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A STUDY ON ENERGY FLOW OF THE CROP GROWING SUB-SYSTEM IN GUANGDONG

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ABSTRACT

On the basis of the data collected from various fields , the energy input-output state in the crop-growing sub-system in Guangdong is estimated and analyzed. Results show that the input of the artificial supplementary energy is approximately 201×10^5Kcal/ha.year; the output of the agricultural products and by-products energy is about 953×10^5Kcal/ha.year and the input and output ratio equals 1:4.73. Measures for improving productivity and speeding up the development of agricultural mechanization in Guangdong are eventually suggested.

1. INTRODUCTION

In China, the investigations on energy flow in agro-eco-system started in early 1980's, but stagnated up to the mid-late 1980's due to many reasons. Although some iniquities have been made into energy flowing state in small regions in Guangdong, no study in big region or in the whole province was reported. Therefore, beginning from last year, the author continued to further work on the subject and probed into the new trend of energy flowing in the agro-eco-system of Guangdong in the recent years so as to provide scientific and sound basis for the police-making bodies and producers on their energy input and production planning.

2. METHODS

In this study, systematical analyzing methods are used to analyze and assess crop production in Guangdong in the field of energy flowing.

On the basis of the collected data, statistical analysis and calculation are made. According to the international standard, the method used is that converts the materials involved in the process of agricultural production (including farm machinery, fossil fuels, chemical fertilizers, pesticides, electricity, man and animal power, organic manures and seeds) into thermal unit which is expressed in Kcal. Meanwhile, agricultural products and by-products are also converted into thermal unit.

3. RESULTS AND ANALYSES

After making statistical analysis and calculations, the author has obtained the following results (see Table 1. and Table 2.).

3.1. Sunshine energy utility

Crop production is the principal part of the agro-ecological system. Green plants, through photosynthesis, transform sunshine energy to chemical energy of the organic matters stored in the plant body. So sunshine energy utility is one of the important standard to measure ecological effects. In line with our calculation, all sunshine energy casting over the fields of the whole province is approximately 117558×10^5Kcal/ha. year. Energy output of agricultural products and by-products is about 953×10^5 Kcal/ha.year. Through calculation, sunshine energy utility is about 0.81%, which is 0.41% higher than the average of 0.4% in the whole country in 1991, and 0.395% lower than Xiangyou Sagarcare region in Fujian province in 1980. This shows that there are still great potentials in sunshine energy utility in the crop-growing sub-system in Guangdong.

3.2. Input of the artificial supplementary energy

Agro-eco-system is a complex system. Its self-regulation and stability are believed to be very poor. Therefore, sustaining its existence and development either needs input of the sunshine energy (ecological energy) as natural eco-system does, or needs various kinds of inputs of supplementary energy (artificial energy) .As industrialization progresses, it is the artificial energy that surely plays an even greater role in the system. In Guangdong, there are several characteristics in energy flow in the crop-growing sub-system:

3.2.1. A greater density of the artificial supplementary energy flow with 201×10^5 Kcal/ha.year,in which the industrial energy flow density is about 107×10^5 Kcal/ha.year, accounting for 53.26% and the biological energy flow density approximately 94×10^5 Kcal/ha.year, accounting for 46.74%.The ratio is equal to 1:0.88.

3.2.2. In the industrial energy , ranking first are chemicalfertilizers, making up to 76.88%. Next is the electric power, about 19.13%. Farm machinery, farm chemicals and fossil fuels are 3.98%, 0.0033% and 0.00065% respectively.

3.2.3. In the biological energy, crop stalks returned to the fields account for 36.75%. Human and animal excreta only 0.0004%. Man and animal power 11.6%, 11.26% respectively.

3.3 Energy output of agricultural products and by-products in the fields

The product energy output in this sub-system is higher, 953×10^5 Kcal/ha.year, in which the staple products energy makes up to 63.94%, by-products energy and the total output of products energy and output of the staple products energy equals to 1:5.68.

4. DISCUSSIONS AND SUGGESTIONS

4.1. Adding inputs of materials and energy enables the sub-system to improve its productivity and its energy transformation efficiency. First, this shows the sub-system has become more efficacious. Because the implementation of the rural economic reforms and the family contract responsibility system linked with

output, has effectively brought farmer's enthusiasm into full play, the output of the artificial supplementary energy, particularly chemical fertilizers, is greatly increased. In the light of statistics, applied amount of chemical fertilizers increased to 697.05 Kg/ha. in 1991 from 197.55 Kg/ha. in 1978. Secondly, it indicates the sub-system structure is more rational, and it's function could be brought into full play.Since 1978, Guangdong has adjusted production structure, and greatly developed "three high" agriculture (high quality, high output and high profits) so as to raise land productivity and energy input-output ratio by a big margin. For, instance, Guangli town in Gaoyao county of Guangdong province is a typical region for agricultural production. It's energy output per Ha. in 1983 was about 801×10^5 Kcal, and the whole province in 1991 increased to 953×10^5 Kcal. Energy input-output ratio in Guangli town was 1: 2.34, while in Guangdong it cames to 1: 4.73. The latter is 1.03 times higher than the former.

4.2 The input of machinery power energy decreased slightly while the animal power energy increased (see Table 1. and Table 3.). Machinery energy is about 4×10^5 Kcal/ha.year for the whole province, but in Guangli town it is 10×10^5 Kcal/ha.year, even though the total power of farm machinery in Guangdong increased to 13,397 million watts in 1991 from 4,897 million watts in 1978. Land ploughed by tractors decreased to 910,870ha./year in 1991 from 120,480 ha./year in 1978. This shows no difference between investigation and statistics data. But the input of animal power increased to 11×10^5 Kcal/ha.year in 1991 from 5×10^5Kcal/ha.year in 1983. What is the reason for that? Because the family contract responsibility management has made the cultivated areas much smaller and more scattered. Ploughing the small plot by draught animal is more convenient than by tractor. In addition, the increased machine power is mainly used for transportation and processing. So generally speaking, the pace of mechanization of farm work is still slow. For this reason, one of the important projects for deepening the rural reforms is to further resolve the small and scattered land problem in order to develop the moderate scale management and push forward the mechanization of agriculture.

4.3 The amounts of applying chemical fertilizers increased and organic manures applied turned out to have decreased (see Table 1. and Table 3.). The former is about 82×10^5 Kcal/ha.year, an increase of 32×10^5 Kcal as compared with that in Guangli town in 1983. The latter (including human and animal excreta, crop stalks) is about 35×10^5 Kcal/ha.year. This is due to the economic profits which stimulate farmers to apply chemical fertilizers more willingly. Beside, applying chemical fertilizers needs less manpower. According to our investigation, total workday per ha. amounted 1,605 work days (8 hours in one work day) in 1979, but in 1991, it decreased to 780 work days. Although some investigations in China have indicated more chemical fertilizers and pesticides would destroy the soil structure, pollute agricultural products and environment. Agro-eco-system in Guangdong, at present and in the coming year, still needs more input of non-organic matter energy which is essential for achieving higher productivity. Surely, we must inherit and develop free tradition of China's agriculture, and more input of the organic matter to the field in order to establish a modern eco-agro-system

with high yield, stable production, good quality, low cost and high profits as well as no pollution.

5. CONCLUSIONS

In this paper, estimates and analyses are made on the energy flowing state in the crop-growing sub-system in Guangdong, China. The main results of the study are as follows:

(1). There are great potentials in sunshine energy utility in Guangdong.

(2). There is a high density of the artificial supplementary energy flow with 201Kcal/ha.year.

(3). There is also a high energy output density in the fields with 953×10^5 Kcal/ha.year.

(4). More materials and energy must be added to the field to improve land productivity and energy transformation efficiency.

(5). More organic matters should be added to the fields in order to establish a modern eco-agro-system with fine cycling.

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TABLES

Table 1. Energy input in the crop-growing sub-system in Guangdong in 1991

Items	Total energy input (10^{12}Kcal)	Energy flow density (10^{5}Kcal/ha.year)
1.Sunshine energy	445850.52	117558.75
2.Artificial supplementary energy	59.691	201.350
(A) Industrial energy	26.106	107.240
a. Farm machinery	0.0720	4.27250
b. Fossil fuel	0.0002	0.00070
c. Chemical fertilizers	20.845	107.238
d. Pesticides	0.0009	0.00350
e. Electricity	5.1876	20.5176
(B) Biological energy	33.585	94.1149
a. Man power	2.7610	10.9200
b. Animal power	2.6601	10.5950
c. Excreta	10.173	0.00040
d. Stalks	8.7449	34.5870
e. Seeds	9.2468	38.0125

Table 2. Energy output in the crop-growing Sub-system in Guangdong in 1991

Items	Total energy output (10^{12} Kcal)	Energy flow density (10^{5} Kcal/ha.year)
Total output	241.0428	953.347
1. Staple products	154.1134	9.53310
2. By-products	86.92940	343.814

Table 3. Energy Input and Output of the Crop-Growing Sub-system in Guangli Town of Gaoyao County, Guangdong in 1983

Items	Energy flow density (10^5 Kcal/ha.year)
1. Sunshine energy	479706.5
2. Artificial supplementary energy input	342.8063
(A) Industrial energy	95.29360
a. Farm machinery	10.15370
b. Fossil fuels	52.82270
c. Chemical fertilizers	50.29000
d. Pesticides	1.646200
e. Electricity	26.08710
(B) Biological energy	247.5127
a. Manpower	10.78260
b. Animal power	5.040400
c. Excreta	64.15280
d. Crop Stalks	129.8008
e. Seeds	37.73610
3. Total energy output	802.1388
(A) Staple products	490.6429
(B) By-products	311.4959