainly related with hydro-geological conditions. In some areas of Daqing, Qiqihar and Suihua, the absolute population and relative proportion of drinking high fluoride water are all in the first place in Heilongjiang Province, where are the disaster area of high fluoride water. The rapid economic development at the expense of the environment is the main factor of man-made water pollution. Due to lack of water in western poor-water areas, the population drinking water unsafety is more than 40%, and the main factors are climatic conditions, economic conditions and topography, etc. At the same time, lacking of emergency response mechanisms, preparedness and monitoring measures is also an important factor in Heilongjiang Province.

According to the main problem of rural drinking water safety in Heilongjiang Province, it is suggested that protecting the drinking water safety is seen as the main object of water pollution prevention and control. Only by strict controlling water pollution, the drinking water safety can be protected radically. According to the distribution difference, reasonable engineering model and advanced technical measures should be adopted in light of local condition. The science and technology research and promotion of drinking water protection should be strengthened, and the monitoring network, emergency response mechanism and preparedness should be established and improved.

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Evaluation Index System of Chinese Eco-agriculture Construction

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Abstract: It is an essential task to make a quantitative analysis for the study of Chinese eco-agriculture construction. The research status of evaluation methods of eco-agriculture construction at home and abroad briefly was discussed. The principle, index system and its weight for the comprehensive evaluation of Chinese eco-agriculture construction were explored with an example of comprehensive evaluation on the practice of eco-agriculture construction at Mulan County of Heilongjiang Province.
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Key words: eco-agriculture construction; index system; index weight

1. Introduction

The evaluation of eco-agriculture construction began in the 1960s and had a rapid development in the 1970s. More and more researches have developed in recent years and focus on the evaluation method, evaluation index system and evaluation criterion. The structure of evaluation index system is the core of eco-agriculture evaluation. Gordon，Conway raised the indices of productivity, stability, durability, flexibility or elasticity as the criteria of measuring the agricultural eco-system performance and described the basic behavior of system for the design of agricultural development planning. With the development of environmental sciences, ecological principles and evaluation methods, the framework system was adopted generally such as the framework system of Pressure-State-Respond (PRS) and Goal—Oriented—Concept (GOC). And with the development of mathematical statistics and mathematical models, many new evaluation methods were proposed, such as the statistical method of fuzzy mathematics and the gray system theory.

The evaluation of Chinese eco-agriculture construction (CEA) began in the 1980s. Although the evaluation has wide inquiries, the principle of selecting indices, the quantity of indices and the hierarchic structure have a great difference and the calculation method of index weight is also different. For example, Yousheng Bian(1994)divided the evaluation index system into economic indices, eco-environmental indices and social benefit indices in the effectiveness evaluation of eco-agriculture system construction of Liuminying village Daxing county of Beijing, which included twenty specific indices. Hongliang Sun(1993)brought up twenty-two specific indices from the system structure, function and effectiveness aspects. And Qianji Ye (1987) brought up more than one hundred indices. The National Eco-agriculture County Construction Leading Group Office wrote the book of *"The Eco-agriculture of China"* in 1996. And it divided the index system of eco-agriculture construction into four layers: the first layer was the composite index of eco-agriculture, the second one was the primary production system index, the sub-class production system index and the processing production system index, the third one was the ecological benefit, economic and social benefit of each subsystem, the fourth layer was composed by thirty-six indices. Most scholars generally used the comprehensive evaluation method to evaluate eco-agriculture construction, in addition, Bin Zhang(1997)applied the theory of matter-element model to the evaluation of eco-agriculture construction on the basis of matter-element theory and extension set theory, Dafeng Pan (1999)applied the artificial neural network theory and the back-propagation algorithm to the evaluation of eco-agriculture construction, Zhiping Cao (1997)applied the holographic theory to the evaluation of eco-agriculture construction. The index system of Chinese eco-agriculture construction and its weight are studied on the basis of previous studies.

2. Selected principles of evaluation index system of eco-agriculture construction

(1) The integration and importance principles

The index system should include the key indices of all study objects and it is necessary to reflect the complexity of eco-agriculture construction comprehensively and accurately. But at the same time the more important indices should be reflected separately and the less important indices can be reflected simply and in combination. For the coverage of eco-agriculture construction is broad and involved the coordinate development of economy, society and environment, the index system should highlight key points on the basis of coverage on a certain degree and it can not include all the indices. A few composite indices can be used to replace some relative indices to guarantee the rationalization of system-level structure and the coordination and harmonization of part and whole to provide the necessary data for the comprehensive evaluation of eco-agriculture construction.

(2) The comparability and operation principles

Because the index system which has the same structure can be compared from space-time continuum, the index system of investigating eco-agriculture construction should be comparable. Not only the economic indices but also the ecological indices should have the uniform standards. In addition, the practical function of index system should also be noted. Because the statistical work of eco-agriculture construction is not very good and the data collection has certain difficulty, this index system should be set up with the representative and comprehensive indices according to the hard and easy extent and reliability of gaining statistical data and meet the future needs of eco-agriculture construction.

(3) The reality and prediction principles

The reality principle means the index system should be able to reflect the basic characteristics of eco-agriculture construction from the current reality. So it should have a higher sensitivity, reflect the different characteristics and have stronger effectiveness and a definite purpose. Some predictive index should be set up on the basis of understanding the present status of Chinese eco-agriculture construction, knowing the problems and their causes in the construction and understanding the international trends of eco-agriculture construction. Of course, these indices can not be too far ahead so as to in line with the needs of Chinese eco-agriculture construction.

(4) The dynamic and static unity principle

As a system, eco-agriculture construction is developing and changing constantly and it is the dynamic and static unity. It should have not only the static indices to reflect the ecological, economic and social state but also the dynamic indices to reflect the subsystem's development and changes in a certain period of time. So it can accord to the characteristics that the production cycle is long and the late result is large in the eco-agriculture system to avoid the one-sided behavior of paying attention to the immediate interests and ignoring the long-term interests.

3. The formation of evaluation index system of eco-agriculture construction

The comprehensive benefits of eco-agriculture construction are divided into three aspects including the social benefit, economic benefit and social benefit through the statistical analysis of most eco-agriculture construction evaluation indices frequency and combining the actual conditions of Chinese eco-agriculture construction. And each aspect is subdivided into a number of specific indices. Through the Delphi method and integrating the views of experts, the evaluation index system of eco-agricultural construction which has a three-level and twelve specific indices is formed (Table 1). An explanation of specific indices is as follows:

Table 1. The evaluation index system of eco-agricultural construction

Target layer	Criterion layer	Index layer	Unit
The comprehensive evaluation of eco-agriculture construction A	Ecological benefit B_1	The forest coverage rate C_1	%
		The basic farmland per capita C_2	hectare
		The extent of farmland water conservancy C_3	%
		The quantity of chemical fertilizers C_4	kilogram/hectare
	Economic benefit B_2	The farmers' net income per capita C_5	yuan
		The grain per capita C_6	kilogram
		The commodity rate of agricultural products C_7	%
		The proportion of planting output value to the total agricultural output value C_8	%
	Social benefit B_3	The natural growth rate of population C_9	‰
		The output of meat food per capita C_{10}	kilogram
		The ratio of poverty-stricken population C_{11}	%
		The transfer rate of labor force C_{12}	%

(1) The forest coverage rate

The ecological benefit of forest is particularly important and it not only provides a large number of agricultural outputs but also contributes to improve the agricultural natural resources and environmental conditions for its function of water conservation, climate regulation, soil conservation, windbreak and sand fixation. It can make a broad measure to the Chinese eco-agricultural construction and also reflect the contribution of eco-agriculture to the entire ecosystem from one aspect. Its calculation formula is the ratio of a regional forest area to the land area.

(2) The basic farmland per capita

The basic farmland is the cultivated land which can not be occupied on the basis of overall land use planning, according to the demographic and socio-economic development demand for agricultural products for a certain period in accordance with the "Basic Farmland Protection Regulations". It is part of arable land and mainly that part of high yield and quality of arable land. It can be said that the basic farmland is the minimum demand of arable land in order to meet the demographic and socio-economic development needs in a certain period. This index is calculated as basic farmland area / population in the system.

(3) The extent of farmland water conservancy

The water conservancy is the lifeline of agriculture. Its calculation formula is the ratio of effective irrigation area to the total area of arable land. The effective irrigation area means the farmland or arable land irrigation area which can be irrigated normally in the general year's harvest on the basis of main conveyance system of irrigation project or equipment, having some water and relatively flat land.

(4) The quantity of chemical fertilizers

It reflects the level of chemicalization and the degree of intensive farming of arable land in agricultural production. It is also an important manifestation of modernization means level of agricultural production. At the same time it has a poisoning effect to soil and agricultural products with the growth of use intensity and frequency and will bring serious environmental and food contamination. So it is the negative index to reflect ecological benefit.

(5) The farmers' net income per capita

It reflects the standard of living condition of farmers and the speed of rural economic development and has complementarity with other indices. So it is the main index to evaluate the comprehensive benefits of eco-agriculture construction. Its calculation formula is the ratio of annual net income to the population in the system.

(6) The grain per capita

It refers the output of grain per capita and it is one of the important indices to reflect the economic benefit. Besides food, wheat, corn, Chinese sorghum, millet and other coarse cereals the grain also includes potatoes and beans.

(7) The commodity rate of agricultural products

It refers to the proportion of agricultural products which are sold to the outside by the agricultural products sector to the total agricultural products. This index measures the produce contribution of agricultural sector to the society and also reflects the degree of agricultural marketization. Its calculation formula is the commodity of agricultural products / the total agricultural products in a certain period of time.

(8) The proportion of planting output value to the total agricultural output value

With the development of society and economy, the law of agricultural internal structure is the proportion of planting output value to the total agricultural output value decreases while the proportion of animal husbandry increases and the agricultural structure tends to be reasonable. This index can reflect if the agricultural structure is reasonable to some extent.

(9) The natural growth rate of population

The population is an important social factor and has a great impact on the ecological environment. It can be said that the good and bad of regional ecological environment are decided by the behavior of people entirely, therefore, it is chosen as one of the indices to reflect the social benefit. Its calculation formula is the ratio of yearly birth ratio-death ratio.

(10) The output of meat food per capita

It reflects the nutritional level per capita to some extent. So it is one of the indices to reflect the social benefit. The meat food mainly refers to pork, beef, mutton and other meat products.

(11) The ratio of poverty-stricken population

The eco-agriculture construction should combine with the work of poverty alleviation and change the type of blood transfusion into the type of hematopoiesis. And it should also change the production conditions, enhance the capacity of fighting natural calamities to turn resources advantage into produce advantage and lead the poverty-stricken population cast off poverty and set out on a road to prosperity.

(12) The transfer rate of labor force

The existence of a large number of surplus labors will restrict the growth of farmers' income, agricultural development, as well as the healthy operation of economy as a whole. It is the key to solve the problem of agriculture, rural areas and farmers and the building of a new socialist countryside to transfer the rural surplus labor force successfully. Its calculation formula is the ratio of rural labor force that has been transferred to the rural surplus labor force.

4. The evaluation methods of eco-agriculture construction

The comprehensive score method of evaluation index is adopted. Its advantage is that it can use a figure to express the situation of eco-agriculture construction through synthesizing the strength and weakness of each index to summarize and analyze the advantage and disadvantage of program and measure in general.

4.1 The determination of index weight

Because the different elements perform different functions to the system and they change as the temporal and spatial changes, and the people's requirements and hope to the system are different, the weight of each index is different. And it embodies the importance of evaluation index in the system. The determination of index weight may adopt Analytical Hierarchy Process (AHP). It is brought up by the famous American professor T.L. Saaty and has an important impact on the field of evaluation index. The basic steps are as follows:

First, establishing the hierarchy structure of successive stage: as indicated in table 1, A layer is the target layer, that is, comprehensive evaluation of eco-agriculture construction; B layer is a criterion layer, including the ecological benefit, economic benefit and social benefit; C layer is the index layer, that is the specific indices of ecological benefit, economic benefit and social benefit.

Second, the judgment matrix is established: the upper layer indices are regarded as the criterion and the relative importance of this layer's two indices are compared to write the judgment matrix (Table 2). The relative importance of two comparative indices is expressed with the 1-9 scale method, as shown in Table 3.

Table 2. The judgment matrix

A	B_1	B_2	…	B_n
B_1	B_{11}	B_{12}	…	B_{1n}
B_2	B_{21}	B_{22}	…	B_{2n}
…	…	…	…	…
B_n	B_{n1}	B_{n2}	…	B_{nn}

Table 3. The measure of AHP

Measure	Meanings
1	The two indices are important equally
3	Compared to two indices, an index is slightly more important than the other
5	Compared to two indices, an index is obviously more important than the other
7	Compared to two indices, an index is strongly more important than the other
9	Compared to two indices, an index is absolutely more important than the other
2,4,6,8	The mean of two close judgment

Third, the single-level sorting (the calculation of single-level weight vector) and the consistency check: The single-level sorting is the weight sorting (weight vector) of this layer's indices to the upper layer's indices. Its calculation method can be summarized to the problem of calculating the eigenvalues and eigenvectors of judgment matrix. As the largest eigenvalue λ_{max} of structural n-order comparative matrix is not necessarily equal to n, the relative error of λ_{max} and n is regarded as the consistency index (CI) of comparative matrix, that is, $CI = (\lambda_{max}-n) / (n-1)$ to limit this error, among them λ_{max} is the largest eigenvalue of the judgment matrix and n is the order of judgment matrix. The consistency ratio (CR) is $CR = CI / RI$, among them the RI is the random consistency index for different order (Table 4).

Table 4. The random homogeneity index (RI)

Order n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

When CR <0.1, the judgment matrix. The ratio value of relative importance between indices is got through seeking advice from experts for three rounds and the comparative judgment matrix is established. The weight value of comprehensive benefit of eco-agriculture construction in accordance with the above steps is obtained (Table 5).

CR = 0.0289 <0.1 through the consistency check. So it shows that the total sorting of C layer to the target layer A has the satisfactory consistency and it can be used for the comprehensive evaluation of Chinese eco-agriculture construction.

Table 5. The weight of each index

Index	Weight w_i	Index	Weight w_i	Index	Weight w_i
C_1	0.0693	C_5	0.2923	C_9	0.0275
C_2	0.1612	C_6	0.1257	C_{10}	0.0439
C_3	0.0415	C_7	0.0457	C_{11}	0.0740
C_4	0.0252	C_8	0.0753	C_{12}	0.0184

4.2 Benefit calculation and analysis

Each index not only reflects the different content but also adopts different dimension in the selected 12 indices. For example, it can not be aggregated because the unit of grain differs from the unit of income, therefore, it is necessary to convert each index into the same measure to express the degree of eco-agriculture construction, and that is, the standardization dispose of each index should be done. There are many ways for the standardized dispose of indices. The method of converting the score of indices into a unified dimensionless value is adopted. The way of range definition of index score is that the highest and lowest values of indices in the nationwide scope are obtained first, then the maximum value and minimum value of each index is determined in accordance with the actual situation of Chinese eco-agriculture construction and the interval of every score between them is determined accordingly. Nine grade scores are adopted, that is, the change range of each index is from 1 to 9(Table 6).

Table 6. The benefit measure value

Measure	1	2	3	4	5	6	7	8	9
The forest coverage rate	≤5	10	15	20	25	30	40	50	≥55
The basic farmland per capita	≤0.011	0.024	0.037	0.050	0.063	0.076	0.089	0.102	≥0.115
The extent of farmland water conservancy	≤10	20	30	40	45	50	55	60	≥65
The quantity of chemical fertilizers	≥13.67	13.33	13.00	12.67	12.33	12.00	11.33	10.67	≤10
The farmers' net income per capita	≤1000	1500	2000	2500	3000	3500	4000	4500	≥5000
The grain per capita	≤300	350	400	450	500	550	600	650	≥700
The commodity rate of agricultural products	≤10	15	20	25	30	35	40	45	≥55
The proportion of planting output value to the total agricultural output value	≥80	75	70	65	60	55	50	45	≤40
The natural growth rate of population	≥5	4.5	4	3.5	3	2.5	2	1.5	≤1
The output of meat food per capita	≤50	75	100	125	150	175	200	225	≥250
The ratio of poverty-stricken population	≥7	6.5	6	5.5	5	4.5	4	3	≤2
The transfer rate of labor force	≤10	20	30	35	40	45	50	55	≥60

Note: The net income for farmers per capita was in 2004 prices

The formula of comprehensive evaluation of various benefits (ecological benefit, economic benefit, social benefit or comprehensive benefits) is:

$P_iW_i=P_1W_1+P_2W_2+\ldots\ldots+P_nW_n$ (P_1, P_2…… P_n is the score of various indices and W_1, W_2……W_n is the weight of various evaluation indices).

5. The evaluation application example: the comprehensive evaluation of eco-agriculture construction of Mulan County of Heilongjaing Province

This evaluation system of Chinese eco-agriculture construction is used to make a positive analysis of Mulan County of Heilongjiang province. The basic situation of eco-agriculture construction of Mulan County in recent years is shown in Table 7. It can be drawn from Tables 6 and 7 the scores of various indices (see Table 8).

Table 7. The basic condition of eco-agriculture construction of Mulan County

Index	2004	2005	2006
The forest coverage rate	43.5	43.7	43.9
The basic farmland per capita	0.071	0.078	0.076
The extent of farmland water conservancy	34	50	51
The quantity of chemical fertilizers	12.14	12.41	14.09
The farmers' net income per capita	3015	3248	3550
The grain per capita	400	416.5	418.4
The commodity rate of agricultural products	61	42	56
The proportion of planting output value to the total agricultural output value	72.4	69	75.1
The natural growth rate of population	3.7	5.7	6.7
The output of meat food per capita	121.3	162.8	196.1
The ratio of poverty-stricken population	14	14	13
The transfer rate of labor force	30	43.5	44.8

Source: Mulan County statistics bureau

Table 8. The score of each index

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
2004	7	5	3	6	5	3	9	3	4	4	1	3
2005	7	6	6	5	5	3	7	3	1	5	1	5
2006	7	6	6	1	6	3	9	2	1	6	1	6

Note：The data are calculated according to Tables 6 and 7

The benefit evaluation value of eco-agriculture construction of Mulan County can be obtained through calculating the benefits of various indices and aggregate in accordance with the tables 5 and 8. From the evaluation value of table 9 it shows that the comprehensive benefits of eco-agriculture construction of Mulan County grew steadily in 2004-2006, it grew 4.34 percent in 2005 and grew 5.83 percent in 2006. Among them, the growth of economic benefit was more obvious and the growth of ecological and social benefits was relatively slower. The local farmers have improved the standard of living, net income per capita grew by 17.7 percent, the rate of agricultural products was higher than before, the proportion of planting output in the agricultural output has some improvement and the grain per capita was also growing steadily in the three years. The ecological benefit of Mulan County in these three years was not very stable and had a decline in 2006. Although the forest coverage rate, the basic farmland per capita and the extent of farmland water conservancy have increased, the excessive use of fertilizer made the ecological benefit grow slowly. The social benefit in these three years has increased steadily. The ratio of poverty-stricken population decreased by 1 percent in 2006, the transfer rate of labor force increased by 14.8 percent, the output of meat food per capita increased by 74.8 percent. But the natural growth rate of population has been in the growth trend and made the growth of social benefit slow. Therefore, Mulan County should reduce the quantity of chemical fertilizers substantially, guarantee the area of basic farmland per capita, increase the commodity rate of agricultural products and control the population growth strictly so that the regional eco-agricultural construction will climb one story higher.

Table 9．The benefit evaluation of eco-agriculture construction of Mulan County

	Ecological benefit	Economic benefit	Social benefit	Comprehensive benefits
2004	1.5416	2.4758	0.4148	4.4322
2005	1.8273	2.3844	0.413	4.6247
2006	1.7265	2.6928	0.4753	4.8946

Note: the data are calculated in accordance with tables 5 and 8

4. Conclusions

As a means of achieving sustainable agricultural development the eco-agriculture construction is essentially the process of economic and ecological environmental coordinate development. The evaluation of eco-agriculture construction benefit and system diagnostics should be done regularly based on the objectives and requirements of ecological and economic system development. Through the identification of selected principles of evaluation index system of eco-agriculture construction and constructing the evaluation index system, the comprehensive evaluation method is used to evaluate the benefits of eco-agriculture construction qualitatively and quantitative. And through regarding the eco-agriculture construction of Mulan County as an example it conducted a benefit evaluation and pointed out its achievements and shortcomings in the development of eco-agriculture. It offered a diagnostic method to the system in order to facilitate the scientific and rational adjustment based on the results of evaluation and system diagnosis.

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A Checklist of the Flora of Edaphic Grasslands in the Rainforest Belts of Edo and Delta States of Nigeria

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Abstract: The flora of 18 and 28 grasslands in Edo and Delta States respectively were studied using a 1 m x 1 m quadrat. In Edo State (Zone A), fifty five plant species belonging to 25 families were identified as constituting the major part of the vegetation. Detailed analysis showed that 29.1% of the plants were grasses, trees (25.5%), herbs (21.8%), shrubs (16.4%), creepers (5.5%) and sedges (1.8%). But in Delta State (Zone B), 48 taxa distributed into 21 families were encountered in the fields. Based on habits, grasses were represented by 29.2%, trees (18.8%), herbs (18.8%), sedges (16.7%), shrubs (10.4%), ferns (4.2%) and creepers (2.1%). Only 14 species of plants were common to zones A and B; both zones had similar Simpson's index of diversity as 0.97 while Sorensen's similarity index was 15.2%.

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Key words: Checklist; flora; edaphic grasslands; Edo and Delta States

1. Introduction

The entire Delta State and most parts of Edo State lie within the rainforest belt of Nigeria. In spite of their location in the rainforest, many isolated but large expanse of grasslands dot both states. Most of the grasslands in Delta' State are submerged in water during the rainy season while the ones in Edo State are upland. No valid scientific reason has been advanced for the existence of the grasslands except incoherent myths.

In Nigeria, many plant biologists had enumerated the weed flora of cultivated fields. Komolafe (1976) surveyed cashew, cocoa and coffee plantations in the old Western Region of Nigeria and documented the weeds associated with them. Agbaka (1977) provided the checklist of weeds found in rubber plantations in Bendel State, now Edo and Delta States. Okafor (1987) studied the weed composition and control in irrigated cotton in Lake Chad Basin, Nigeria while Gill and Onyibe (1990, 1991) studied respectively the phytosociology of weeds of oil palm and abandoned rubber plantations in Bendel State.

Obadoni and Remison (2002, 2004) documented the weed flora of lowland and upland rice ecologies respectively in Edo State. Soladoye *et al* (2005) enumerated the angiospermic diversity of Olabisis Onabanjo University, Ago Iwoye, Nigeria. They encountered a total of one hundred and thirty eight (138) plant species belonging to 55 families. The floristic study of Kirmir Vally, Akara in Turkey was carried out by Burcu and Sadik (2005) and they enumerated 1040 vascular plants.

Information on the flora of this unique type of biome is, to the best the of our knowledge very scanty. The surveys were aimed at: (a) providing a checklist of the flora of these peculiar grasslands; (b) bridge the gap in existing information on grasslands in Nigeria; (c) the results would serve as a basis for comparison in future in the event of a shift in specialization; and (d) compare the flora of the seasonally submerged grasslands of Delta State with those of upland in Edo State.

2. Materials and methods

2.1 The areas studied

In Edo State (Zone A), the grasslands surveyed consisted of the ones found at Ekpoma ($6^0 43^1$N $6^0 08^1$E) and its surrounding villages namely Ukhun, Egoronaka, Uhiele; Irrua ($6^0 44^1$N $6^0 13^1$E), lIushin ($6^0 40^1$N $6^0 38^1$E) and Ozalla ($6^0 47^1$N $6^0 01^1$E). In Delta State (Zone B), field trips were made to the grasslands at Kwale ($5^0 43^1$N $6^0 26^1$E), Abbi ($5^0 53^1$N $6^0 13^1$E), Asaba ($6^0 11^1$N $6^0 45^1$E), Ibusa ($6^0 10^1$N $5^0 35^1$E), Iselegu ($5^0 53^1$N $6^0 28^1$E) and Aghalokpe near Eku ($5^0 75^1$N $6^0 0^1$E). All the grasslands in Delta State are flooded in the rainy season but the water dries up between December and January.

2.2 Sampling techniques

Two line transects were cut 50 m apart along each grassland visited. Leaving 10 m from the margin of each grassland, plants were sampled along the transects at intervals of 10 m using a square quadrat of 1 m x 1 m. Each field was sampled twice and any species that had been encountered during the first sampling was ignored. Trees and shrubs encountered along the transects and 10 m on either sides of the transects were collected and recorded since they could not be sampled with a 1 m x 1 m quadrat.

Grasslands in Edo State were surveyed between September and November in 2007 and 2008 while the ones in Delta State were sampled between January and April in 2007, 2008 and 2009. A total of 18 grasslands were surveyed in Edo State whereas in Delta State, 28 of them were sampled. The number of quadrats laid in each field ranged between 150 and 220 depending on their sizes. Some of the plants were identified in the field while those we could not identify immediately were properly labeled, put in black polyethylene bags and taken to the Department of Botany Laboratory for identification. Taxa were identified using reference materials by Hutchinson and Dalziel (1958 - 1968), Keay *et al* (1964), Akobundu and Agyakwa (1987). Plant specimens collected were poisoned as described by Okoli and Wilcox-Evwaraye (1992) and mounted in accordance with convectional herbarium practice and deposited at Department of Botany Herbarium, Ambrose Alii University, Ekpoma.

In order to investigate the extent of plant diversity within the grasslands, diversity indices were calculated for each zone using Simpson's (1949) index of diversity (I-D). Species diversity is a measure of heterogeneity of a site. Simpson's diversity index is calculated as:

$$\mathbf{D} = \frac{\Sigma n\,(n-1)}{N\,(N-1)} \qquad (1)$$

Where:
D = Simpson's diversity inde
N = Total number of species encountered
n=Number of individuals of ith species encountered

With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. To get over this problem, D is often subtracted from 1 to give:

Simpson's Index of Diversity (1 – D)

The value of this index also ranges between 0 and 1, but the greater the value, the greater the sample diversity.

The similarity between the zones was calculated as a measure of beta diversity (β). The difference between habitats are referred to as (β) diversity (WCMC, 1992). Sorensen's similarity index (SI) was used to calculate similarity between zones A and B. It is expressed as:

$$S1 = \frac{a}{a+b+c} \times 100 \qquad (2)$$

Where:
S I = Sorensen's similarity index
a = Number of species common to both zones
b = Number of species present in zone A but not in zone B
c = Number of species present zone B but not in zone A

3. Results

In the grasslands of Edo State, fifty five plant species belonging to twenty five families were identified as constituting the major part of the vegetation (Table 1). Poaceae accounted for sixteen (16) species representing 29.1 % of the entire taxa; while Asteraceae and Caesalpmaceae accounted 6 and 4 species respectively (Table 2). Among the grasses, *Cymbopogon giganteus* was must abundant followed by *Panicum maximum.* Trees in the sampled grasslands constituted 25.5% of the vegetation; shrubs, herbs, sedges, grasses and creepers represent 16.4, 21.8, 1.8, 29.1 and 5.5. percent respectively (Figure 1a). The grasslands had high Simpson's index of diversity (1 - D) of 0.97.

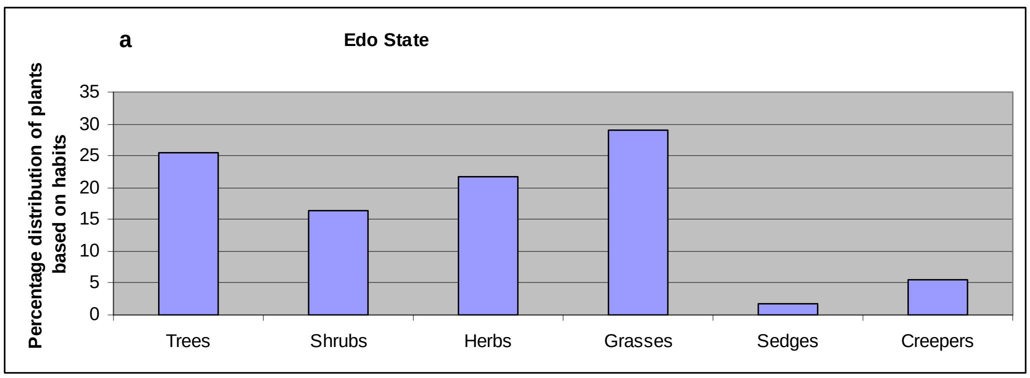
Table 1. Plants found in grasslands of Edo State

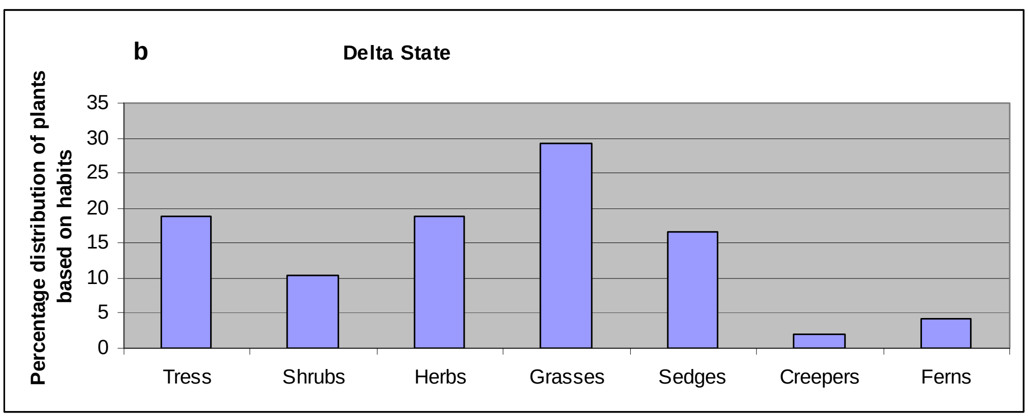
Botanical Name	***No. of Species***	***Family***	***Habit***
Annona senegalensis Pers	57	Annonaceae	Shrub

Aspilia africana (Pers) C.D. Adams	30	Asteraceae	Herb
Chromolaena odorata R.M. Kings & Robinson	101	Asteraceae	Shrub
Melanthera scandens Schum and Thonn	25	Asteraceae	Herb
Syndrella nodiflora Gaertn	76	Asteraceae	Herb
Combretum paniculatum Vent	12	Combretaceae	Tree
Ipomoea involucrata Beauv	18	Convolvolaceae	Creeper
Ipomoea triloba Linn	26	Convolvulaceae	Creeper
Cnestis ferruginea DC	21	Connaraceae	Shrub
Cyperus rotundus Linn	23	Cyperaceae	Sedge
Sida acuta Burm.f.	15	Malvaceae	Shrub
Platostoma africanum P. Beauv	30	Lamiaceae	Herb
Urena lobata Linn	46	Malvaceae	Shrub
Andropogon tectorum Schum & Thonn	120	Poaceae	Grass
Andropogon gayanus Kunth	48	Poaceae	Grass
Cynodon dactylon Linn	88	Poaceae	Grass
Oplismenus gayanus Beauv	91	Poaceae	Grass
Imperata cylindnica (Anders) C.E. Hubband	206	Poaceae	Grass
Panicum repens Linn	150	Poaceae	Grass
Dioda scandens SW	86	Rubiaceae	Herb
Setaria megaphylla (Steud) Dur. & Shinz	97	Poaceae	Grass
Pennisetum polystachion (Linn) Schult	82	Poaceae	Grass
Dissotis rotundifolia (Sm) Triani	111	Melastomataceae	Herb
Harungana madagascariensis Lam. ex. Poir	33	Hypericaceae	Tree
Alchornea cordifolia (Schum & Thonn) Muell. *Arg.*	28	Euphorbiaceae	Shrub
Lophira lanceolata DC	172	Ochnaceae	Tree
Alstonia boonei De Wild	52	Apocynaceae	Tree
Terminalia glaucescens Planch ex. Bth	61	Combretaceae	Tree
Vitex cuneata Schum and Thonn	28	Verbenaceae	Tree
Mitragyna inermis (Wild) O. Kuntze	31	Rubiaceae	Tree
Cassia mimosoides Linn	81	Caesalpiniaceae	Shrub
Cassia obtusifolia L.	38	Caesalpiniaceae	Herb
Smilax kraussiana Meisn	22	Smilacaceae	Creeper
Eragostis atrovirens (Desf.) Trin. ex Steud	162	Poaceae	Grass
Rottboellia cochinchinensis (Lour.) Clayton	34	Poaceae	Grass
Rauwolfia vomitoria Afz.	42	Apocynaceae	Shrub
Costus afer Ker	84	Zingiberaceae	Shrub
Pouzolzia guineensis Benth	52	Urticaceae	Herb
Daniellia oliveri (Rolfe) Hutch & Dalz	170	Caesalpinaceae	Tree
Funtumia elastica (Preuss) Stapf	18	Apocynaceae	Tree
Panicum maximum Jacq.	209	Poaceae	Grass
Hyparrhenia involucrata Stapf	182	Poaceae	Grass
Acanthospermum hispidum DC	90	Asteraceae	Herb
Alternantera pungens H.B.K	82	Asteraceae	Herb
Hypoestes cancellata Nees	50	Acanthaceae	Herb
Anacardium occidentale L.	105	Anacardiaceae	Tree
Bomhax buonopozense P. Beauv	8	Bombacaceae	Tree
Cassia fistula L	17	Caesalpinaceae	Tree
Ceiba pentandra (L.) Garten	8	Bombacaceae	Tree
Elaeis guineansis Jacq.	29	Palmae	Tree
Gloriosa superba L	8	Liliaceae	Herb
Setaria pallide-fusca (Schum) Stapf C.E. Hubband	90	Poaceae	Grass
Pennisetum pedicellatum Trin.	107	Poaceae	Grass
Axonopus compressus (Sw) P. Beauv.	83	Poaceae	Grass
Cymbopogon giganteus	303	Poaceae	Grass

Table 2. Species distribution according to families

Edo State grasslands (A)	No. of Species	Delta State grasslands (B)	No. of Species
Acanthaceae	1	Amaranthaceae	1
Anacardiaceae	1	Annonaceae	1
Annonaceae	1	Apocynaceae	2
Apocynaceae	2	Asteraceae	2
Asteraceae	6	Athyriaceae	1
Bombacaceae	1	Azollaceae	1
Caesalpimaceae	4	Boranginaceae	1
Combretaceae	2	Convolvulaceae	1
Connaraceae	1	Cyperaceae	7
Convolvulaceae	2	Euphorbiaceae	1
Cyperaceae	1	Hydrophyllaceae	1
Euphorbiaceae	1	Lamiaceae	1
Hypericaceae	1	Melastomataceae	2
Lamiaceae	1	Meliaceae	1
Liliaceae	1	Ochnaceae	1
Malvaceae	2	Onagoraceae	2
Melastonmataceae	1	Palmae	2
Ochnaceae	1	Poaceae	15
Palmae	1	Rubiaceae	3
Poaceae	16	Sterculiaceae	1
Rubiaceae	2	Tiliaceae	1
Similacaceae	1	-	-
Urticaceae	1	-	-
Verbenaceae	1	-	-
Zingiberaceae	1	-	-





Figures 1a and b. Percentage distribution of plants based on their habits:
a) Edo State grasslands；b) Delta State grasslands

In Delta State, the vegetation of the sampled grasslands was made up of 48 plant species belonging to 21 families (Table 3), Poaceae was also the most common. *Andoropogon incanellus* was the dominant grass in most of the grasslands sampled. The distribution of the enumerated plant species based on habit was presented in Figure 1 b. The grasslands also had a high Simpson's index of diversity of 0.97 indicating that both zones had similar index of diversity.

Table 3. Plants encountered in grasslands of Delta State

Botanical Name	***No. of Species***	***Family***	***Habit***
Melochia corchorfolia Linn.	45	Sterculiaceae	Herb
Dissotis rotundifolia (Sm) Triani	192	Melastomataceae	Herb
Hydrolea glabra Schum & Thonn.	86	Hydrophyllaceae	Herb
Eclipta prostrate (Linn.) L.	56	Asteraceae	Herb
Cyperus haspan Linn	157	Cyperaceae	Sedge
Fuirena ciliaris (Linn.) Roxb.	193	Cyperaceae	Sedge
Leersia hexandra Sw	81	Poaceae	Grass
Axomopus compressus Beauv	204	Poaceae	Grass
Ludwigia abyssinica A.Rich	115	Onagoraceae	Herb
Sacciolepsis africana Hubb & Snowden	221	Poaceae	Grass
Leptochloa caerulescens Steud	212	Poaceae	Grass
Oplimenus bumanii P.Beauv.	159	Poaceae	Grass
Clappertonia ficifolia (Wild) Decne	183	Tiliaceae	Shrub
Echinochloa pyramidalis Hitch & Chase	221	Poaceae	Grass
Chromolaena odorata (L) King & Robinson	82	Asteraceae	Shrub
Alstonia boonei Engl.	11	Apocynaceae	Tree
Entandrophragma cylindricum Spra	21	Meliaceae	Tree
Lophira alata Banks ex. Gaertn f.	12	Ochnaceae	Tree
Annona senegelensis Pers.	35	Annonaceae	Shrub
Alchornea cordifolia (Schum, & Thonn.)	31	Euphorbiaceae	Shrub
Funtumia elastica (Preuss) Stapf.	18	Apocynaceae	Tree
Borassus flabellifer	23	Palmae	Tree
Mitragyna inermis (Wild) O. Kuntze	9	Rubiaceae	Tree
Brachystegia euryocona Harms	7	Boranginaceae	Tree
Hyptis lancoelata Poir	35	Lamiaceae	Herb
Diodia scandens Sw	58	Rubiaceae	Herb
Dissotis erecta (Guill & Perry) Dandy	116	Melastomataceae	Shrub
Imperata cylindrica (Anderss.) C.E. Hubbard	93	Poaceae	Grass
Cyperus difformis Linn	88	Cyperaceae	Sedge
Ischaemum rugosum Salisb	71	Poaceae	Grass
Ludwigia decurrens Walt	94	Onagoraceae	Herb
Acroceras zizanioides Dandy	191	Poaceae	Grass
Scleria verrucosa Wild	201	Cyperaceae	Sedge
Paspalum vaginatum Sw	245	Poaceae	Grass
Killinga erecta Shumach	221	Cyperaceae	Sedge
Pycreus lanceolata (Poir) C.B.Cl.	91	Cyperaceae	Sedge
Panicum repens Linn	192	Poaceae	Sedge
Paspalum orbiculare Forst	87	Poaceae	Grass
Mariscus longibracteatus Cherm	221	Cyperaceae	Sedge
Oryza barthii A. Chev.	86	Poaceae	Grass
Alternanthera sessilis (L.) R.Br ex Roth	61	Amaranthaceae	Herb
Diplazium sammatii (Kuhn) C. Chr.	101	Athyriaceae	Fern
Azolla africana Desv.	92	Azollaceae	Fern
Ipomoea aquatica Forsk	42	Convolvulaceae	Creeper
Elaeis guineensis Jacq.	22	Palmae	Tree

Mitragyna stipulosa (DC) O. Ktze	183	Rubiaceae	Tree
Paspalum conjugatum Berg.	261	Poaceae	Grass
Andropogon incanellus	341	Poaceae	Grass

Only 14 species of plants belonging to 8 families were found to occur in both zones A and B (Table 4). The total number of plant species encountered in grasslands of Edo and Delta States were 4038 and 5537 respectively. Result of Sorensen's similarity index between the zone was 15.2%.

Table 4. Plant species common to Zones A and B

Plant Species	***Family***
Annona senegalensis	Annonaceae
Alstonia boonei	Apocynaceae
Fumtumia elastica	Apocynaceae
Chromolaena odorata	Asteraceae
Alchornia cordifolia	Euphorbiaceae
Dissotis rotundifolia	Melastomataceae
Dissotis erecta	Melastomataceae
Axonopus compressus	Poaceae
Cymbopgom giganteus	Poaceae
Imperata cylinderica	Poaceae
Panicum repens	Poaceae
Elaeis guineensis	Palmae
Diodia scandens	Rubiaceae
Mitragyna inermis	Rubiaceae

4. **Discussion**

The disappearance of many plant species due to human activities is depleting the world's genetic resources and is putting man's heritage of biodiversity under serious threat (Soladoye *et aI,* 2005). Most of the grasslands in Edo State (zone A) provide arable lands for the Igbiras who migrated from Kogi State. Besides, they are prone to annual bush burning set by the cattle rearers who also came from the northern parts of the country. Excessive cultivation to feed the ever-increasing human population and bush burning to ensure nutritious fodder for the farm animals were responsible for the very few plant families found in these fields. Most of the tress, shrubs, grasses and sedges encountered were those that could withstand intense heat of fire or able to regenerate few weeks after burning (Table 1). *Panicum maximum* is widely grazed upon by cattle and constituted one of the most dominant plants in the fields; it burns aggressively when dry but regenerates at about 2-3 weeks after the fire to produce very fresh and nutritious fodder for the animals.

Grasslands in Delta State were intensively utilized for cultivating paddy rice in the 1960's before the oil boom of the 1970's. Being submerged under water for about six months (June - November) of the year, only plant taxa that could survive hydromorphic environment or complete their life cycles during the short dry period inhabit this unique habitat (Table 3). However, some plants could tolerate both hydromorphic and upland habitats because their roots were able to respire in the oxygen-deficient soil characteristic of hydromorphic environment.

Similarity in Simpson's index of diversity (0.97) for both zones was expected. The sampled grasslands occurred in rainforest belt known for high species richness or large number of plants per unit area – a fundamental feature of tropical rainforest (Peters, 1996). Result of Sorensen's similarity index (15.2%) between the zones did not reveal any variability between them. This was due to the occurrence of the grasslands in the same climatic belt with similar amounts of rainfall, photoperiod and temperature. This was also very evident in the number of plant families encountered in both zones - 25 in Edo State and 21 in Delta State (Table 2).

Although grasslands were sampled, trees and shrubs were many in both zones (Figures 1a and b). The shade effect of these trees did not encourage undergrowth regeneration or their establishment. This could contribute to reduction in plant diversity. Observations of soil samples in the fields from both zones showed marked variations in their physical properties in terms of colour, texture and water contents; these did not significantly affect the diversity of plants collected. Though located in the rainforest, the total number of species recorded during the surveys (55 for zone A and 48 for zone B) showed a marked decrease in plant species compared to 308 species reported by MacGregor (1937), to 50-100 plants per hectare reported by Lowe (1993) in a typical rainforest.

The large decrease was due to several human activities that had taken place in the grasslands over the years. As at today, the grasslands in Edo State are still being intensively cultivated and also grazed upon by cows, while in Delta State, large areas of the fields are destroyed by natives who obtain white sand for construction purposes after removing the top, black and muddy soil. The flora of these grasslands therefore have a very bleak future.

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Rural Human Settlements Project Construction in the Building of a New Countryside in Northeast of China

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Abstract: It is an important part for the building of a new countryside to improve the rural human settlements constantly and it has important meanings to promote the planning of city and village and build the harmonious society. As the important production base of farm products, northeast of China should strengthen the rural human settlements project construction. So the government planning of village space should be made, the rural housing construction of saving energy and protecting environment should be spread, the renewable energy should be developed and utilized actively and the rural living garbage should be disposed according to the principle of cycle economy. And the ecological civilization concept should be regarded as the standard to build the rural human settlements to promote the sustainable, coordinate and steady development of local rural economy.
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Key words: northeast of China; building of a new countryside; rural human settlements

1. Introduction

The Greek scholar C.A. Doxiadis proposed the word of human settlements in the book of *"Ekistics: an introduction to the science of human settlements"* in 1950s. His "science of human settlements", especially the thinking of studying human settlements systematically has a far-reaching impact in the world. Wu Liangyong, School of Architecture of Tsinghua University, constructed the scientific system of human settlements through using the western academic thinking for reference and considering the Chinese national conditions. He made the definition as "human settlements, as the name suggests, is a place where human beings live life, is the earth' surface space which is related to the survival activities of human beings closely, it is the base which human depends on in nature and the main places of utilizing nature and transforming nature of human "in his book *"Introduction to the Science of Human Settlements"*. Thus, the relevant researches spread on different levels.

2. The necessity of strengthening rural human settlements project construction in the building of a new countryside

The report of the 17st Communist Party of China proposed the new requirements of constructing well-off society wholly. The most difficult and most arduous task lies in rural areas in the building of well-off society, because if there is no modernization of rural areas and comprehensive well-off, there can be no modernization of the country and comprehensive well-off society; and if the modernization of rural areas can not be promoted effectively and with the same pace, the entire national economic growth will be blocked. Therefore, the relations between workers, peasants, city and village must be handled properly to accelerate modernization and the rural economic and social comprehensive progress must be promoted to building the harmonious society. Only developing rural economy and building their homes to let farmers lead a comfortable life, the economic and social development result can be shared by all the people and the national economic development can continue. "Production development, well-off life, civilized local customs, clean village appearance and management democracy", outline the beautiful blueprint of building a new countryside, which is the major historic task in the process of Chinese modernization, the specific measures to coordinate the urban and rural development, the major strategic initiatives of constructing well-off society wholly. In a sense, the construction of rural human settlements is the key link in the building of a new countryside. The reasons are:

First, the construction of rural human settlements aims at coordinating the urban and rural development, improving the rural residential environment and upgrading the living standards of farmers through the construction of rural infrastructure, housing and sanitation facilities and coordinating the production and living activities of rural residents so as to promote the agricultural economic development and farmers well-off life. Second, it can make people live in the good environment, beautiful scene and harmony through the construction of rural human settlements. Marx once said，“the relationship between people and the natural world contains the relationship between people directly, and the relationship between human beings is the relationship between humans and nature directly.” So we can say the relationship between human and nature embodies the relationship between human beings. The improvement of the relationship between human and nature and the increase of people's own accomplishment will promote the harmony among people, thus promoting the civilized local customs greatly. Finally, the construction of rural human settlements can promote clean village appearance. Some of rural human settlements are not satisfactory for a long time. The filthy，disorder and bad rural environment is due to the way of production and living of wasting resources polluting the environment. If the concept of ecological civilization is regarded as the standard in the construction of rural human settlements，the filthy，disorder and bad problems can be solved in the internal of production and living，the negative efficiency of pollution can be changed into the positive efficiency of resources and the pollution prevention and control can be put in the increase of agricultural efficiency and farmers' incomes. And the environment and human settlements which have been destroyed will be improved evidently，the farmer can drink clean water, breathe clean air, eat safe food and village has clean appearance, attraction and reaches the perfect combination with surroundings.

3．The present situation of rural human settlements construction in northeast of China

Northeast of China, including Liaoning, Jilin and Heilongjiang provinces and three cities and a union in eastern Inner Mongolia Autonomous Region, is more than 1600 km long from north to south, more than 1400 km wide from east to west, the land area is 1,244,200 km^2. It has a broad distribution of forest and meadow grassland, a broad area of permafrost and marshes. The soil fertility is good and the rural settlements are extensive. The area of arable land is 1.948 million hectares which is higher than the national average. So it is the important production base of agricultural products. In the northeast, the climate shows a long winter and a short summer；the winter is dry and cold；the summer has concentrated rainfall，long sunshine and it is warm humid ; the spring has strong winds and low precipitation, and the autumn has a sharp fall of temperature and more early frost by the humid temperate and sub-humid continental monsoon climate. According to the information of statistics, the existing population in the northeastern region is 108 million, the rural population is 48.244 million, accounting for 44.8 percent of the population of the region. With the economic development, the living standards of farmers are improved constantly. The net income per capita rose from 2198 yuan in 2000 to 3616 yuan in 2007 and increased 55 percent, which is higher than the national average of 11 percentage points；Engel coefficient of rural residents dropped from 45.5 percent to 40 percent. Based on the unique geographical culture, the residential housing in northeast of China is the house with oblique roof，quadrangle or other style of courtyard. The residential area is small and it is mostly the single-layer structure with the insulation and heating equipment. In recent years, the rural residential area per capita is growing steadily, as shown in Table 1, the rural residential area per capita of Liaoning, Jilin and Heilongjiang provinces continues to be improved.

Table 1． The rural residential area per capita in the three provinces of northeast of China in 2004-2006

the rural residential area per capita（square meter）	2004	2005	2006
Liaoning Province	23.9	25.1	25.2
Jilin Province	19.8	20.1	20.7
Heilongjiang Province	20.4	20.4	20.9

Source：The statistics yearbook of Heilongjiang Province of China 2007

The great achievements have been gotten in the construction of rural human settlements in northeast of china， but it is still in the development state of spontaneous and disordered，it exists the following problems：

(1) The layout and construction are disordered

Benefiting from the strengthening farmer and favoring farmer policy of the Communist Party of China and government，many farmers have a steady growth in their income，and their common practices are building houses. However, many rural settlements do not have the detailed planning, make centralized building，or build along the road，all of these will cause the density of building is too large，the space is too small， the roads are blocked，the sewage are emitted randomly and the signs of having new village without new looks can be found everywhere. And some residents do not demolish the old house after building the new house and form the so-called “hollow village”.

(2) The scientific content of residential construction is low

The rural houses of northeast of China are mainly the red–brick houses with 490 mm or 370 mm wall thickness and part immature soil building. And the coefficient of wall conducting heat is between 2.0 -1.4W/m^2· K. For example，the rural brick and tile cottage area accounts for 49.2 percent in the rural housing area，reinforced concrete structure accounts for 2.5 percent，the brick and wood structure area accounts for 15.2 percent，and the area of brick and tile cottage and brick and wood structure area account for 50 percent respectively in the new building area in Heilongjiang province in 2006. According to the survey of Wenhe Liu，only the utilization rate of solar energy is higher in the use of renewable energy source of biomass, solar, wind and heat pump of ground source in the village of northeast of China，it accounts for 46 percent，and the energy-saving measures which are adopted in the rural residential walls, roofs , windows, floors, account for 60 percent，30 percent，10 percent，2 percent respectively. The brick and tile building in which the thermal insulation energy-saving design are neglected exists the defects of small envelope structure and large energy consumption, resulting in the large fluctuations of indoor temperature, the morning temperature is generally low, below 10 ℃, and even some north corners of residential kitchen have frost as a result of twinkling high humidity and can’t achieve energy-saving requirements. At the same time, the nitrogen and oxides affect the ecological environment directly which the building releases to the external environment for adding heat loss. Therefore, this high consumption, high emissions, low comfortable building needs transformation to the type of low consumption，low-emission, high comfort, high-tech content.

(3) The infrastructure lagged behind and the environment is dirty and disordered

Many rural infrastructure construction lagged behind in northeast of China and there are difficult issues of walking，drinking water and communicating in the village. The water penetration rate is lower in some villages，there is no unified water supply and drainage systems，the farmers get the water through drawing the underground water wells and the water treatment equipment is deficient. The majority of villages lack of necessary garbage collecting system and treatment measure，the mode of garbage cleaning，transporting and processing has not been formed yet. It is very slowly to promote clean energy and the number of biogas digesters and straw gasification station is small. It caused bad impacts on the human settlements for the indiscriminate discharge of life sewage and garbage and the mixed housing of human, livestock, poultry and nourished the emergence of disease and plague in rural areas. According to the typical survey report which was carried out by the Chinese villages and towns construction office of Ministry of Construction in 2005 to 105 rural works of 74 villages of 3 counties of 9 provinces，there was no centralized water supply in 41 percent villages，there was no drainage ditches and sewage treatment system in 96 percent villages，it was difficult to walk on rainy days in 40 percent villages，the pen of livestock was mixed with housing in 72 percent villages，the traditional lavatory was used in most villages，the garbage was littered everywhere in 89 percent villages，there was no fire safety facilities in 95 percent villages.

4. The countermeasures of strengthening human settlements construction in the building of a new countryside in northeast of China

(1) Paying attention to the renovation planning of village space

The minister of Ministry of Construction Wang Guangtao has pointed out that the natural ecological space must be protected strictly and the village layout should be determined in the next 10-20 years. Therefore, the relevant departments should be guided by the concept of ecological planning to make scientific and reasonable renovation planning and make the comprehensive arrangements to the housing，water supply ， electricity supply, roads, afforestation, sanitation and production facilities according to the level of local economic development in the process of drawing up the rural renovation planning. The layout and proportion configuration of various types of land use should be adjusted further to build a scientific and rational land-use structure. It is necessary to protect not only the interests of farmers but also the former home of the famous with cultural heritage and the historic building with value to embody the characteristics of the region. The popularity of tap water and drainage project construction should be strengthened, and the capital investment should be added to the agricultural water-saving irrigation, drinking water, rural roads, rural water and electricity and irrigation area transformation in the agricultural infrastructure planning.

(2) Making experienements and spread the energy-saving and environment-protecting rural housing construction

The rural housing is the basic living and production sites and it is related to the farmer's health and quality of life directly. First, it should be in line with the standards of healthy housing which are recommended by the World Health Organization. Second, the advanced energy-saving technologies should be spread vigorously, the concept of ecological civilization should be regarded as the standard to the planning，design, construction, use, maintenance, removal of rural housing construction to minimize the building energy consumption and the energy-saving, land-saving, water-saving and wood-saving rural housing should be built. For example, the straw can be made into crop blocks through the new technology processing and regarded as the building wall to replace the traditional red brick. And its strength and indicators in some aspects have exceeded the red brick so it is used widely in the developed countries， Mongolia, and Hebei Province of China. Finally, the thermal resistance value of rural residential envelope structure should be increased, the economic, efficient and rich thermal insulation materials should be adopted to compose the composite wall and roof，thereby the quality of rural housing is enhanced and the living conditions of farmers are improved .

(3) The renewable energy should be exploited vigorously

The Fourteenth Meeting of the Tenth National People's Congress Standing Committee adopted the "Renewable Energy Law of People's Republic of China "on February 28, 2005 and it came into effect on January1,2006. The article II of this Act states the so-called renewable energy is wind, solar, hydropower, biomass, geothermal energy, ocean energy and other non-fossil energy，it can not only increase the rural energy supply substantially to solve the problem of energy scarcity fundamentally but also reduce the consumption of fossil fuels and the emission of reducing carbon dioxide, sulfur dioxide and other harmful gases through the development and use of renewable energy in rural areas. It can reduce environmental pollution to provide the basic guarantee for sustainable development through turning waste (straw, manure, garbage) to treasure (fuel, feed, fertilizer) and turning harm into treasure with technical means. And the above types of energy are abundant in the northeast of China so the potential of energy should be tapped further and the renewable energy should be made full use of. For example, the biomass refers to the energy which is transformed through using the plants of nature, manure, and urban and rural organic waste. It is the earliest, the largest, the most direct source of energy which is used by human and it stems from trees, crop straw, firewood, water plants, manure of livestock， processing residues of agro-forestry product and organic waste. It can be converted to high-grade energy, such as gas and liquid fuels， and it can replace much conventional energy so it is the fourth largest energy besides coal, oil and natural gas. As the high grade biomass, the biogas can not only solve the energy problem but also saving resources and protect environment. The raw materials of biogas are rich, such as rural crop straw, livestock manure, distiller's grains and the waste materials in the production process of biogas, such as biogas liquid and biogas residue, are also the excellent organic fertilizer. The application of cycle mode which regards the biogas as the key makes the picture of the stack of crop straw and animal manure in the past village change radically. In addition, the promotion of biogas can replace the original way of logging，so that the forests get protection and the rural ecological environment gets improvement. Thus, with the energetic development and use of renewable energy，the problem of rural energy scarcity can be solved effectively and the rural human settlements will be improved greatly.

(4) The rural living garbage should be treated according to the principle of cycle economy

It is the foundation for garbage collection to carry out the scientific classification in the rural living garbage. If the garbage is filled or incinerated without classification，it is not only the huge waste of resources, but also the secondary pollution. The disposal way of living garbage is mainly incineration, filling and compost after classification at present. Because the levels of economic development, the way of production, living and residential environment in different regions are different, these three disposal ways are used at the same time generally. The disposal of rural living garbage in northeast of China started rather late and the current sanitary standards and disposal ways are in accordance with the city. The Ministry of Construction in the general principles 1.6 of urban living garbage disposal and pollution control technology policy states that the garbage disposal technology and equipment of sanitary fill，incineration, compost and recycling have the appropriate conditions of application, one of them or the right mix can be chosen on the conditions of adhering to local conditions, technical feasibility, equipment reliability, appropriate scale, comprehensive management and use. Therefore, the choice of rural living garbage disposal technology should also be guided by this principle.

The organic garbage which will rot and deteriorate, such as residual refuse，leftovers，the skin of fruit and vegetable leaves, can be composted. It regards solar energy as its heat source and makes high temperature anaerobic digestion to the organic garbage, as a result, the garbage can be used as high-quality organic fertilizer after three months. The garbage which can be reused, such as plastics, rubber，metal scraps, may be sold to the recycling companies and the brickbats and stones may be used as the road filler to pave the way. And a certain amount of methane, carbon dioxide and small amounts of nitrogen, oxygen can be released in the process of natural fermentation and degradation through the sanitary fill of garbage and these gases can be collected for power generation, lighting and so on. The hazardous waste, such as batteries and residual pesticide bottles should be handled separately. The power generation of incineration is also the garbage disposal technology which is widely used around the world. The garbage calorific value can meet the requirements of garbage incineration after the classification in Chinese village. So it is the key development direction of garbage disposal in the northeast of China. In short, the way of eco-composting, sanitary fill and power generation of incineration is different in different geographical environment，garbage composition and level of economic development，but the common ground is to follow the principle of recycling to protect the rural human settlements effectively.

5. Conclusions

As the important production base of farm products，northeast of China can promote the sustainable，coordinate and steady development of local rural economy through strengthening the rural human settlements project construction, paying attention to the government planning of village space，spreading the rural housing construction of saving energy and protecting environment, developing and utilizing the renewable energy actively，disposing the rural living garbage according to the principle of cycle economy and regarding the ecological civilization concept as the standard to build the rural human settlements.

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Development Strategy Research of China's Rural Biomass Energy Based on SWOT Model

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Abstract： Rural biomass energy possesses a very important position in the whole energy system as renewable energy, it is not only a strategic measure to relieve contradiction between energy supply and energy demand, but also an important responsibility to promote sustained development of economy in rural area as well as the whole society to vigorously develop and utilize rural biomass energy. On the premise of expounding development status of China's rural biomass energy, this article made a qualitative analysis to advantage, disadvantage, chance, threaten of rural biomass energy development by SWOT matrix, and analytic hierarchy process (AHP) was also introduced, furthermore, an SO strategy referring to Chinese rural biomass energy development was proposed by quantitative analysis, including to speed up exploitation, demonstration, popularization and application etc of biomass energy transformation and utilization technology.
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Key words: Rural Biomass Energy; SWOT Matrix; AHP

1. Introduction

Developing bio-fuel has become an important measure to improve energy security, reduce greenhouse-gas emission, cope with climate change all over the world along with increasingly outstanding of global environmental problems as well as steadily rising of petroleum price since 1970s of the oil crisis. Chinese energy consumption had been more than 1.4 billion tons of standard coal with the economic development at the last twenty years of 20th century, and China had became the second energy consumption dominant country. However, China was faced with traditional energy issue, for example, excessively depending on fossil fuels in the field of energy development, therefore, China must positively extend renewable energy no matter from the view of environment protection or energy crisis [1], biomass energy could not be neglected in this aspect. Rural biomass energy possessed an important position in the whole energy system as an initial ingredient of renewable energy, vigorously developing and utilizing rural biomass energy were not only a new energy way to for China, but also an important responsibility to resolve issues concerning agriculture, countryside and farmers and ensure sustained development of economy and society[2].

2. Present Situation of China's Rural Biomass Energy

The Chinese government issued Medium and Long-term Development Scheme of Science and Technology in 2006, and published Development and Design Scheme of Biological Industry, both of which put research and development of biological energy on the important position. During The 11th Five-Year period, National Pillar Program, High-tech Development Plan and Plan for The Development of High-tech Industries increased research-and-development capital to biological energy one after another, Ministry of Science and Technology, all of the National Development and Reform Commission, the Chinese Academy of Sciences, Ministry of Agriculture had set up special fund for biomass energy, a total of more than 0.8 billion RMB was spent on research and development. The Chinese Government specially issued Medium and Long-term Development Scheme of renewable energy in September of 2007, and took the biological energy as an important ingredient of renewable energy, and it also made the concrete development objectives of China's biological energy until 2020, the exploitation of China's biological energy was meeting an unprecedented historical development opportunity.

Table 1 Current situation of China's biomass feedstock resources

（Data source: China Statistical Yearbook 2006）

Organic waste	Annual energy/ a hundred million ton			Marginal land	area /ten thousand hm2	Annual energy/ a hundred million ton	
	Available physical quantity	Equal standard coal	proportion/%			Equal standard coal	proportion/%
Crop straw	3.90	1.96	52.8	Reserve land suitable for farming	734		
domestic animals and poultry manure	7.15	0.75	20.2	Current Marginal land	2000	1.13	26.7
Forestry remnant	0.07	0.40	10.8	Reserve land suitable for forest	5704	1.75	41.2
Collecting woody firewood	0.38	0.22	5.9	Current firewood forests	303	0.13	3.0
Industry waste	0.62	0.35	9.4	Current oil forests	343	0.06	1.5
Municipal organic refuse	0.16	0.03	0.8	Current bush forest	4530	1.18	27.6
Total	12.91	3.71	100.0	total	13614	4.25	100.0

At a preliminary estimate, the annual total amount of available biomass energy resources was about 0.5 billion tons standard coal in the near future. China's biomass energy generation total installed capacity was 2,200,000 kW until the end of 2006, among this, the co-production of thermo-electricity by bagasse was 1,700,000, the power generation by agriculture and forestry refuse, agriculture biogas, direct combustion of garbage and landfill gas was 500,000 kW. State and local National Development and Reform Commission approved amount to 39 biomass energy direct combustion power generation item, total installed capacity was 1,284,000 kW in 2006, estimated investment was 10.03 billion RMB, 54,000 kW was completed in 2006.

Furthermore, a power generation of 30,000 kW was completed by biomass gasification and landfill gas in 2006, and another 90,000 kW was completed by projects currently under construction. 18,700,000 rural household bio-gas pools have been constructed by Chinese government until the end of 2006, and 140,000 biological sewage purification bio-gas pools were built, more than 2,000 husbandry industry and industrial wastewater bio-gas engineering were built, the annual bio-gas was about 9 billion cubic meter, providing high quality living fuel for approximately 80,000,000 rural population.

Chinese has exploited multiple fixed bed and fluidized-bed gasifier, taking crop stalks, wood chips, rice hull, branch as raw material to product fuel gas. At present, more than 800 sets machines were used to dry wood and subsidiary agricultural products, approximate 600 centralized stalk gasification supply system of village and town were used, annual production of biomass fuel gas was 20,000,000 cubic meter. More than 20 sets biomass energy gasification power generation system have been popularized and applied. During the 11th Five-Year period, Chinese National Programs for High Technology Research and Development has supported to build biomass energy power generation demonstration project of 6 MW scale. In recent year, crossbreed sweet sorghum was planted experimentally all over the country, and a kind of high glucose and high product breed was obtained, and the straw yield per mu was more than 4 tons. Juice of sweet sorghum was high quality raw material to produce alcohol, during the 11th Five-Year period, utilizing the supporting of Chinese National Programs for High Technology Research and Development, technology to obtain alcohol was exploited by utilizing juice of sweet sorghum, cornstalk cellulosic fibre refuse and so on, the construction of pilot-plant and research experiment were also completed, a industry demonstration project of annual 5000 tons scale was built to obtain ethanol fuel by sweet sorghum, pilot-plant facilities of annual 600 tons scale was built to obtain ethanol fuel by cellulosic fibre refuse. Biodiesel fuel was a kind of high quality biological liquid fuel, it was also a development direction of China's biomass energy industry, and now it is in a state of experiment research and small scale production and application. Ministry of Science and Technology has put biological diesel oil technology into the 11th Five-Year Chinese National Programs for High Technology Research and Development and International scientific and technological Cooperation.

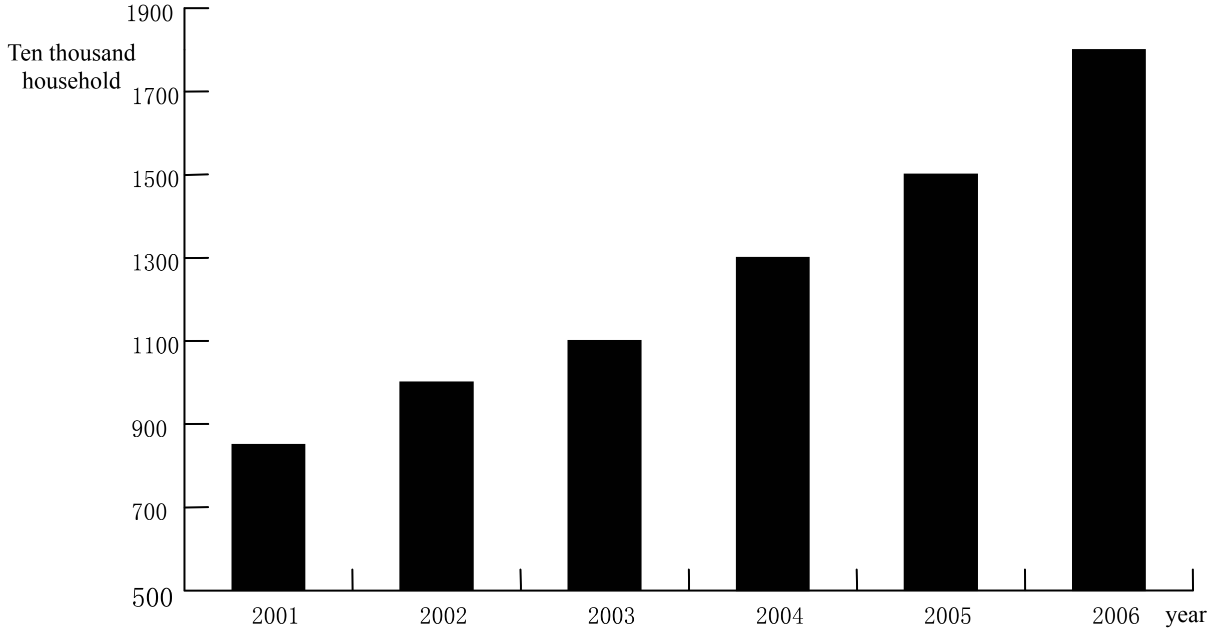

Figure 1 China's rural household biogas development scale（2001-2006）
（Data source: China Statistical Yearbook 2007）

3. SWOT Matrix Qualitative Analysis of China's Rural Biomass Energy Current Development

3.1 Advantage of China's Rural Biomass Energy Development（strengths）

3.1.1 S_1 Resource Advantage

China's rural biomass energy included several main types, such as crop straw, human and animal manure, by-product of agricultural product processing and energy crop and so on, rural biomass energy resources possess many varieties, great amount, and were widely distributed.

Table 2 China's rural available biomass energy resources potentiality(unit: a hundred million tons standard coal)
（Data source: National agricultural and rural economic development in the 11th Five-Year Plan）

category	2005	2010	2020	2030	remarks
crop straw	0.69	0.88	1.43	2.34	Entity amount increased to five hundred million tons
domestic animals and poultry manure	1.07	0.71	0.91	1.16	Calculating as annual growth to be 2.5%
Energy source crop straw	—	0.04	0.25	0.34	Reserve land suitable for farming and exploitation rate of winter slack farming field gradually increased to 10% until 2010
Total	1.76	1.63	2.59	3.84	

According to measure and calculation by Chinese Ministry of Agriculture, annual production of rural straw was about 0.39 billion tons, this data will increase to 0.726 billion tons, which is equal to 0.5 billion tons standard coal, measure and calculation by the development speed during the 11th Five-Year period, China's main agriculture crop straw yield will reach about 0.9 billion tons predicting to 2015, and approximate a half yield can be used as raw material of rural biomass energy among this. Agricultural product processing industry refuse (including rice hull, corn cob, peanut shell, bagasse and so on) exceeded 0.1 billion tons, domestic animals and poultry manure and agricultural product processing industry organism waste water were about more than 1.8 billion tons [3].

3.1.2 S_2 Foundation Advantages

China's rural biomass energy has possessed excellent development foundation by approximate more than ten years' construction, and the biomass energy industry has begun to take shape, establishing solid foundation for the further development of industry. Household biogas and large and medium-sized biogas program will get into the initial stage of industrialization development, biomass gasification and solidification technology get into the stage of enlarging scale to reduce the cost, biogas kitchen stove, power generation by biogas, biogas heating house have get into the stage of demonstration or generalization.

3.1.3 S_3 Technical Advantages

China's rural biomass energy transformation technology was increasingly matured. At present, there were four main transformation technologies: direct burning technology, materialized transformation technology, biochemical transformation technology, vegetable oil technology, and it can also be concretely divided into different subdivides.

Table 3 Current Development Stage of China's Rural Biomass Energy Main Transformation Technology

Technology	Development Stage	Further development	Development potentiality
Biofuel	Mature technology	Looking for low cost raw material	good
Biogas technology	Mature technology	Generalization	good
Gasification technology	Comparatively Mature technology	Power generation	Relatively good
Burning technology	Mature technology	Power generation	Relatively good
Compressing and shaping technology	Comparatively Mature technology	Technology practicability	Relatively good
biofuel cell	Initial starting	Mature technology	good
Technology of hydrogen production	Initial starting	Mature technology	good

As described by above table, generally speaking, China's rural biomass energy technology has been in a mature stage, and with the development of technology, China's rural biomass energy will inevitably obtain greater development and more extensive application.

3.2 Weaknesses of China's Rural Biomass Energy Development

3.2.1 W_1 Unsoundness of Management and Service System

At present, China's rural biomass energy property management and service system was not founded completely. For example, property service was hysteresis to biogas consumers, a phenomenon of stressing construction but slighting management existed in some program construction; standard management system was deficiency in utilization and maintaining of energy facilities, independent rural energy institution was scarce in some region; the whole diathesis and business level were low in rural energy procession, especially speaking, foundation service organizational strength was weak and construction technologist was insufficiency.

3.2.2 W_2 Channels of Investment and financing were comparatively single

Because of several reasons, such as the higher cost of China's rural biomass energy or equipments, the limited China's rural biomass energy marketing and so on, most of domestic energy companies which were abundant in capital and technical efficiency were unwillingness to put there capital to the field of China's rural biomass energy. China's rural biomass energy program was not brought into each class financial administration normal appropriation or loan channel as normal energy construction program, so besides several big energy companies, small companies and farmers were more short of financing channels to exploit China's rural biomass energy products.

3.2.3 W_3 Market Competitive Ability of Biological Fuel Oil Products Was Weaker

Because of the influences of several aspects in China, such as raw material sources, production technology and industrial organization, the fuel alcohol production cost was higher, at present, the fuel alcohol production cost by means of aging food as raw material was about 4000 RMB per ton, the national annual financial subsidy to 1.02 million tons fuel alcohol was about 1.5 billions, at the current technical and marketing conditions, it need great fund subsidy to enlarge fuel alcohol yield.

3.3 Opportunities of China's Rural Biomass Energy Development

3.3.1 O_1 China Strongly Supports and Thinks Highly of Rural Biomass Energy Construction

Because rural biomass energy construction tightly connected with the raising of farmer living standard and the improvement of rural ecological environment, it had become an important constituent of building socialism new village. The central has issued documents for continuous three years, putting to speed up rural energies, such as biogas as one of the construction engineering to strengthen rural infrastructure constructions. The suggestion concerning the 11th Five-Year Plan of Central Committee, Chinese Communist Party passed by the Fifth Plenary Session of the Sixteenth Party Central Committee explicitly indicated that rural biogas should be widely spread, and clean energy characteristic of countryside should be developed positively, the Plan also issued many policies and regulations.

3.3.2 O_2 Cooperation Mechanism of CDM Program

CDM program provided serial chances for stakeholder of China's interest: as for Chinese Government, CDM program could provide capital and technology promotion to carry out the necessary scientific development view for keeping economic growth; as for domestic enterprise, CDM program was an positive motivator (supernumerary resource of foreign capital) to promote Chinese enterprise to voluntary assume the social responsibility of enterprise, and strengthen competitive advantage by improving utilization rate of resources[4]. Up to December 30, 2008, there were 1797 CDM programs approved by Chinese Government, and up to February 4, 2009, the amounts of registered programs were 399, which represented 28.98% of global total registrations.

3.3.3 O_3 Guarantee of Regulations and Laws

The new issued regulations and laws provided powerful guarantee for speeding up rural biomass energy constructions, Renewable Energy Law practiced on January 1, 2006 identified that exploiting and utilizing biomass energy, such as biogas and son on, were the responsibility of governments at all levels,. The National Energy Office formally announced Energy Law to external and solicited opinion draft on December 3, 2007, and this meant that the draft work of Energy Law was also entered into a new stage.

3.4 The threaten of China's Rural Biomass Energy Development（strengths）

3.4.1 S_1 Characteristic of Uncertainty of CDM Program

Although the Kyoto Protocol had become effective all over the word at present, United States, the biggest global carbon emission country, did not formally joint in this protocol, furthermore, the legal effect of Kyoto Protocol was questioned, so the CDM program processed Characteristic of Uncertainty. However, CDM itself had an "additional" concept, this made the emission reductions of this program was hard to generate under the conditions without CDM. Moreover, because of the requirement of "additional", most of the CDM programs were not by-products, which could only sell emission reductions amount after investment, these investments probably had no benefits under the conditions of uncertain approval results[5].

3.4.2 S_2 Investing Obstacle of Foreign Company in China

Although China need a large amount investments at the aspect of developing rural biomass energy, great challenges were still confronted by China no matter technical support or direct investment by foreign companies. These challenges included that unreal tariff, low repay rate of investment, lack of the hard currency, practice of protective policies, improper protection of intellectual property rights, opacity and cracked rule bureaucracy, as well as deficiency of policy support, and the financing limit was the biggest problem to be overcome if the foreign company intend to develop in Chinese energy market.

3.4.3 S_3 Imperfect of Support Policy

Although Chinese Government had published Renewable Energy Law, reasonable and effective encourage policies were deficient in the aspect of financial administration, monetary, market opening and so on, for example, biofluid fuel that took non-food crops as the raw material could not enter market and share government subsidy, the pricing mechanism of biomass energy did not reflect the factors of environment profits; there were also the problems such as insufficient concordant, policies were hard to implement and so on among relevant policies, the prolonged action mechanism of supporting rural biomass energy industry sustained development was not yet formed.

4 SWOT Matrix Quantitative Analysis of China's Rural Biomass Energy Development

Carrying out quantitative analysis to SWOT matrix by introducing analytic hierarchy process can provide evidences for strategy selection of China's rural biomass energy development and could effectively avoid blindness and subjectivity of strategy formulation.

4.1 Constructing Compare-Judgement Matrix

After building SWOT strategy analytic hierarchy process model of rural biomass development, the subjection relationship between the two elements of superstratum and substrate was decided. As for the same level element, applying higher element as standard to compare by pairwise comparison, the comparable results were expressed by AHP-9 rating scale method: 1 represented equally important; 3 represented slightly important; 5 represented obviously important; 7 represented intensively important; 9 represented extremely important; the medium class between both sides was expressed by 2 , 4 , 6 , 8. This article evaluated the intensity importance of each element relevant to influence rural biomass energy development during the process of qualitative analysis to SWOT, and four co-occurrence matrices by pairwise comparison A, S, W, O can be obtained.

Strategy development compare-judgement matrix A

	S	W	O	T
S	1	4	5	8
W	1/4	1	2	5
O	1/5	1/2	1	2
T	1/8	1/5	1/3	1

Subroutines advantage compare-judgement matrix S

	S1	S2	S3
S1	1	4	9
S2	1/4	1	2
S3	1/9	1/2	1

Subroutines disadvantage compare-judgement matrix W

	W1	W2	W3
W1	1	2	2
W2	1/2	1	1
W3	1/2	1	1

Subroutines chance compare-judgement matrix O

	O1	O2	O3
O1	1	2	7
O2	1/2	1	3
O3	1/7	1/3	1

Subroutines threaten compare-judgement matrix T

	T1	T2	T3
T1	1	4	9
T2	1/4	1	2
T3	1/9	1/2	1

4.2 Hierarchy Order and Completing Consistency Checking

The maximum characteristic root λmax of compare-judgement matrix and corresponding normalized characteristic vector were calculated by root method, and deciding if it could pass consistency checking according to the values of C.I. 、R.I.、C.R. When

$$\text{C.I.}=\frac{C.I}{R.I} < 0.1, \quad (\text{C.I.}=\frac{\lambda - n}{n-1})$$

it was considered that the consistency of compare-judgement matrix was accepted. Detailed calculation see table 4.

Table 4 Hierarchy Order and Completing Consistency Checking

matrix	n	maximum eigenvalue	C.I.	R.I.	C.R.	normalized characteristic vector
A	4	4.098	0.033	0.9	< 0.1	(0.6.7，0.215，0.216，0.052)
S	3	3.004	0.002	0.58	< 0.1	(0.737，0.177，0.088)
W	3	3	0	0.58	< 0.1	(0.498，0.251，0.251)
O	3	3.006	0.003	0.58	< 0.1	(0.613，0.293，0.094)
T	3	3.003	0.002	0.58	< 0.1	(0.734，0.179，0.734)

Building coordinate system by taking S, W, O, T variables as four semiaxis of plane coordinate, deciding respectively corresponding point of the total advantages, total disadvantages, total chances and total threatens about SWOT analysis relevant to rural biomass energy development, and then a strategy quadrilateral was formed, calculating the center of gravity of quadrilateral many times, P（x， y）=（$\sum xi/4$， $\sum yi/4$）=(0.03,0.01)， i=1， 2， 3， 4. The center of gravity of P was the equivalent abstract made to each disintegration factors. The strategy type could be decided according to the placed quadrant of barycentric coordinates, because the barycentric coordinates placed in the first quadrant, SO strategy was adopted [6].

5. Development Strategy of China's Rural Biomass Energy

The above combined SWOT qualitative analysis and AHP quantitative analysis to study rural biomass energy development, and the strategy of combining self-advantages and external opportunities was obtained to develop rural biomass energy. Based on above, the following four aspects strategies could be adopted to develop China's rural biomass energy.

5.1 Accelerating biomass transformation and utilization technology exploitation, demonstration and popularization and application

The government should further strength support to biomass energy basic research, accelerate exploitation steps of new energy technology possessed independent intellectual property, fend to occupy commanding point in multiple technology competitive of global biomass energy. The key point was to introduce from abroad the advanced technology and management expertise and strengthen scientific and technological research to several problems such as quick-wearing of straw solidification mould, high content of gasification tar, product store and transportation and so on, and develop research at the aspect of energy consumption transformation of crop straw from high-energy efficiency to low expenditure, producing fuel alcohol by cellulose, providing biomass raw material by transgenic technology, striving for making breakthroughs at the aspects of new breed, new raw material, new technology, new equipment, gradually forming a cooperation system among industries, universities and research institutes of technical design, demonstration and extension and industry service[7].

5.2 Establishing prolonged action input mechanism

Establishing prolonged action input was the key point of rural biomass energy development and could be implemented by the following two steps. The first step was to implement government subsidy policy to rural biomass energy program. Giving subsidy to rural biomass energy program constructed by household and possessed significantly ecological benefit and comprehensive profit but the lump sum investment was comparatively large and the direct profit was not obvious. Striving for establish stable increasing mechanism of supporting rural biomass energy construction capital for financial administration, ensuring local match fund for national debt program of "eco-household project", gradually shaping stable fund resources for rural biomass energy construction; the second step was to actively explore, innovation mechanism, activating investment main body. With the promise of due benefits to investors, and leading enterprise, society and farmer to increase investment to energy construction, the government should gradually build a investment mechanism of all-direction, multi-layered and multi-channels.

5.3 Strengthen Market Exploitation of rural CDM program

In recent year, the amount of Chinese renewable energy resources CDM program accounted for 70% of total development amount, but only accounted for more than 22% of total emission reductions, however, the rate of renewable energy resources CDM program accounting for total emission reductions was gradually increasing from the view of development tendency. So the exploitation of renewable energy resources CDM program will become one of the main increasing resources of Chinese CDM program exploitation in future, the rural area will become the main exploitation market of CDM program because of resource advantages.

In addition to above discussed factors such as advantages, disadvantages, chances, and threatens, there was other factors influencing the implementation of CDM program, such as the approve of Kyoto Protocol by United States, the fluctuation of international carbon transaction market, and the implementation conditions of CDM program by other developing country and so on. Chinese government should also think highly of this factors at the same time to implement CDM program using rural biomass energy, developing international cooperation, winning competition victory, gaining more long-term development.

5.4 Constructing and Consummating Service Security System

During the process of rural biomass energy development, the government should pay more attention to integrate resources, consummate technology and industry service system, overall improving innovation ability and industry service level of rural biomass energy technology. Meanwhile, the government should also positively exploit generalization service mechanism of biogas technology, striving for declination of national funds, leading and shaping three classes service network including countries, townships, villages, providing full scale service during the process of construction, management and utilization, ensuring sustained, sound development, and gradually established industry service system of crop straw collecting and delivery. The government should positively lead farmers to develop professional cooperation organization to grow energy crop, collect and pretreatment of crops straw, constructing product and logistics system.

6. Conclusion

The article carried out a qualitative analysis to China's rural biomass energy development using SWOT model, and pointing out that its development possessed three aspects advantage in resource, foundation, technology by the view of internal, and several disadvantages such as unsound management service system, single investment and financing channel, weaker competitive power of biological fuel oil product market; meanwhile, there were three aspects chances of the government strongly supported and thought highly of rural biomass energy construction, cooperation mechanism of CDM program, possessed regulation and law security in developing rural biomass energy in external environment; there were also uncertainty of CDM program, obstacle of oversea companies investing in China, threatens of unsound support policy.

Appling AHP to decide the intension of advantages, disadvantages, chances, and threatens as well as total advantages, total disadvantages, total chances, and total threatens on the basis of above, forming strategy quadrilateral, conforming comparative matrix and completing consistency checking, the results showed that a strategy combing self-advantages and external chances should be adopted by China's rural biomass energy development, proposing strategy measure from fore aspects such as constructing rural biomass energy development prolonged action input mechanism, enforcing exploitation of rural CDM program market and so on.

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Annual Precipitation Series Multiple Time Scale Analysis of Major Grain Production Regions in Sanjiang Plain

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Abstract: In order to research the drought phenomenon of Sanjiang Plain that has appeared in the unconventional drought region frequently in recent years, the authors took the annual average precipitation of Hongxinglong Branch Bureau and its ten farms as the basic data, analyzed the multi-time scales variation characteristics with the application of a complex Morlet wavelet. The alternate variation process of drought and flood are also shown in the different time scales. The results showed annual average precipitation series had two main periods which were 3 years and 11 years; the changes of the two main periods played a major role in variant characteristics of annual average precipitation; and the major variant trend of the annual average precipitation has been in the low flow since 2008.
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Key words: Sanjiang Plain; precipitation series; wavelet transformation; multi-time scales analysis

1. Introduction

Sanjiang Plain lies in the northeast of Heilongjiang province, which is surrounded by Heilong river, Xingkai lake, Wusuli river and Xiaoxinganling region, and contains 21 cities (countries) such as Jiamusi and 50 state farms in administrative region. This site has a temperate humid, semi humid continental monsoon climate. The distribution of precipitation is odds in a year, in which approximately 75%～85% takes place from June to October. Even though the water conservancy facilities were improved constantly since the 1990s, the occurrence of flood and drought had an increasing tendency, especially drought, even in the wet year. Sanjiang Plain, as one of nine major commodity grain production regions in China, plays a decisive role in the food security. Therefore, in order to ensure the sustainable agriculture development, it is important to research the drought of this site.

It has been known for some time that there are some relationships between precipitation and drought. Conventional analysis methods were mainly functional analysis, Fourier analysis, numerical analysis and so on. However, these methods had some disadvantages including single-level time scale, lock of localized character and precision in multi-time scale analysis of precipitation. Therefore, wavelet analysis method is introduced and applied in this research to analyses drought occurring characteristics and regularity of Sanjiang Plain. The study can provide a new theoretical basis for exploring drought complexity deeply, forecasting the future drought quantitatively and revealing the drought occurring regularity and mechanism in a fully new angle, and also provide a reference for drought prediction scientific.

2. Study Method

2.1 Wavelet Function

The core of wavelet analysis is wavelet transform that determines the localized variation between time and frequency domain. It is in complete contrast to the Fourier analysis that can solve many difficult issues. Because of better localization properties in both time and frequency domain, the Morlet wavelet is chosen for analyzing the multiple time scale of precipitation series and is defined as:

$$\phi(t) = e^{ict} e^{-t^2/2} \tag{1}$$

Where c is the constant, i is the imaginary number.

Morlet wavelet is a single frequency complex sine modulation Gaussian wavelet, and is a common complex wavelet. There is a one-to-one correspondence between scale factor a of Morlet wavelet and cycle of

Fourier transform, that is $T = [4\pi/(c+\sqrt{2+c^2})]\cdot a$. And there is an expression as $T = 1.00057a \approx a$ when the constant c is 6.2. Therefore, Morlet wavelet can be applied to cycle analysis [2].

Because the precipitation series has a discrete features in practical applications, it is necessary to disperse factors to $f(k\Delta t)$. In this research, the discrete form of wavelet transform is chosen as the analysis method and its function expression as follows [3]:

$$W_f(a,b) = |a|^{-\frac{1}{2}} \Delta t \sum_{k=1}^{n} f(k\Delta t)\bar{\phi}(\frac{k\Delta t - b}{a}) \qquad (2)$$

Where $W_f(a,b)$ is the wavelet transform coefficient, a is scale factor reflecting the length of wavelet cycle, b is the time factor reflecting the translation in the time domain, $f(k\Delta t)$ is the precipitation anomaly ($k = 1,2,\Lambda,n$, Δt is the time interval of samples).

Two-dimensional contour map is plotted based on the wavelet transform coefficients $W_f(a,b)$ changes with the time parameter a and b , in which the abscissa is a and ordinate is b .The wavelet map represents the change wavelet features of precipitation series.

2.2 Wavelet Variance

The wavelet variance is obtained by integrating all the square of wavelet coefficients that belong to different scales after demeaning the precipitation series, which is expressed as follows [4~6]:

$$Var(a) = \int_{-\infty}^{+\infty} |W_f(a,b)|^2 \, db \qquad (3)$$

The change process of wavelet variance following with the scale a is called wavelet variance change chart, in which reflects the fluctuations and strength variation characters of various scales (cycles) of the hydrological time series. Therefore, the main time scale (cycle) of one time series is obtained easily from this map.

3. Case Study

3.1 Data sources and anomaly analysis

In this research, the annual precipitation within the period 1971-2008 at the Hongxinglong branch bureau and its ten farms (853、852、597、291、youyi、raohe、shuangyashan、jiangchuan、beixing and hongqiling) will be applied for wavelet analysis as the basic data, which is from Hongxinglong meteorological observatory. It is necessary to demean (centralize) the annual average precipitation of 11 stations. And the anomaly variation of the annual average precipitation is shown in Fig.1.

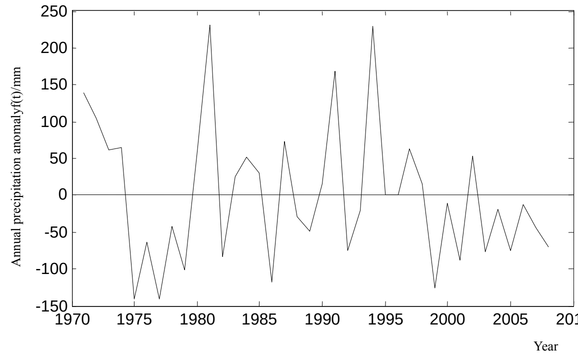

Fig.1 The anomaly variation curve of annual average precipitation in Hongxinglong branch bureau and its ten farms from 1971 to 2008

3.2 Time-frequency analysis of annual average precipitation anomaly series

The wavelet transform coefficients modulus square distribution (fig.2) and real part time-frequency distribution map (fig.3) of annual average precipitation anomaly series is plotted to analyze the time-frequency variation based on above methods.

3.2.1 Time-frequency analysis of wavelet transform coefficients modulus square

From Fig.2, the strength of signal energy distribution in various time scales can be seen clearly, in which the greater the gray scale, the smaller the signal energy, and vice versa. There are 9 energy gathering centers of annual average precipitation in fluctuation energy curved surface of wave variation domain, which represents the energy variation features. However, 2 energy gathering centers are obtained from the magnitude of modulus square peak value. They are A (11, 1997) and B (3, 1993).

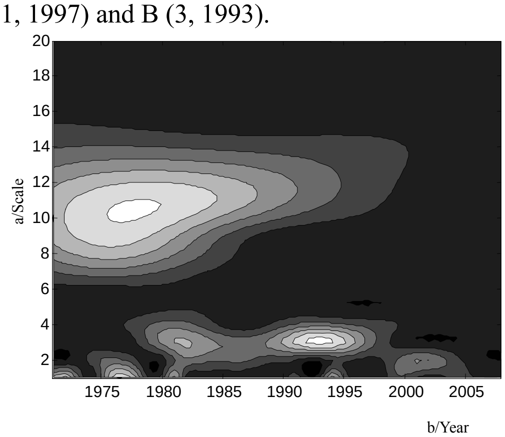

Fig.2 The wavelet transform coefficients modulus square distribution map of annual average precipitation anomaly series of Hongxinglong branch bureau and its ten farms

On center A, the greater fluctuation energy of annual average precipitation in fluctuation variation domain run through the most part of time domain, which the effect range is about 1975-1979. There is a gentle fluctuation energy gradient variation except the spectrum, which effect scale spectrum is about 6-15 years, the scale center is about 11years, and the oscillation center is about 1997; On center B, there is also a greater fluctuation energy that the effect spectrum is about 1993-1994. But the greater gradient variation gathering area and periphery are very small, in which the effect scale spectrum is about 2-5 years, the scale center is about 11 years, and the oscillation center is about 1993. Meanwhile, it is faintish that the fluctuation energy of center B affects the period of 1971-1977.And the spectrum affected by a low fluctuation energy that the center is (1, 1976).Therefore, the fluctuation of annual average precipitation affect the most part of time domain on a 3-year scale. The strength of fluctuation changes with various fluctuation centers energy at different times.

The 38 years of annual average precipitation of Hongxinglong branch bureau and its ten farms has a main fluctuation variation that the scale center is about 11 years and the oscillation center is about 1997; The scale center of strength fluctuation variation is about 3 years auxiliary (the oscillation center is about 1993) in the late 1970s. The fluctuation of the two scales (cycles) play an important role in multiple time analysis of annual average precipitation series.

3.2.2 Time-frequency analysis of wavelet transform coefficients real part

The Fig.3 shows the variability in time scale, and it represents the droughts-floods alternation features of the annual average precipitation that change with time at different scales, which characterized by wavelet coefficients, and the location of catastrophe point. The time scale of 2-5 years and 6-15 years behave significantly, and the positive-negative phase appears alternate, which the time scale centers are about 3 years and 11 years. In order to further research above features, the hydrograph is plotted that the time scale value a is fixed and the cutting lines is drawn parallel to b axis, which represents the real part of wavelet transform coefficients $W_f(a,b)$ (expressed as $R[W_f(a,b)]$) changes with the time shift b, as shown in Fig.3.

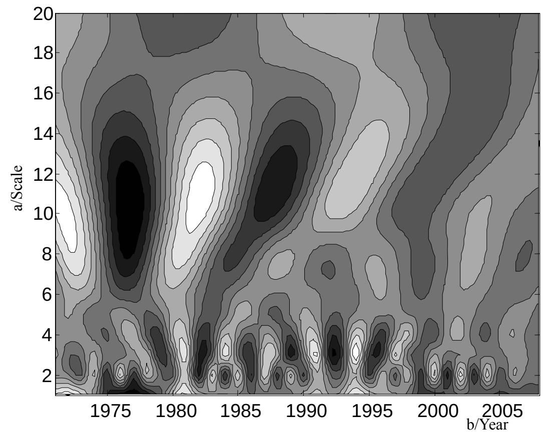

Fig.3 The wavelet transform coefficients real part time-frequency distribution of annual average precipitation anomaly series of Hongxinglong branch bureau and its ten farms

The fluctuation variation of annual average precipitation characterized by wavelet coefficient can be seen from Fig.4. On a 3-year scale, the periods of1971-1972, 1974-1975, 1976-1977, 1980-1982, 1984-1985, 1986-1988, 1990-1991, 1994-1995, 1996-1997, 2000-2001 and 2005-2007 are the high-water periods, while1972-1974, 1975-1976, 1977-1980, 1982-1984, 1985-1986, 1988-1990, 1991-1994, 1995-1996, 1997-2000 and 2007-2008 are the low-water periods since 1970s. And the annual average precipitation would enter into a low-water period after 2008.

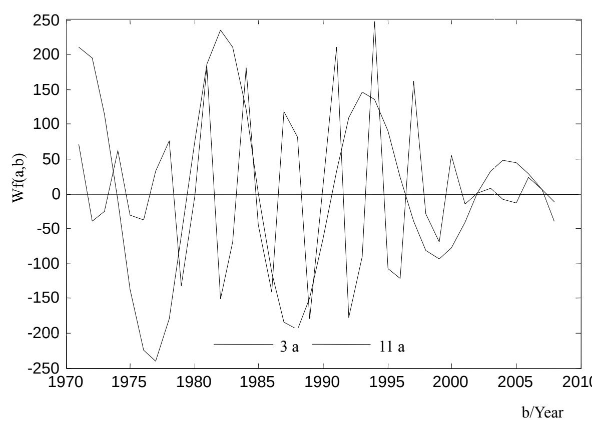

Fig.4 The Morlet wavelet transform real part variation course of annual average precipitation anomaly series with different scales

On an 11-year scale, the periods of 1971-1974, 1980-1985, 1991-1996 and 2003-2007 are the high-water periods, while 1974-1980, 1985-1991, 1996-2003 and 2007-2008 are the low-water periods since 1970s. And the annual average precipitation would enter into a low-water period after 2008.

3.3 Main period analysis of annual average precipitation variation

The wavelet variogram is applied in this research to analyses the main period that the time-dependent variation process of annual average precipitation of Hongxinglong branch bureau and its ten farms. The wavelet transform variation of annual average precipitation anomaly series is computed based on formula (3) and is plotted as shown in Fig.5.

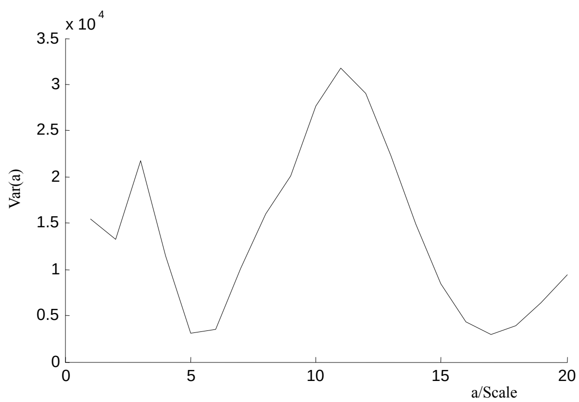

Fig.5 The wavelet variation of annual precipitation anomaly series in Hongxinglong branch bureau and its ten farms

The wavelet variation peak value is significantly obvious within 3-year and 11-year scale from Fig.5. It also shows that the most powerful cycle are 3-year and 11-year scale. As is known, above two scales have an obvious periodic oscillation, and the fluctuation represents the features of annual average precipitation of Hongxinglong branch bureau and its ten farms in the whole time domain.

4 Conclusions

Based on the 38 years of annual average precipitation data (1971-2008) from Hongxinglong branch bureau and its ten farms, the multiple time scale analysis have been accomplished using a complex Morlet wavelet. The results showed that:

The annual average precipitation of Hongxinglong branch bureau and its ten farms has an obvious periodic variation on the 3-year and 11-year scale that determines the variation features of annual precipitation in this site.

According to the droughts-floods alternation features analysis of annual average precipitation of Hongxinglong branch bureau and its ten farms within two main periods, the annual average precipitation would enter into a low-water period after 2008. Therefore, it is of great importance to research the drought in Sanjiang Plain.

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The economy analysis of small and medium irrigation area management participated by private and innovation on water rights system

— Case study: the water management mechanism's changes of Changgang irrigation area

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Abstract: Currently, water resources of China's irrigation areas is less efficient, the reason is the backward irrigation management system, system innovation deficiency. As well as the use property rights of water resources is not clearly defined, so water resources can not be rationally allocated ,leading to waste, abuse. Based on these problems, we investigated Changgang irrigation area for water management mechanism' changes and private participation in irrigation area management, in Lanxi county, Heilongjiang Province, and analyze the using efficiency of agricultural irrigation water. Conclusions show that through the establishment of water market, the performance of water-saving can greatly enhance, moreover, innovation of water management system is to ensure that the operation of irrigation area is long-term and effective.

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Key words: water shortage; water rights system innovation; resource allocation; performance

1. Introduction

China is a large agricultural country in the world, and the irrigation water is also mass. Until 2005, the national irrigated area is 0.848 billion mu, accounting for 55 % of cultivated land, the farmers of relying on irrigation water for production up to 0.4 billion , and output 75% of the food, 90% of the cash crops of country's total. In the total water resources which can be utilized, agriculture accounted for the majority of water. In 2005, the total national agricultural water consumption is more than 75%, that means1.25m^3 irrigation water to supply the average 1kg food. At the same time, due to a large population, vast territory, water amount per capita and per mu have extremely limited. In recent years, especially the scarcity of water resources, coupled with the backward management system in a lot of irrigated areas: egalitarian practice of everybody eating from the same big pot, works aging and lack of maintenance, difficulty to collect water charges, water using can not be guaranteed, so that agricultural irrigation are faced with severe challenges. Such as Changgang irrigation area in Heilongjiang province was founded in 1964, the design irrigated area up to 15 thousand mu, and the irrigation area station belongs to public institution. In 1980, the irrigation was forced to stop due to mismanagement; by transformation, the irrigation area continued to operate during 1989-1997, but difficulties in collecting water charges, management department is indebted, in 1998 ,the irrigation area once again stop. After that, the pumping station equipment is idle, and workers lay off; 18,000 farmers rely on the irrigated areas are in an extremely difficult life. In this way, the irrigation area which the state has a cumulative investment up to nearly a thousand million is into a standstill. Therefore, the innovation of the small and medium-sized irrigation area management system is imminent.

In China, the management of small and medium-sized irrigation area has been formed in the planned economy, the state take charge of funds from projects maintenance and water charges collection; with the current transition to the market economy has become more sophisticated, the innovations and practices of irrigation area management system did not try before. Five years ago, the success transaction of the water resources property rights, in Dongyang City and Yiwu City, Zhejiang Province created a beginning for water rights transactions in China, and provide a operable the policies basis and experiences during practice; However, due to property rights transactions is not complete or theory need further exploration, the water rights transaction of Yiwu and Dongyang are too high to appear new trouble. Abroad , many theories can be drawn on in solving the issue of in public resources and property rights, such as Elinor Ostrom 's "The government of public affairs" ,which ,in the focus on small-scale common pool resources, in a large number the basis of experience and case studies, develop the system theory of self-organization and management in public affairs, moreover has opened up a new path for the people facing public choice, but also avoid the degradation of public affairs, protect public affairs, and realize the sustainable use of public affairs, thus enhance human well-being, provide the basis for self-governance system. What inspired by her research is: we need to think about how to avoid the degradation of public affairs in China, and to save the already degraded public affairs, such as irrigated areas water shortages. She also explored the possible of self-governance common pool resources outside the government and the market ,from the perspective of game theory, particularly for " the game implementation for self-financing ", and think that there is a no complete privatization, no complete control of government power, the user of public water resources formulated and implement the contract of common pool effective using through self-financing .She investigated the origin of a series of groundwater basins system in the south of the Los Angeles area. She analyzed the region's "pumping competition", which led to degradation of groundwater resources. Seeing that producers carried out a lot of litigation in order to get rid of the bad pumping competition, but it does not solve the problem, finally, established autonomous public enterprises, which can properly manage groundwater resources .On the basis of a number of public enterprises, finally formed a "multi-center public enterprises game", such as the most effective organization, "civil society" to be set up (Elinor Ostrom, 1999). This has opened up new ideas for the management of China's small and medium-sized irrigation area. Through degradation of water resources empirical research, Michael McGinnis aimed at providing the basis of a viable system for the sustainable development of human society, "Multi-center Governance", that is, development is at all levels, in all places simultaneously, and not just some political center. The base of comprehensive and sustainable development depends on the autonomy governance capacity of the local community, as well as multi-center governance and multi-level system framework on that basis, which will no doubt help us to further reflection and to promote the "decentralization" changes. That is, small and medium-sized irrigation area is no longer relying on government, and this situation must be broken. In the study of system performance, Dealessi concluded that "the structure differences of the resources use right o have a systematic, foreseeable impact for the behavior "(Dealessi, 1980). Irrigation development will have to face the issue of governance, so human resources and other resources are made use of to take measures, besides using the appropriate irrigation techniques, arranging appropriate systems and organizations (Coward, 1980). While Elinor Ostrom study the design principles of long-lasting irrigation systems, for the water rights of irrigation water in Valencia, Spain as cases, noting that the strict privatization of water rights in many countries within the broader system framework is not a viable. If authorized to providers and users of irrigation water in the design of their own system, combined the arrangements principle for collective choice and the minimum recognized principle of the organized right, which is feasible reform in the many countries system framework. In this way, we can look forward to many of those who inspire the most will find solution what they are facing their most prominent problem (Elinor Ostrom, 1999). These concepts that foreign scholars explore the public resources and property rights, provides a reference for the innovation of management system in China's small and medium-sized irrigation areas.

2. The Existing Problems of State-Owned Small and Medium-Sized Irrigation Areas

2.1. Water Rights Fuzzy

Alchain defined property rights as: "It is the right that the society implements an application right to choose economic goods" (Alchain, 2002). From an economic point analysing, the property rights is not a general material entities, but rather refers to conduct relations of mutual recognition arising from the use of materials. It is used to define the people in economic activities how to benefit or impair, as well as the rules that how to compensate. Therefore, in order to complete the function definition, the property rights must be clear, which is the basic conditions of normal market mechanism, which is the prerequisites of effective use, exchange, preservation and management of resources and investment. Water is no exception. First of all, the fuzzy water right result to weak external constraint of irrigation area water ,the quantity of water withdraw mainly restricted by natural factors, especially in the upper region, often excessive mining water, waste serious, the phenomenon of "pumping competition" is widespread. Secondly, the fuzzy water right lead to unknown property rights, so water rights can not be transferred, water can not flow from the low-value areas to the high-value areas, reducing the total income of society, in fact, the allocation resources is distorted.

2.2. The Low Water Price and Difficult to Collect

A long time, the standards of water charges is generally low, shown in the Table 1, the difference between water supply costs and the water price subsidizes by government. In this way, on the one hand, people form the ideas that the water is a priceless resource and waste water during in the production and life; On the other hand, investment in rural water projects can not be recovered compensation, totally depending on government subsidies, so the national burden is growth, while supply water projects are run-down, hard to sustain. What is worse is that during the period of economic transition in recent years, reducing government subsidies every year, funding for operation of irrigation area management deep into a low-level "trap"; even in the harvest year, due to the backward mechanism, unclear responsibilities and rights, the result that it is difficult to collect water charges , furthermore forming a vicious circle.

Table 1. The Water Prices of Different Periods, Water Supply Costs and Subsidies Rate in Changgang Irrigation Area

Year	1990	1995	1997	2003	2007
Water price（yuan/m^3）	0.020	0.022	0.025	0.030	0.035
Water supply cost（yuan/m^3）	0.030	0.040	0.047	0.050	0.058
Subsidy rate（%）	18.0	8.0	0	1	0

2.3 The Performance of Managers to Pursue in Office

Irrigation system is invested, constructed and managed by the government, the managers' earnings origin from wages and allowances of the country, rather than from the farmers by providing service quality. Term limits and job promotion system for irrigation managers make them focus more on keeping good relations with superiors and maintain the short-term benefits of irrigation systems. When the irrigation managers work only to please their superiors rather than to meet the needs of local farmers, they do not have enough motivation to obtain extensive and accurate information. Irrigation managers have more incentive to seek funding for the development and construction of new irrigation systems, without caring disruption to the existing irrigation system and careless maintain, because the development of new irrigation systems to maintain the old irrigation system easier to demonstrate their achievements ,and can obtain a higher appreciation and job promotion. As a result, their main task is to run higher-level departments, in charge of maintenance funds for projects or project investment, even a little work performance has become the law code of work promotion. During 10 years from 1985 to 1995, Changgang irrigation area has 5 managers, whose short-term behavior caused a serious loss for the collective economy.

2.4 The Management System can not meet the Objective Requirements of Reform and Development of Irrigated Areas

Like the majority of small and medium-sized irrigation areas, Changgang irrigation area belongs to the state, no any changes in four or five decades. The irrigation area management department attach to the county (city) Water Bureau. Irrigation area manager ,water user, the township government, village committees are not standing the common "interests" base, so that farmers did not actively participate in management of irrigation areas; in water bills to pay, particularly in drought years, farmers have emotional conflict. Irrigation commissioned township government or village committee to collect, for the officials to create the opportunity for rent-seeking behavior; the farmers also have a lingering fear. Therefore, the irrigation area management system should meet the objective requirements of reform and development, in the market-oriented economy, to encourage farmers to actively participate in irrigation water management and engineering maintenance, to make irrigation area managers, farmers water users, the township government, village committee, and other water managers to play all the enthusiasm and creativity.

3. The Innovation of Water Management System for the Irrigation Area

The management system of Changgang irrigation area has reformed for five years, constant exploration, and the system searching for novelty step by step. Only in 2 years, it has established 12 responsibility systems, 26 management systems, 9 contract management ordinance, and 3 statutes. The establishment of these rules-based systems made the whole irrigation area orderly management, and users actively participate in irrigation area management, fully mobilize each person's enthusiasm and creativity.

3.1 The Principle of Institution Innovation: Comparing Costs and Benefits

Whether innovation or change of any system can be realized, the profit of the system change and comparison of the system cost are key factors. Drawing on Coase's property rights ideas, considering transaction costs, "the initial definition of the legitimate rights will have an impact on operating efficiency of the economic system. The right is a kind of adjustment, than the other arrangements will generate more output." Therefore, detailed analysis to actual results, select the appropriate institution arrangements. The output of system arrangements depends on comparison of operation proceeds and operation costs of the system.

Only when the expected return is greater than the expected costs, system change will ultimately realize. Changgang irrigation area's practice illustrates this point. In theory, it is not hard to see:

The total output of common system (I) = system (I)'s proceeds - system (I)'s transaction costs

The total output of property rights system (II) = the system (II)'s proceeds - system (II)'s transaction costs

It is clear that the condition that the arrangements of system (II) are more efficient than system (I) is that the output of system (II) greater than the system (I), namely:

System (I)'s proceeds - system (II)'s proceeds > system (I)'s transaction costs - the system (II)'s transaction costs

Analysis results showed that a prerequisite of smooth changes in water resources management system, is the proceeds of the system operation is a corresponding increase to transaction costs, and to choose the clear water property rights arrangements to achieve maximization value, that have two functions, that is increase the proceed of the system operation and reduce the transaction costs of the system operation.

3.2 Clarity the Idea of Water Resources Property Rights

The managers of Changgang irrigation area know the concept "water rights" in the end of 2001, and a small number of farmers water user know "the right to water" clarity in the end of 2002. The main water right problem in Changgang irrigation area is How to dispose the water savings of the irrigation area; properly dispose can bring what earnings for the people of water conservation. To resolve this problem, it must be clear on whether the water savings have usufruct and the transfer right.

"Water Law" states that "Water resources belong to the state, that the whole people", "water in the ponds and reservoirs of the agricultural collective economy, are collectively owned". From the semi-open access to the exercise of collective water rights, it is the basic direction of water rights change. The basic meaning that irrigation water right becomes collective water right, endow the irrigation area with use right and profit right, and allow moderate transfer right. From a management view, the water rights of irrigation area is, through the form of organization consultation and signing protocol by public agency and public consultations, the right that the public basin give specific irrigation area a certain number and quality water resources; from the irrigation area itself, this water rights means that irrigation area as using water group, in a certain water basin, according to their own population, resources, potential development and other factors, have the rights of access and consumption for certain amount and quality of the water. At the same time, it should be noted that the water rights of irrigation area must be shared by all residents, and entrust public institutions to manage; Irrigation area should have an initial water quality, that is, the initial water rights; For agriculture saving water ,irrigation area should have the proceeds right and transfer right; The law is the most commonly used method to define property rights of natural resources, also including water resources, and legal intervention can produce scale economies of defining property and reduce transaction costs.

The specific ideas to clarity irrigation area property rights:

First, trading water is introduced. We should establish goods attributes of supplying water conservancy project, to establish the sale relations between water user and provider. In accordance with the contract, irrigation water management department supply water. The farmers use irrigation with some compensation, and all farmers should pay some water charges in the early year in advance. In the survey, almost all rural households know that water is a commodity, and there are 2/3 of farmers could still point out the current water price and price policy of irrigation water.

Second, the farmers are directly involved in the management of irrigated areas. The water user associations require water users to participate in all-round management, including the investment construction of irrigation project in water association field, operation and maintenance management, participation in water plan and allocation, and the democratic supervision of water users associations and water supply sector. The water user associations in irrigation area increase the transparency of democratic decision-making, making farms to understand association election, payment of wages and the proportion of management costs in water prices. Farmers recognize that active participation in the association to ensure that their views can be adopted, their desire of increasing their own quality to improve.

Third, between the water user associations and rural economic development has shown a benign interaction. Many aspects have improved, such as channel's construction and maintenance, timeliness water supply, farmers' democracy supervision, the relations between the associations with the water sector; so that the water management departments reduce inappropriate interventions to irrigation activities. The unreasonable burdens on farmers reduce. The property rights have a clear relationship, a substantial reduction in society transaction costs, promoting faster development of the rural economy.

Fourth, the interest compensation mechanism is established. The core of the interest compensation mechanism is to protect the interests of farmers, especially the poor and the damaged, and bring water-saving incentives to the farmers. In addition to saving water and reducing the cost, compared to the original means, farmers are able to gain more revenue, thus we can achieve the dual purpose of agriculture water-saving and benefit for farmers .In the Government's support, introduced water-saving incentives to the water user associations and farmers. The compensation channels of benefits are: the financial transfer payment, income of water market, investments and subsidies of the State to water facilities.

3.3 The Establishment and Design of Water Rights' Transfer Mechanism

The core of the water rights market is to build transfer market of water rights in irrigation area, that the water rights are authorized by the government, to allow the independent operation and circulation. The water user who didn't own or lack of water rights can own water rights through the system of water rights transfer. The circulation of water rights can improve the efficiency of resource allocation, because there is no effective circulation system of water rights, so water rights will be long-term stay in the owner of the existing water rights, if it lasts for a long time, the phenomenon of low efficiency will occurs. Through circulation system, water rights can be obtained by owners who can be good at management and efficiently make use of water resources, which can always ensure the efficient allocation and effective use. The circulation of water rights can sale the water of irrigation areas to the outside, as well as the transfer between farmers in irrigation areas.

(1) The external circulation of water rights

As mentioned earlier, to sell water outside will increase the economic benefits of farmers, but in reality, the business of selling water can not do by the scattered farmers, but by the completion of the collective farmers. The prerequisite of selling water is to require the consent of every member, who agreed to the principle of consistency, that is all farmers must have requirements to sell the water. Therefore, it is necessary to establish water associations, a wide participation and information disclosure can reduce transaction costs and management costs. In addition, farmers' views in the region have a significant impact on collection system of water prices. The external circulation of water rights should pay attention to the following questions:

First, the calculation of the water charges uses the following formula:

$$P = (B + R + E) / W$$

Where: P is the water price; B is the annual cost of water conservancy construction; R is the maintenance and management cost of water conservancy facilities; E is the energy consumption cost of water conservancy facilities; W is the total water quantity of irrigation areas.

Second, when selling water outside, the irrigation area collectively sell water and collect water charges, and the member shall not operate this business alone.

Third, the income of selling water is allocated by the extent of every member's contribution. Here, the contribution volume is equivalent to the reducing amount of the crop. The revenue of selling water will be allocated to members as a reward. The reward of every member as follows:

$$M = P \times G$$

Where, M is the rewards of members; P is the price of selling water; G is the contribution volume of selling water.

Fourth, selling water is uniformly carried out by the irrigation area. Every member (farmer) can not buy water from irrigation area in a lower price, to transfer in a higher price.

Fifth, the management institutions of the basin have the implementation of the monitoring mechanism to water right transfer in irrigation areas.

(2) The internal circulation of water rights

The internal circulation of water rights is water right transfer between different farmers in the irrigation area. The farmers in the same irrigation areas have a stable flow and relatively fixed position, and the consultation and design management of water rights' circulation are lower than the external circulation in transaction costs. The water right transfer just consults with the parties, by approved with the farmer's water association.

3.4 The Benefits of Structure Adjustment from Single to Multi-center Treatment

Changgang irrigation area is divided into a number of drainage domains that the main is branch drainage and large-scale dou drainage. Every drainage domain established a farmers association whose executive board member and chairman is elected alone, who can execute independent powers in the drainage area, the formulation and implementation the rules of water fees and channel maintenance, construction of the multi-center governance structure, that is, "define the main body of construction and management, improve the functions of members participation and management, regulate the standard the volume of water measured water charges to ,determine financing channels and clear the interests relationship of all parties ".There are three water user associations, 1.5 million mu irrigation area, accounted for 80% of total irrigation area. In the multi-center governance structure, the water users association is the responsibility body and decision-makers in irrigation system. They make rules of water users in the drainage area, that is, they have obligation of water distribution, channels maintenance, the collection of water charges.

(1) Solve the collection of water charges

First of all, as a water user, he should sign water charges contract with the water management department, and have the duties of water using and payment. If only using and non-payment or less payment, it will be subject to sanctions. In such incentives rules, they made two kinds of water charges collection. One is round fee, that is, if the awareness in payment is not strong or difficult to collect, one watering received a water fee, or purchase water in water vote that according the planned water amount, water user buy water vote in advance. Another is collection of water charges in acres, that is, in the base of water amount and actual irrigation areas in the dou drainage, the water price in the round water is the standard, and water users is unit. According to the irrigation areas, one watering received a water fee by the area. In these rules, if you do not pay, you have no right to water. If you want to pay less, you will have less water. In the past, some "nail households" don't pay water charges, harming the interest of water management department, so water management department don't have any way; now the integration of water supply and water charges, water fees and water amount is directly linked to the interests of water users, so non-payment will be against the interests of other water users and "nail households" will be severe sanctions by the water users association. Inspired by such a system, we can put an end to many phenomenon of wasting water resources.

Secondly, as the household of water supply, association must provide an efficient and equitable water supply services to water user, in order to alleviate the difficulty of charge. In the original supply management system, the management and maintenance of channels is to rely on masses workers. The masses did not have any incentive mechanism to channel maintenance. The phenomenon that people use water and don’t mend channel is very serious problem, leading to channel siltation and serious water supply problems. The efficiency of water management department decline year by year and farmers are not satisfied with the water service, having a direct impact on enthusiasm of payment and conservation of water resources. After irrigation reform, the association established public rules that water users commonly manage, in the ways of raising capital, or collection of management fee by mu. For example, after the establishment of water user associations, the farmers raise more than 7000 Yuan, establish two new regulators, clear the channels of water blocking .In the three branch canal, water users adopt a proposed approach, and charge 1.3 Yuan maintenance costs per mu for project maintenance and protection. These effectively ensure the project facilities in good condition, so it is possible that water users association provide a good service, solving the “free-rider” phenomenon in the maintenance and management of public affairs. This creates a good foundation for the sustainable operation of irrigation areas.

Third, in the multi-center governance structure, the water user associations can more effectively and accurately determine the real needs of farmers for irrigation water. Each executive committee can more clearly understand that each water user's land area and different needs, to eliminate the gap in time and quantity due to agricultural products the structure and geographical factors, providing a impartial management, allocating effective services of water supply. Water user associations regularly publish the accounts, increasing transparency of collection of water charge, avoiding the emergence of the "gray" water charges. In this case, people used reasonable water and pay the reasonable costs, so it is great to mobilize positive of the masses to pay water charges.

(2) The water users from initiative water-saving to passive

In the shortage of water resources, farmers’ high expenditure of water charges, as managers, another responsibility of water users association is to meet the water supply needs of water households and reduce the expenditure of farmers. Therefore water user associations have to consider optimal allocation of water resources and the incentive to save water. From the beginning of 2002, irrigation areas established the irrigation system of “water, moisture, dry planting, water allocation” in order to save water resources. The irrigated area increased by 0.4 million mu, meanwhile diversion works have no major changes, saving 50 million cubic meters water in the three year.

(3) The effective institutional arrangements provide an effective incentive

Coase in his article “Social cost question”, proposed the importance of definition and arrangement of the rights in economic trade. He believes that when A damaged B (the external of Pigou said), people often considered that how to stop A. Most approach is to request A to compensate B or tax A, or even to stop A (Coase, R, 2002). This theory has a great deal of inspiration to district reform: establishing water user associations, effective rules and regulations to restrain and coordinate the responsibility and rights of members, to form a clear mechanisms of incentive , mutual supervision, and mutual benefit. Practice has proved that the governance structure of multi-center self-management can provide at least three kinds of effective incentives. The first is incentives of choose collective. The multi-center governance structure of water users’ self-management stimulates the responsibility of each water user. The most water users affected by the rules of the game can participate in the establishment and revision of rules. Therefore, water users strictly abide by the incentive of rules. The second is the effective supervision and classified sanctions. This can timely detect the offenders and punish the offenders who do not act in accordance with the rules of the game by other water users. The third is the resolution mechanism of conflict .This can transform dissatisfaction caused by the contradictions of water supply for the Government and the Association to the internal of the Association or between the Association and irrigation management departments. Water users use their own water, self-management, self-settlement of the conflict from all sides. Letting water users know that the benefits that they comply with the requirement is at least equal to the cost of collection, this is very important. After reform, the collection rate of water charges reaches more than 97% every year. The general contradictions between water supply and payment in the agricultural water supply has been fundamentally resolved in the link of water user association. In the multi-center water management structure, water users realize self-management that the government can't manage efficiently, so the continued operation of irrigation area has a reliable basis.

4. The Design of Water Market in the Irrigation Area Established under the Multi-center Management structure

4.1 The Establishment of Main Body of Water Market

Water user associations play a very important role in the establishment of multi-center governance structure. As mentioned above, the water users association as a spokesman for the interests of water users will sign the fee contract with water management department, and bear the responsibility of water using and payment. When the water price increased, the association will reduce water demand according to their situation of water using; when the price of water decreases, water user associations will increase in water demand in accordance with the goal of maximizing the interests. By measuring the relationship between the costs of water saving and the cost of water using and the relationship between the income of increasing water and the cost of water using , water users will decide whether increase or decrease water amount; that water user associations with "economic man" of the features can be used as market main.

Secondly, the establishment of water user associations will be effective in the internalization of externalities, and enhance the effectiveness of the market. Water users use their own water, the self-management, including water distribution and channel's construction and maintenance, solution contradiction from all aspects by self, such as a nail households, water collection, raising maintenance fund, and common labor, avoiding the phenomenon of "free-rider" in the maintenance and management of public affairs.

Therefore, multi-center management structure of the irrigation area objectively cultivates the market body to adapt the changes of the market, laying an organization foundation for the water rights market.

4.2 The Nature Division of Irrigation Water Market

If the irrigation areas exist the basic right, according to the basic water rights whether are allocated to specific water users associations, water market of irrigation area can be divided into two cases to discuss.

(1) Not allocate the basic water rights to the water user association

This case refers to the country allocates the basic water rights to the irrigation area , while the irrigation areas do not specifically allocate water rights to the various water user associations, the basic water right only retained in the irrigation area. Because the basic water rights have a high guarantee, the initial basic water rights also have a low water price, so the basic water rights are water rights which include the interests. The existence of the basic water right affected the income level of irrigation areas and the water supply rate of irrigation areas.

The basic water rights have some impact on the water supply rate of the irrigation area. The guarantee rate of the basic water right is high. Therefore, the more basic water rights, the higher guarantee rate in the irrigation area.

If the basic water rights are not assigned to the water user associations, so when the irrigation areas increase new area, the interests of the original irrigation area will be damaged, because their interests of basic right will be shared by the new users.

(2) Allocate the basic right to water user associations

If each water user associations have the basic water right, so the water rights market of the irrigation area exists transfer of the basic water rights.

The advantage of the basic right is more obvious in shortage of water resources, which is mainly high guarantee rate. In addition, the initial basic water rights are low price, but including commitment fee.

The benefits of allocating the basic water rights to water user associations is: when extending new irrigation areas, can protect users interests of the original irrigation area.

Under normal circumstances, within the same irrigation area the transfer of the basic water right should be inactive. This is reasoned that in accordance with in the same irrigation area, the planting structure is similar and the difference of the interests is not large.

Based on the above analysis, the transactions of irrigation water market are divided into two situations. One is the transactions between the irrigation areas management agencies and the water users associations. The other is basic water rights transaction between the water users association.

The first is the nature of a monopoly market. Water (water rights) is supplied by irrigation area management agencies. Based on supply and demand situation of water market determine their supply and demand of water rights market in the basin. The supply of irrigation water market is the demand of water right market in the basin. The demander of irrigation water market is the water users association. The market type, can be seen as the right to water market, water can also be seen as a commodity market. The trading price of market is water price of full cost, not only reflecting the price of water right.

The second is the nature of free competition markets. The supplier and demander are the water users. However, this situation will depend on whether the irrigation area allocated basic water rights to the user.

4.3 The Demand and Supply Analysis of Water Right Market in the Irrigation Area

The demand and supply analysis of water right market have similarity with general merchandise. According to the supply and demand relationship of commodity, we can analyze supply and demand of water right market.

(1) The demand for water rights

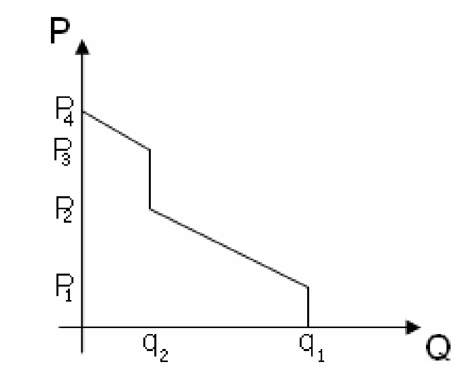

Figure 1 The Demand Curve of Single Household Water

Figure 1 is the demand curve of single household water. When the price is less than p_1, the water quantity stabilizes at q_1.The reason is that in the existing circumstances, the factors including leakage losses are basically stable. If too much water will also result in floods and the water table rising, making household subject loss which is not done in rational economy. When the price lies between p_1 and p_2, the water quantity will gradually reduce with the price increasing. In this interval, the water quantity is sensitive to water price. When the price lies between p_2 and p_3, the water quantity stabilizes in the q_2. Because the water users are in the existing planting structure, the effective using water will not significantly change with the price. When the price continues to rise, water users will not afford the expenditures, so water users will reduce the area of planting crop, or even completely stop draining water.

The demand curve of irrigation area facing is shown in Figure 2:

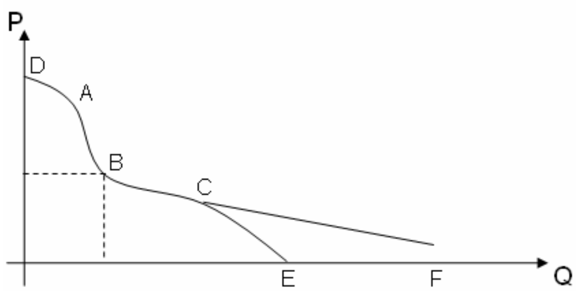

Figure 2 The Demand Curve of Irrigation area Facing

When the potential water users outside the existing water users to participate in irrigation area market isn't considered, the demand curve of the irrigation area facing is DABCE. If we consider the potential water users, the demand curve may be DABCF.

DA paragraph shows that when the water price is too high, the water users can't afford, so the water quantity will drastically reduce. AB paragraph shows that when the water price at a higher price range, the price elasticity of crops' water consumption is small, so water quantity don't significantly reduce with the price increasing. BC paragraph shows that when the water price maintains at a lower price range, due to adopt the necessary water-saving measures of allocating water management and anti-seepage treatment, a significant reduction in water reduce the expenditure of the water charges . In this paragraph, water using is sensitive to water price and price elasticity is great. CE paragraph shows that when the water price maintain at a low status, water quantity will increase, but due to reach the limit, using more water will lead to excessive loss of water, so water quantity will also be stabilized. CF paragraph shows that when the water price maintains at a very low position, the potential water user require joining to the irrigated areas, so the water quantity will increase. However, due to the inherent cost factors of reclaimed irrigation area, the increase water quantity will in a certain limit.

(2) The supply of water right

The supply of water right in irrigation area can be divided into two situations. One is when the supply of water right is in certain, or only accordance with national water right to distribute indicator, or when the outside water supply far from impact of the price, or this impact can be negligible, the supply curve is a straight line perpendicular to the horizontal axis, as S_1 shown in the Figure 3. The second situation is when there is water right market outside the irrigation area; the outside water supply is obvious influenced by the prices. When the prices rise, the supply of water rights increases. When the prices decline, the supply of water rights declines, as S_2 shown in the Figure 3.

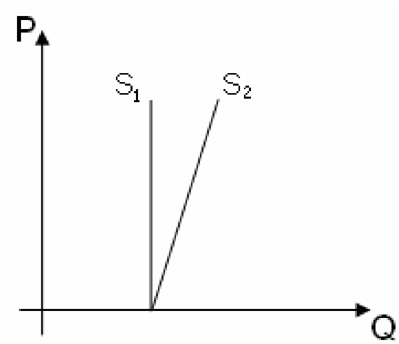

Figure 3 The Supply Curve of Irrigation Area Facing

When the supply curve of irrigation water rights is S_1, the demand curve is the D, and then the equilibrium price is the P_1, because the supply curve is the vertical line, that is when the supply of water right is in certain. When the price is less than P_1, the demand greater than Q_1, thus the supply can't meet the demand. When the price is higher than P_1, the water demand less than Q_1, thus give rise to the phenomenon of lack of demand. When the price is P_1, the demand is equal to the supply, thus all the limited water resources is exactly allocated.

When the supply curve of irrigation water rights is S_2, the demand curve is the D, and then the equilibrium price is the P_2, because the supply curve is the slash, that is the supply of water right will increase with prices rising, when the price is less than P_2, the water demand is greater than Q_2, thus the supply can't meet the demand. When the price is higher than P_2, the demand for water rights less than Q_2, thus give rise to the phenomenon of lack of demand. When the price is P_2, the demand is equal to the supply, thus all the limited water resources is exactly allocated

Due to the slope of supply curve is different, in the same demand curve, the market equilibrium price is different. As in the Figure 4, when the supply curve is S_1, equilibrium price is higher than the price when the supply curve is S_2.

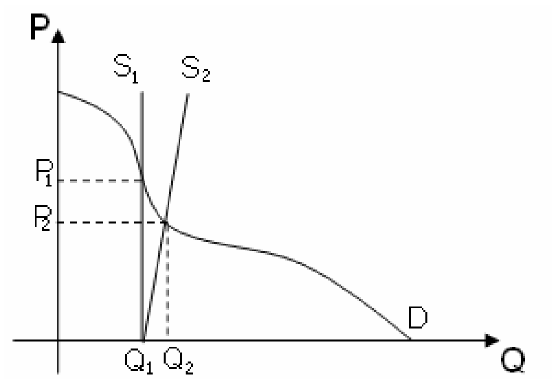

Figure 4 The Balance of Irrigation Water Market

4.4 The Control and Regulation of Irrigation Water Market

In order to control selecting water, the Government can generally take two measures. One is limiting the supply, reducing the indicators of selecting water right. The other is suppressing demand, primarily through raising the water price, also reducing the demand for the Chief. When the Government or the relevant department restrict the amount supply of water right in a certain irrigation areas, as shown in the Figure 5, thus equilibrium price of water rights market will rise. When the supply curve changes from S_1 to S_3, and the limited supply water of water rights reduce from Q_1 to Q_3, thus the equilibrium price balance of water right increase from P_1 to P_3.

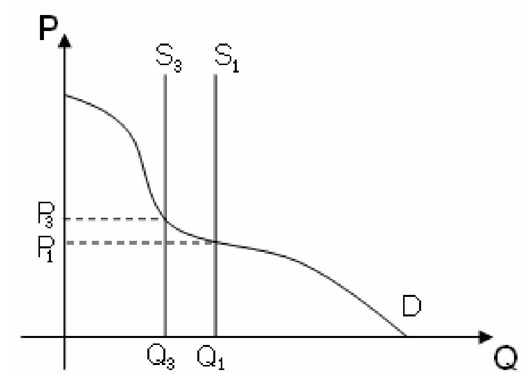

Figure 5 The Control of Water (Right) Market - Restrictions on the Supply of Water Rights

When the Government or the relevant department wants to curb demand by raising the water price, as shown in the Figure 6, the price level raises from P_1 to P_3, the water demand will reduce from Q_1 to Q3.

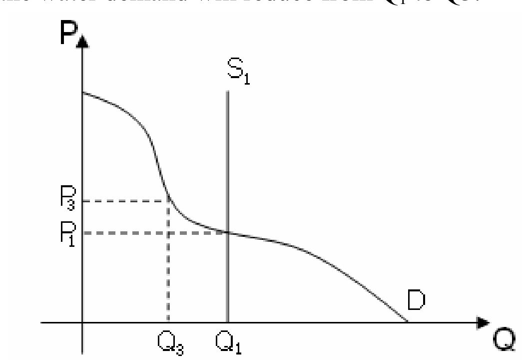

Figure 6 The Control Water (Right) the Market - to Raise the Price of Water

At present, Hulan River locates in the upper of Changgang irrigation areas. Due to the convenience of selecting water in the irrigation areas, the water quantity is rich, the state of the supply curve and demand curve shown in Figure 7. The D and S_1 do not intersect, that is, without taking into account the price and t water rights indicators, all needs can be met. In that case, for the need of macro-management, the Government need restrain the using water in the upstream to ensure continuous flow in the downstream. At this time, price control can suppress the demand for water rights. Assumed that the supply of water resources isn't affected by the price, as shown in the Figure 7, the demand can be met in full, thus the demand is decided by the price. When the price is the P_3, the demand is the Q_3. This is the effect of price control.

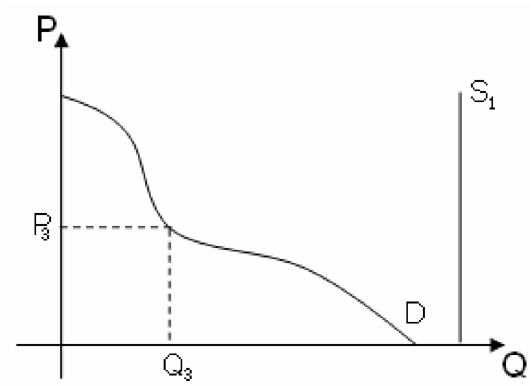

Figure 7 The Control of Water (Right) Market - a Simple Price Control

5. The Operation Rules of Irrigation Area Water Market

(1) Procedures

In accordance with the demand, water user association purchase water rights from the irrigation area, irrigation areas make advantage of the channels and appropriate measuring water facilities to allocate water according to the declaration of selecting water rights. Water users pay water charges in accordance with the water price (containing the cost of water conservancy project's construction and maintenance, management fees, distribution management fee, measurement costs).

(2) Treatment measures of lacking of water

When there is bound, water not enough, the demand of water right to all the water users can not be fully met. While the measures may include: reduction in the same proportion; administrative restrictions on certain water; improve water price and suppress some water; determine the order of using water in accordance with water rights priority. These measures have their advantages and disadvantages.

(3) The management of irrigation project

Trunk and other major distribution channels and water facilities must be managed by the irrigation area. The water users associations is difficult to manage, so it is essential that the water right market should put the management of water conservancy project such as channels management into the incentive mechanism of irrigation area.

5. The economic analysis of irrigation water use efficiency after the establishment of water markets

According to the above, if water markets and the structural design are established, the water use efficiency of Changgang Irrigation Area will greatly enhance, benefited from the effective operation in practice and guidance in theory. According to four different kinds of circumstances, to discuss farmers profits, the result is: through the establishment of water market (although the quasi-market), according to per cubic meter charges, but also transferring the savings of the water resources , is conducive to water conservation and to play economic performance. Specific analysis is as follows:

5.1 The Conditions Assumption

(1) Farmers as the economic men, pursuit maximization profit. Farmers have the land area of T, which do not transfer and cultivated a single crop.

(2)The actual water loss in the process of irrigation is G (contains fields surface evaporation, underground infiltration, irrigation management losses), this part of the water loss can not be avoided, only reduce by taking certain measures; the supply water loss of not water-saving investment is G_0; the conservation water of carrying out water-saving investment is g; water-saving investment is I, which is a function of g.

While $G = G_0\text{-}g$

$I = I(g)$ (I 'and I "are greater than 0)

(3)The water demand of farmers X = G + W. W is the water demand of crop natural growth. The assumption that the region with plenty of water, farmers can get all the water they need, and the water consumption of the farmers does not exceed the allocation of water X_0, while the remaining water, X_0-X.

(4)The crop yield is Q, whose production function is Q = Q (W, T), that element is a variable, that is, the volume of water input is variable. The input of water W and yield Q is the decline law. The price of crop unit production is P.

(5) Farmers can not influence the price of water, but can choose yield to influence profit.

5.2 The Analysis of Farmers' Profit in the Four Different Situations

(1) According to land area, collecting water charges, the water price per unit area is P_0, and the water trading market does not exist

In this case, the farmers subjectively believe that the price water per cubic meter is zero, so they will not take any water-saving measures with costs, and to maximize the use of water resources. Π_1 represents the profits of farmers in this case:

Π_1 = sales revenue – the cost of using water -the cost of saving water

$= P \bullet Q (W, T)-P_0 \bullet T-I (g)$

The water balance conditions of farmers to pursue profit maximization: $\Pi_1 = P \bullet Q = 0$

$$\Pi_{1g} = I' = 0$$

That is, when the profit of the farmers is the biggest, the marginal benefit of using water is equivalent to the marginal cost of water-saving, and is equivalent zero. Marginal benefit of using water means adding one unit water brought the changes of the output. The marginal cost of water-saving means the cost of farmers saving one unit water.

Π_1 = sales revenue – the cost of using water –the cost of saving water = $S_{oa}-P_0 \bullet T$ (Shown in Figure A, S for area)

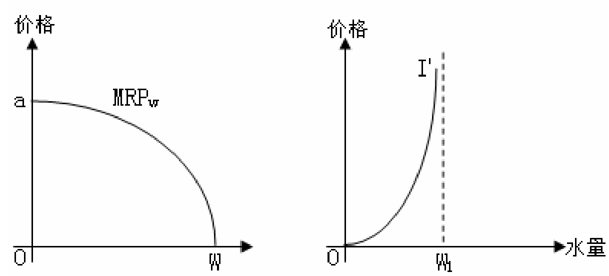

Figure 8 The Farmers' Profits of Charged by the Area and No Water Transaction Market

In Figure 8: OW represents crop water use; OW1 represents the loss G_0 of water in no water-saving measures; the volume of water-saving g is zero.

(2) According to land area, collecting water charges, the water price per unit area is P_0, the existence of water trading market, and the trading price of water is P_a per cubic meter.

Assume that if farmers are willing, he can sell some or all of allocation water to the non-agricultural sector. In this case, farmers will take the necessary measures to save water. Π_2 represent the profits of farmers in this case.

Π_2 = sales revenue + the revenue of selling water – the costs of using water - the costs of saving water = $P \bullet Q (W, T) + P_a \bullet (X_0-W-G_0 + g)-P_0 \bullet T-I (g)$

The water balance conditions of farmers to pursue profit maximization:

$\Pi_2 = P \bullet Q-P_a = 0$

$\Pi_{2g} = P_a-I' = 0$

That is, the marginal benefit of using water = the marginal benefits of saving water = trading price of water

$\Pi_2 = \Pi_2$ = sales revenue + the revenue of selling water – the costs of using water - the costs of saving water = $S_{oab} + (S_{bcW3} + S_{odeW2} + S_{W1fgX0})-S_{oPab}-S_{oeW2}$, shown in Figure B.

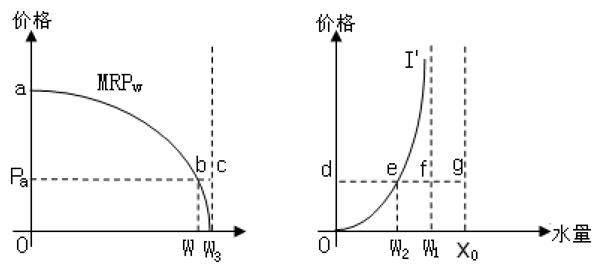

Figure 9 The Farmers' Profits of Charged By the Area and Existing Water Transaction Market

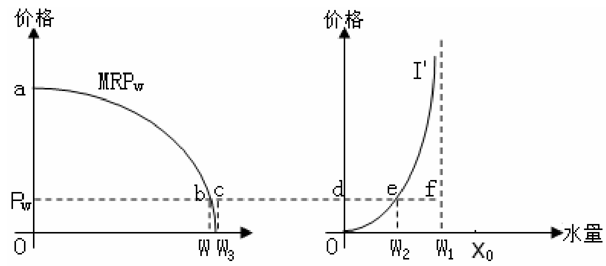

Figure 10 The Farmers' Profits of Charged By Cubic Meter and Existing Water Transaction Market

In Figure 9: OW represents the actual water of the crop using; WW_3 represents water quantity of the crops reducing; W_1X_0 represents the remaining water in no water-saving measures, that is, $(X_0\text{-}G_0)$; OW_2 represents the saving water g in adopting water-saving measures; W_2W_1 represents water losses G in actual irrigation.

(3) Collecting water charges by per cubic meter P, no water trading market

In this case, farmers will take water-saving measures to reduce the cost of planting. Π_3 represent the profits of farmers in this case.

Π_3 = sales revenue – the cost of using water - the cost of saving water= $P \cdot Q\ (W, T)\text{-}P \cdot (W + G_0\text{-}g)\text{-}I\ (g)$

The water balance conditions of farmers to pursue profit maximization: $\Pi_3 = P \cdot Q\text{-}P = 0$

$$\Pi_{3g} = P\text{-}I' = 0$$

So, $P \cdot Q = P = I'$, that is, for production, farmers invest the water until the marginal revenue of the water is equal to the marginal cost of saving water.

Π_3 = sales revenue – the cost of using water - the cost of saving water= $S_{oab}\text{-}(S_{oPb} + S_{efW1W2})\text{-}S_{oeW2}$

Shown in the Figure 10, OW represents water using of the crop; WW_3 represents water quantity of the crops reducing water; OW_2 represents the saving water g to adopt water-saving measures; W_1W_2 represents water losses G in the process of the actual irrigation.

(4) Collecting water charges by per cubic meter P_W and existing water trading market, the trading prices is P_a per cubic meter, and P_a is greater than P_W

Assume that if farmers are willing, he can sell some or all of allocation water to the non-agricultural sector. In this case, farmers will take the necessary measures to save water. Π_4 represent the profits of farmers in this case.

Π4 = sales revenue + the revenue of selling water - the costs of selling water - the cost of saving water = $P \cdot Q\ (W, T) + P_a \cdot (X_0\text{-}W\text{-}G_0 + g)\text{-}P\ (W + G_0)\text{-}I\ (g)$

The water balance conditions of farmers to pursue profit maximization: $\Pi_4 = P \cdot Q\text{-}P_a\text{-}P = 0$

$$\Pi_{4g} = Pa\text{-}I' = 0$$

Farmers choose planting strategy b point according to the water prices of (P_a + Pw), the corresponding water quantity W. The actual planting cost of farmers is S_{oPd} (the opportunity cost is S_{oPac}). Farmers choose water-saving strategy g points starting from the price of P_a, all the saving water used for the transaction.

Π_4 = sales revenue + the revenue of selling water - the costs of selling water - the cost of saving water == $S_{oabw}+(S_{wceW3}+S_{oPagW2}+S_{W1mnXo})\text{-}S_{oPwdw}\text{-}S_{W2hiW1}\text{-}S_{oW2g}$

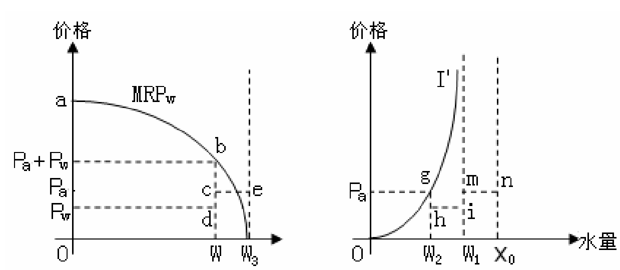

Figure 11 The Farmers' Profits of Charged By Cubic Meter and Existing Water Transaction Market

In Figure 11, OW presents the actual water of the crop using; WW_3 presents the water of the crops reducing; W_1X_0 presents the remaining water in no water-saving measures, that is, $(X_0\text{-}G_0)$; OW_2 presents the saving water g of taking water-savings measures; W_2W_1 presents actual water losses G in the process of actual irrigation.

From the above analysis, we can conclude that: Π_1 less than Π_2, Π_3 less than Π_4. Through the water rights market, on the one hand, farmers can transfer water resources of saving, so farmers will have a larger incentive mechanism of water-saving. On the other hand, with the adjustment of agricultural structure, the farmers will plant the crop whose coefficient of water consumption is low, or crops of high efficient. Otherwise, their margins benefit will be lower than the transfer price of water resources. Through the water rights market to transfer income of water resources, it can be used to supplement insufficient funds of water conservancy infrastructure, speeding up the construction of water-saving facilities, to form good circle of agricultural water-saving.

6. The Preliminary Assessment of Economic Performance of the Existing Management System Innovation

6.1 Intuitive Data

In November 1999, Water Conservancy Bureau in Lanxi seeks the views of their superiors and listens to the views of farmers, putting reform program of the irrigation area, which is submitted to county party committee and government, and has been ratified. On April 1, 2000, through the county bid, a senior engineer of the County Water Conservancy Bureau won the bid and signed a contract with the responsible department of Water Conservancy Bureau. The terms of the contract: the responsible people do not pay any costs to the Water Conservancy Bureau; the time limit of irrigation management rights is 25 years; during this time, the increased buildings and equipments are unconditionally to the Party (government departments); the responsible people must implement employment system for existing employees, and have the right to manage and use all the assets of irrigation areas, but may not sell assets; the responsible people raise funds to resolve funds of equipment maintenance and engineering maintenance by themselves ; ensure to achieve standardization of the irrigation area in 10 years ;in the contract , the two sides' rights, responsibilities and interests have been clearly defined. In 2000, the managers of irrigation area take over responsibility for the management of irrigation area, so the nature of the business has changed, from the state-operated to the privately managed. The management of irrigation area has a series of significant changes. The manager raises 410,000 Yuan to repair projects by self-financing, pre-paid 205,000 Yuan for electricity cost, creating conditions for the resumption of irrigation, preventing seepage of water channels, rebuilding the renovation project, expanding of new irrigation area. The implementation of the employment system, although existing workers fully employed, only one opportunity to work. The implementation of wage reform, the header's wages in irrigation period is 1,500Yuan; 1,200 Yuan for the grouper is per month, 800 Yuan for the managers. The award and penalty system is strictly implemented. In that very year, the irrigation area was 333.3 hectares, and the value of water increased. The water consumption reduced from 1700 cubic meters to 1100 cubic meters per acres, and contract disputes of water greatly reduced. By 2005, due to the change of water management mechanism and innovation of management system, the benefit of irrigation area distinctly improved, guarantee rate is greatly increased agricultural income of farmers is doubled than 1999.The table 2 lists the GDP Y, the total capital K, the total workforce L (including water user and water manager).

6.2 Performance Analysis

If we introduce the data into the economic model, the evaluation of water rights system will be more clearly in Changgang irrigation area during this period. Smith pointed out that there are two basic factors on economic growth: first is the labor of determining productivity that is division of labor productivity; second is the capital of determining the number of productive labor. Stigluos think there are mainly factors that are impact on economic growth, such as the increase in capital accumulation, the improvement of the workers' nature, improvement of the efficiency of resource allocation, technological change and so on. Therefore, in the situation containing technical factors, I believe that the economical performance of water rights system is mainly affected by the capital accumulation of irrigation area, the nature of workers and technical factors.

Table 2 The Statistical Graph of the GDP, the Total Capital, the Total Workforce in Changgang Irrigation Areas

Year	**Y***	**K**	**L**
1964	50	150	320
1969	62	165	350
1988	13	300	400
1995	14	340	620
2000	25	400	680
2001	52	480	720
2002	100	650	900
2003	200	800	1000
2004	450	870	1110

Source: 《Reform Documentary of Changgang Irrigation Area》(2003); the data in 2004 is estimates ; the data in 1964-1995 is on the basis of annual summary of irrigated area, estimated by the financial officers.

Table 3 The Performance Analysis of Water Rights System

Year	***y***	α	***k***	β	***l***	γ
1969	0.24	0.8	0.1	0.4	0.09	0.123
1988	−0.8	−0.4	0.82	−1	0.14	−0.35
1995	0.08	0.03	0.13	0	0.55	0.071
2000	0.79	0.18	0.18	0.18	0.1	0.736
2001	1.08	0.34	0.2	0.68	0.06	0.973
2002	0.92	0.28	0.35	0.27	0.25	0.756
2003	1	0.67	0.23	1	0.11	0.735
2004	1.25	3.57	0.09	2.27	0.11	0.688

Therefore, the production functions with the technological level as the following:

$$Y(t) = A(t)F[K(t), L(t)]$$

Where $Y(t)$ $A(t)$ $K(t)$ $L(t)$, respectively represents, in the time of t, the production, technical conditions, the capital stock and labor total. Finding Logarithm and derivation to both sides of the production function, shown in the following:

$$\frac{Y'(t)}{Y(t)} = \frac{A'(t)}{A(t)} + \frac{[F'_k(t)K'(t) + F'_L(t)L'(t)]}{F[K(t), L(t)]}$$

$$\frac{Y'(t)}{Y(t)} = \frac{A'(t)}{A(t)} + \frac{F'_K(t)K(t)K'(t)}{F[K(t), L(t)]K(t)} + \frac{F'_L(t)L(t)L'(t)}{F[K(t), L(t)]L(t)}$$

Made,

$$\alpha = \frac{F'_K(t)K(t)}{F[K(t), L(t)]}, \beta = \frac{F'_L(t)L(t)}{F[K(t), L(t)]}, \gamma = \frac{A'(t)}{A(t)},$$

$$y = \frac{Y'(t)}{Y(t)}, k = \frac{K'(t)}{K(-t)}, l = \frac{L'(t)}{L(t)},$$

Thus $y = \gamma + ak + \beta\, l$

$$y = \gamma + ak + \beta\, l \quad \gamma = y - ak - \beta\, l$$

Among them, γ represents the performance of the water rights system; y represents of the GDP growth rate of irrigation area; α represents the elasticity of the total capital to the total capital; k represents the total capital growth rate; β represents the elasticity of the total workforce to the total output; l represents the total growth rate of workforce. The $\gamma, y, \alpha, k, \beta, l$ is the function of t, discretization of time variable, so there are: $\gamma_i = y_i - \alpha_i k_i - \beta_i l_i$

The indicators represent the meaning of the indicators in the phase of i. Therefore, the assumption that technical level doesn't change, through access to the data of each side and each year or some period (seen in the table 2), the performance analysis of water rights system can be drawn on in the Table 3. In the traditional irrigation area management system, the economic performance of system is extremely poor. Adopting new operating system, the economic performances of system gradually increase.

6.3 The Assessment of Water Using Efficiency

1. The water users' awareness of water-saving is relative high. Water users participate in water management of the irrigation area, strengthening the awareness of water conservation. They consciously adjust planting structure, smoothing the land, implementation of lace cultivation and irrigation in small ditches to reduce water quota, a decrease of water loss, to improve the utilization efficiency of water. For example, after the establishment of the association, water quota of some household decreased from 800 cubic meters to 500 cubic meters.

2. Comply with the principle of water rights of the "first come, first served" (first in time, first in right), that is, to ensure the longest occupation of the water rights are not affected by the new occupants, to avoid "pumping race" (in 1970's, in United States, the Los Angeles area didn't well define the water right. On the ground, the owners of the land possess the water rights under the ground. The adjacent pumping water users have a race, and even excessive use and waste.), especially irrigation areas included the well irrigation. Because water rights are not well defined, the possession principle dominated the ownership of the reserves. People have exclusive rights to the pumping water. No pumping water can be pumped by others, resulting in "Pumping competition".

3. Enhanced awareness of the democratic management and decision-making, improve the transparency of Irrigation Water Management. To avoid Village cadres' the phenomenon of free-rider charges, reducing the burden on farmers. Person buys building materials in their own money to mend project is appeared. After the establishment of the Association, supervision mechanism, transparent charges, making financial affairs and expenditure public, reduce costs. Today, water things must be through democratic consultation and decision-making, and stress of fair, reasonable and efficient principle, a reduction of a variety of water disputes. More than 95% of people have reflected that

since the establishment of water associations, the disputes of villages, households, between the households and irrigation station reduce. The phenomenon of destruction of channels, segments chaos, chaotic opening and other chaos have been put an end.

4. To strengthen the irrigation project management, the irrigation project is changed to "public goods" and "quasi-public goods", the major group is responsible for management and maintenance of “branch” drainage, dou drainage is managed by several households. Prior to the establishment of the Association, water conservancy projects are built by the national investment, water management department should be responsible for the maintenance and construction of the project, therefore, farmers are indifferent to maintenance works, not enough measures for water-saving technologies. After the establishment of the Association, the quality of the channel is improved, project management facilities linked to their own interest .In policies we adopt the measures of sub-management and responsibility, so that the farmers actively participate in project management. Utilization coefficient of irrigation water is also greatly enhanced.

5. Saving the major labor of the family, to play the women status, the result of water-saving is significant. Before setting the Association, in general family the men are engaged in seeing, retaining water, irrigation tasks, for the past in the process of competition for water, women, the elderly are in disadvantaged status. When the association is set up, no need for competition, according to a irrigation water quota and irrigation methods and order, equality and fairness make women and the elderly participate in, increasing availability of irrigation water. At the same time, women are in charge of water management, they are patient, meticulous, and significantly effect of water-saving better than men. According to the survey, in the 18 water user, from men management to women can save more than 10% water.

6. The users actively pay water charges. If the association is a shortage of funds, users can pay in advance to make up lack of funds.

7. Conclusions

At present, the water rights of Changgang Irrigation Area are at the initial stage of reform, so many problems need to be improved and deepened. Although the article on the water property rights and the establishment of water market are expected to design in future, but the following questions need to be explored in depth:

In the irrigation areas, land expropriation of other public facilities is not to take part in the form of shares, but one-time low-cost compensation, which is not fair for long-term farmers’ land use rights. In the modernization construction, if farmers drive real benefits and long-term gains, it is necessary to transfer farmers’ land and long-term investment dividends.

The role of water associations is too narrow, so it should be extended to other community-based management and major activities. If occurrences of major natural disasters, in the process of collective relief, the collective construction of mitigation projects, and drought resistance, water associations should play its role. In particular, some efficient water-related activities, the association should be actively involved.

The field management of women needs to be further mobilized. Practice has proved that, in the management of irrigation systems, the status of women is all the more important. Engaging in the field water management, women have more advantage than men for water-saving methods and the extent of careful awareness. Moreover, the participation of women in water management, not only reflects gender equality, more importantly, water conservation and water efficiency is greatly enhanced.

Water management associations sometimes conflicted with the local government, farmers in a dilemma. First, farmers’ burdens are still heavy. The officials of township government are too many, so small-scale peasant economy can not support the huge superstructure. Second, the township government has too much power, especially in control land, and sometimes penetrated into private affairs. Leading to excessive force asymmetric with narrow tax source, the relationship between farmers and the public servant is feed and fed relationship, not service and serviced relationship.

The property rights reform of irrigation area should focus on three relationships. First, the state-owned assets and the transfer of property rights (define ownership, sell the management right; define the operator's the dispose right of assets invested; define redistribution of benefit of national capital); Second, the tenant's pursuit of profit and the burden of farmers; Third, the interests between he tenant and irrigation area staff.

In the near future, the water rights transfer of irrigation area is mainly short-term, focusing on cultivating different households, within the same irrigation area, transfer of water rights, because short-term trading is relatively simple and easy organization. Long-term transfer, particularly the external long-term circulation of irrigation water right, directly determines the long-term investment in water conservancy construction. Therefore, it is necessary to cultivate operating companies of water conservancy facilities.

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Eco-agriculture and Agricultural Sustainable Development Strategy

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Abstract: Eco-agriculture is a main characteristic of modern agriculture, it is vital to high-speed and efficient development of Chinese agriculture, it is also a fundament and premise of Chinese agriculture modernization and sustainable development. The result of eco-agriculture demonstration county construction shows that a comprehensive program, design, management and enforcement of eco-agriculture in a certain representative county area can realize the sound circulation of two systems in both local environment and rural economy. It is, therefore, to reach the unity of economic benefit, ecological benefit and social benefit and perform the function of radiation and, thus, to push Chinese eco-agriculture in an all-round way.
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Key words: modern agriculture; eco-agriculture; sustainable development

1. Introduction

The development of agriculture has been had the history of ten thousand years. It has experienced the primitive agriculture, traditional agriculture and modern agriculture. The long history of agricultural development has been breeding the development of mankind's civilization. People, however, confined themselves to cognitive ability and pressured by the population growing, have done so many that had disobeyed the objective law such as the development of economy is the high price to pay for sacrifice resources and environment. Thus, it has been revenged and punished by nature violently. Entering into modern agriculture, that is "the petroleum agriculture" especially, global ecological crisis caused by resources damage, environment pollution and in shortage in both grain food and energy resources is getting from bad to worse. The development of agriculture is facing new trouble. To be lifted out of trouble, America raised "organic agriculture" for nearly half a century. Western European countries put forward" biology agriculture" and the third world countries also advanced "fine agriculture". Europe, America as well as Asian countries put forward eco-agriculture in narrow sense. All these are to study new ways of agriculture development actively.

2. The development of eco-agriculture in the world

Having been had beneficial experience in many countries of the world, many "alternative agriculture" developed slowly and cut down the production and benefit caused by resources and environmental protection, reducing or refusing petroleum energy input. Eco-agriculture, however, drew the elite of traditional agriculture and modern agriculture. It raises productivity constantly in the meantime protect the harmonious development of biology and environment. Eco-agriculture has a tenacious vitality and a broad development prospects as it is a newly-typed agriculture production system with high efficiency and steadiness. In 1981, English agronomist Worthington M. defined eco-agriculture as small type agriculture in which it can be maintained in itself, low input and has vitality in economy. It is also accepted in environment, ethics and aesthetic. The main idea is to put agriculture on the basis of ecology. But there are also some extremes practice that chemical substance was prevented from being used in agriculture. So that was called "narrow sense" eco-agriculture. Instead of western countries, China is the source of true and comparatively complete eco-agriculture theory and technology. Followed by the traditional and petroleum agriculture, China's eco-agriculture is a new typed agriculture model of which people and nature developed harmoniously against China. Eco-agriculture of China is a systematic engineering system in which according to ecological theory and ecological economics law to design, assemble, adjust and manage the agricultural production and rural economy according to different places and areas. It demands the combination of development of farming with multi-economic crop production; and the development of grand agriculture with the secondary industry，tertiary industry and also the combination of farming with forestry, animal husbandry, side-line production as well as fishery. The sound circulation in both ecology and economy and also the unity of economic benefit, ecological benefit and social benefit are formed by human design ecological engineering, coordination development with contradiction of environment, resources utilization and protection. It absorbs the elite of China's tradition and modern agriculture and does not refuse the moderate input of chemical fertilizer as well as pesticide. It utilizes and protects the natural resources rationally and maintain ecological system moderately both in strong substance circulation and energy flow with the characteristics of high production, high benefit and less pollution: eco-agriculture stressed the comprehensive and coordinated increase of economic, ecological and social benefit. These will unit agriculture production, permanent utilization of resource and effective protection of environment, so that China's agriculture, rural areas can be directed into the track of persistence, steadiness and harmonious development.

3. Sustainable development has been a common strategy of world economy and social development

In 1983, the United Nations founded "World Commission on Environment and Development (WCED)", in1987, the committee put forward global policy of "turning into sustainable agriculture in 2000 firstly". In 1991, the United Nations Grain Food Organization with Dutch government held the conference of international agriculture and environment. The conference passed renowned *"Den Bosch Declaration"*. In 1992, the United Nations held the conference of international environment and development of which passed *"21st Century's Agenda"*. It clearly put forward " the sustainable development strategy", that is, the development satisfied not only the present needs but also not to weaken the descendant that satisfy the ability of needs. In 1983, China clearly put rationally use natural resource to keep well ecological environment and keep strictly control population growth as the three major premises together for China's agriculture development and rural area's construction. In 1992 China first made *"China's 21st Century's Agenda-China's 21st Century Population, Environment and Development"*. In 1996, China in *"the Ninth Fifth Program and Long-range Target Outline of National Economy and Social Development"* definitely put forward the science and education and sustained development strategy has become the radical starting-point of China's agriculture and rural area development. For 20 years, China's eco-agriculture development has gotten great achievements and preliminarily formed the system of eco-agriculture theory instruction model distribution, technology, construction and protection. The development significance of eco-agriculture direction follows by:

(1) Eco-agriculture is one of the characteristics of modern agriculture and the key of agriculture sustainable development

It's a primary direction for the modern agriculture development that eco-agriculture as a modern agriculture development model different from traditional agriculture production type. It especially emphasizes the protection and improvement of natural resources ecological environment of which agriculture production depend on. Based on this, rationally use ecological environment and natural resources, rationally arrange agriculture productive forces so that agriculture production with resources, environment as well as relevant industries harmonious development can be realized. Thus, not only can production efficiency be increased, but also through the constant improvement of ecological environment, ecological superiority may further the rational use and appreciation of agriculture resources, maintain ecological balance and therefore realize the sustained development of agriculture economy.

(2) Development of eco-agriculture can help to promote modern agriculture development and ensure grain safety

Eco-agriculture construction always put grain production as the more important place and also put grain production development on comprehensive industries combined with many industries of rural economy. Thus, efficiency can be improved while developing grain production. On the other hand, the fields' quality can be improved through developing grain production. Eco-agriculture demands us of nourishing land by cultivating them, in the meanwhile pay attention to protecting fields' resource, so that the fields can get more and more fertile and better by using. This is an agricultural ecological economic principle of combining fields' resources utilization, nourishment and protection together. Such the utilization of organic fertilizer and crops straw returning back to fields, crops rotation, planting leguminous plant and green manure and the measures of planting different crops in one plot of fields may renew soil and therefore improve the fields' productivity. By actual test, after constantly using methane manure for 3 years, the organic in soil containment increased 0.39 percent, the whole nitrogen increased 0.05 percent, hole gap increased 6.6 percent, soil microbe was active and drought resistance as well as water-saving ability was improved. By statistics after breaking straw into pieces and returning back to fields, around 30-40 percent of nitrogen could be found in the soil, phosphorus and potassium containment was as high as 70 percent. By test, edible bean crops contains nitrogen fixation quantity 75-105kg per hectare, apart from self-use of nitrogen itself, 2/3 of nitrogen still maintain in soil and thus improved the soil fertilizer supply.

(3) Development of eco-agriculture may benefits increasing farmers' income

Instead of arbitrarily spoil natural resources people depended on, eco-agriculture emphasizes maintaining and improving it. While constantly improve agricultural products quantity and quality control production cost. Stop changing and spoiling natural environment by human being so that agriculture protection may acquire sustained development. This, however, doesn't mean returning back to the natural economic state of primitive agriculture. Build up ecology, ecological economics and other eco-agriculture based on modern science and technology research achievements may better satisfy people's demand of modern society for quality, quantity, variety and others, so that the farmers may increase their incomes, thus this is a win-win situation for both consumers and suppliers. Generally speaking, the market price of agricultural products from farmers who engage in eco-agriculture, their sales volume is two or three times higher than normal ones and their production cost is much lower for the reason that eco-agriculture demonstration county construction practice based on the design methods of eco-agriculture model. In this way the utilization of fertilizer and pesticide had decreased greatly and their agricultural cost had also been much lower. And that development of eco-agriculture facilitates combining many industries, such as fish breeding and poultry raising, cultivation together so that agricultural economic efficiency can be raised, therefore farmer's income channel can be widened.

4．China's eco-agriculture demonstration county construction achievement and significance of enlightenment

Through the construction of eco-agriculture demonstration county, not only can ecological economic development in rural areas be pushed, but also the massed be freed from the expropriation management thinking and traditional small farmer’s mentality, the massed be armed with new values so that spiritual motive power for building of a new countryside is provided.

First of all, eco-agriculture demonstration county construction may improve surroundings ecological environment and make people live in a good ecological environment and also harmonious environment for both people and nature. Take Dongguan city for example, through eco-agriculture construction these years, fruit trees coverage rate is up to 50 percent in farms with green shadow from fruit trees and villas against them, breeze blows gently just like an elegant Peach Garden.

Second, eco-agriculture demonstration county construction may raise farmers' scientific cultural quality. Eco-agriculture demonstration county construction pay more attention to training work, for example, the first training work for eco-agriculture demonstration county construction was held during 1994-1998, from then on, 1120 classes of training were held and one hundred and sixty thousands people were trained. Through all kinds of training, not only can the farmers’ abilities of turning scientific knowledge into nowadays productive force be improved, but also their sense of admiring science, relying on science and technology. Enforcing eco-agriculture will promote to adjust industrial structure and make labor forces transfer from just cultivation in the fields to other industries, such as all kinds of new technology and knowledge intensive work so that gradually change farmers' production and living condition. In the process of eco-agriculture construction in Jingshan County, the labors' quality has been improved notably, the fields in getting rich in rural areas goes from low level to higher ones. There are more than 1000 farmers in the county have acquired middle and junior technique professionals, 2/3 of the labors have mastered one or two management practical technique or eco-agriculture knowledge. With improving qualities, farmers could look for way to get rich in fields of high technical production and outside conventional agriculture, labors could gradually transfer to the secondary and tertiary industry.

In the end, developing eco-agriculture can promote to improve rural area's environment and living quality. Developing eco-agriculture can not only mean the changing of agriculture production model but also have the great influence to rural area's living ways. Mankind faces more pressures made by ecological problem than before. Eco-agriculture construction will improve farmer’s living environment, influence or change their living ways and lead China's building of a new countryside to the correct way.

Eco-agriculture demonstration county construction may lead county area's agriculture productive economy to a rational ecological way to promote clean village appearance. Eco-agriculture demonstration county construction may solve the problem of dirt, disorder and mess within the productive living unit, the most marked characteristics are to recycle using energy and substances from crops through sunlight. The result is to get the maximum production in the less land, less space area, shorter time and the least drainage rubbish of environment. For human and animal's excrement, crop straw and biological rubbish especially, eco-agriculture may utilize rationally for multi-levels and multi-ways of all these. The procedure form of reproduction process follows as: material-product-waste materials-materials. Any of each productive process is the material of another productive process, thus the waste material in rural area has become resources and combined pollution prevention with agricultural increasing efficiency and farmer's increasing incomes. The biogas tank construction, especially, plays a button function of importance in clean village appearance. If the construction of biogas tank combines with the sty, kitchen and toilet changing together, people as well as animals excrement and living polluted water flow into the biogas tank to have the anaerobic ferment treatment, so the parasite ovum and partial germ can be killed to elementarily reach the standard of excrement harmless, the situation of people and animal living together can be changed and also decrease the disease of people-animal having together. "The backwards condition of smoke brings tears to eyes by chipping sticks for meals and excrement water as well as mosquitoes and flies everywhere in the yard will also be changed. All in all eco-agriculture construction embodies the traditional ideas of nature and human are harmonious, for it provide us with rural scenery of mountain water and quiet comfortable living environment. The ecological and living environment once were destroyed will evidently improve with deeper construction of eco-agriculture model, village appears tidy, everything is full of new life and the villages with the nature nearby combine perfectly.

5．Conclusions

With the twenty odd years' development, the Chinese modern eco-agriculture reveals great vitality. The practice proved: eco-agriculture construction can promote agricultural production development, increase peasant's income. It benefits to economize on energy resources, protect ecological environment and increase agricultural sustained development ability. It can promote agriculture to develop deeply and broadly so as to promote the whole quality of agriculture. As comrade Wen Jiabao said: the 21 century is the key historical stage to realize our agriculture modernization, the modern agriculture should be the effective eco-agriculture. Therefore, it is not only the farmer's survival base and development essence, the potential exist and charm show of agricultural steady development but also the target and long-term countermeasure of building of a new countryside and ecological civilization to promote eco-agriculture development continuously and protect fields and gardens sight and mountains-and-waters beautiful scenery of village during the strategies of the building of a new countryside and ecological civilization.

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