Effect of EM on Crops and Animal Husbandry in China

Li Wei-jiong[1], Ni Yong-zhen[1], Hiroshi Umemura[2], Sun Qin-long[3]
[1]Beijing Agricultural University, Beijing, China.
[2]International Nature Farming Research Center, Japan.
[3]Handan Agricultural School, Hebei Province, China.

Abstract
EM effective microbe is a land of new compound microbial inoculum developed by Prof Teruo Higa, the Ryukyus University, Japan and it has various functions to improve the production of agriculture and animal husbandry, increase resistance to disease and clean the environment. It has been applied and spread in more than 40 countries and areas in the world and gained greater attention by the wide peasants, agricultural scientists and all social circles. Since 1992, we have cooperated with the Japanese International Research and Developmental Center of Natural Farming carried out the applied research of the EM effective microbe on the Chinese agricultural and livestock production and gained the preliminary result. This article summed and analyzed the experimental results in recent three years.

Key words:
EM effective microbe applied effect research to increase the output, resistance to disease and clean the environment.

Introduction
Effective microorganisms (EM) is a mixed microbial inoculum developed by Prof. Teruo Higa of the Ryukyus University, Japan in the early eighties. Compared with the present microbial inoculum, its main features are the complex composition, the application of the special fermentation technology to mix the aerobic microorganism with anaerobes according to certain proportion, to culture various microbial communities, and to develop a complex but stable micro ecological system. It may be sealed tightly and stored for six months to one year under the normal temperature. Because of its stringent selection, it is almost composed of the beneficial microbes that survive the acidic condition below pH 3.5. The useful materials produced by various microbes during their growing process and their secretions, form the substrate and raw material for their growth and symbiotic relationship. These microbes were able to carry out various functions that affect animal husbandry, crop production and environmental protection.

The cooperation with the International Nature Farming Research Center of Japan was started in 1992 to carry out research on the effect of EM on agriculture production and animal husbandry, the mechanism of its action, and to provide reference for further research, application and extension of EM in China.

Effect of EM on Crops
Experiments were carried out in pot culture, greenhouse, and field plot at Beijing Agricultural

University, and Pinggu County and Quzhou County Summary of the results are as follows:
The seed soaked with EM solution has better germination and growth during the seedling period. The pot culture experiment showed that the germination and growth of corn, pea, rape, radish and amaranth, were better compared to control when soaked with EM and manure. During 20-30 days after their emergence, the fresh weight per plant increased 13.0%, 93.8%, 51.2%, 14.5% and 71.4% respectively while the biomass (dry weight) per plant increased 5.2%, 43.8%, 25.0%, 10.4% and 34.3% respectively compared to control treatment.

Tests in the greenhouse and protective ground showed that the spraying of EM increased yield of cucumber, eggplant and tomato, ranging from 3.5% to 15.1% (Table 1). For each crop, higher yields were obtained with higher EM concentration.

Table 1. The effect of EM on vegetables

EM con. (%)	Cucumber		Egg plant		Tomato	
	Yield (t/ha)	Increase (%)	Yield (t/ha)	Increase (%)	Yield (t/ha)	Increase (%)
0.2	92.85	13.8	23.2	15.1	55.03	2.6
0.1	88	7.8	22.4	11.2	54.31	1.2
0.05	85.25	4.4	20.85	3.5	54.06	0.8
Control	81.6		20.15		53.65	

Note: For tomato, no fertilizer was used for treatment 0.2% EM concentration, while the other three used chemical fertilizer.

In an experiment on corn and wheat, EM compost and traditional compost were compared to chemical fertilizer treatment. The compost were made of animal dung, crop stalk and weeds as the main raw materials, and EM were applied for EM compost, while the traditional compost was made of the same raw materials but without EM. Results showed that EM compost increased yield compared to traditional compost ranging from 9.1 % to 19.6%; with higher increases at higher rates of application (Table 2).

Table 2. Effect of EM compost to corn and wheat

Treatment	Corn		Wheat	
	Average unit yield (t/ha)	Increase (%)	Average unit yield (t/ha)	Increased than CK (%)
7.5t/ha EM compost	6.54	28.2	2.93	3.6
7.5t/ha traditional compost	5.54	8.6	2.63	-13.5
15.0t/ha EM compost	6.98	36.9	3.6	18.4
15.0t/ha traditional compost	5.84	14.5	3.3	8.6
Control*	5.1	0	3.04	0

Control : for corn = 0.3 t/ha urea, for wheat = 0.3 t/ha ammonium phosphate

Effect of EM on Animal Production

In these experiments, EM was used in the drinking water of poultry (broiler) and pig. The experiments were carried out at Beijing Agricultural University, Quzhou County of Hebei Province and Pinggu County of Beijing city.

The effects of EM treatment on broilers, raised from 8 to 56 days, are shown in Table 3. EM treatment increased weight, reduced meat to feed ratio and increased income (Table 3).

Results from EM treatment on layers showed that chicken treated with EM increase resistance to disease, reduce mortality rate, increase egg production and average egg weight rate (Table 4). The mortality rate was decreased by 35.5%, especially at the earlier stages, where a reduction of 80% and 58.6% was observed during 1-6 weeks and 7-20 weeks respectively. Other positive effects of EM treatments include slightly advanced laying period, improved laying rates (68% compared to 61.6%) average egg weight increased from 55g to 56.6g, and chicken weight increased to 9.12kg compared to 8.03kg for control.

Table 3. Effect of EM on broiler

Parameter	Treatment	
	EM	Control
No. of chicken	50	50
Weight of chicks (kg)	3.69	3.69
Weight at selling (kg)	90.85	88.3
Meat/Food ratio	2.05	2.26
Cost of chicks (Yuan)	100	100
Cost of feed (Yuan)	207.74	222.73
Total increase (Yuan)	427	415.01
Bet income (Yuan)	119.16	92.27
Income difference (%)	29	

Table 4. Mortality rate of layers treated with EM

Age	Parameter	Treatment		Difference
		EM	Control	
1-6 weeks	No. of chicken	500	500	
	No. of death	1	5	4
	Death rate (%)	0.2	1	80
7-20 weeks	No. of death	12	29	17
	Death rate (%)	2.4	5.8	58.6
21-57 weeks	No. of death	67	90	13
	Death rate (%)	13.4	18	14.4
1-57 weeks	No. of death	80	124	44
	Death rate (%)	16	24.8	35.5

The economic analysis of rearing 500 layers up to 401 days, showed that treatment with EM can raise income by about 3 Yuan per chick and the total economic benefit can increase by 28.5%, such that for 500 chicken the extra income can be more than 1500 Yuan (Table 5).

Table 5. Economic benefit of rearing layers

Parameter	Treatment	
	EM	Control
Income:		
Egg production (kg)	3,830.4	3,019.3
Unit price (yuan/kg)	4.4	4.4
Total income (yuan)	16,853.8	13,284.9
Cost:		
Feed (kg)	9,806	7,880
Unit price (yuan/kg)	1	1
Total cost	9,806	7,880
EM used (L)	5	
Unit price (yuan)	20	
Total cost (yuan)	100	
Net Income:		
(yuan)	6,947.8	5,404.9
increase (%)	28.5	
Feed to egg ratio	2.56	2.61

The use of EM in pig rearing also showed several advantages. In the experiments with 16, 20 and 50 pigs at different periods, results showed that in EM treatment the hog's skin and hair gradually turned to lustre, its growth was more even and growth speed was quicker. Within 4 months, the average gain per day per pig was 0.65 kg which was 70 g more than control treatment. The total gain per pig was 78 kg which was about 8 kg more than control or an increase of 11.4%.

Benefit of EM in Environmental Improvement

According to the research reports, EM not only improved growth of animal and plant, control pests and diseases, and improved the economic benefits, but it can also eliminate odour of animal dung giving an excellent ecological environmental benefit. Feeding the layers with EM resulted in a lower concentration of ammonia gas from 87.6 ppm to 26.5 ppm, a reduction of 69.7%.

Similarly, in the pig experiments, the use of EM in feed for 5-7 days, in general the bad odour and fly number were reduced. These effects are welcomed by the users especially during hot weather when bad odour and flies are at their worst and fly numbers were reduced.

The Mechanisms of EM Effective Microbial Action

From the above experimental results, it is obvious that EM has various functions of accelerating the growth of plant and animal, improve their resistance to diseases increase the output, and reduce bad odour. It may be one of the best microbial inoculum to be used in agriculture production and animal husbandry. In order to know its mechanism and cause of its

functions, a series of tests researches were conducted.

Research results showed that the rhizosphere of high plants is the most active area and the microbes, such as bacteria, actinomyces, fungus, algaes, protozoa, etc. gather around the plant root system in great numbers. They can turn the organic matter in the rhizosphere into inorganic elements and compounds which provide nutrients for the plants. They are the main resources of the needed inorganic nutrients of plants. After EM was applied to the soil, the effective microbes around the rhizosphere increased (Table 6) which accelerate the decomposition of the organic matter in the soil and made plant nutrients more available. Table 7 shows that compost treated with EM has higher N content (+27.9%) compared to conventional compost. When these two kinds of compost were applied to soil during the crop growing season, the analysis of the samples showed that the available nutrients in the upper soil layer (0-20 cm) were similarly increased (Table 8).

Table 6. The influence of EM compost on microbial content in the upper (0-20 cm) soil layer (1994)

Parameter	EM compost	Conventional compost	Chemical fertilizer
Bio-carbon content (mg/100g soil)	2.24	1.13	2.01
Bio-nitrogen content (mg/100g soil)	1.47	0.06	0.66
Bio-phosphorus content (mg/100g soil)	5.08	0	1.01

Table 7. Available N in EM compost and EM compost (1993)

Sampling No.	Conventional Compost (ppm)	EM compost (ppm)
1	1830.5	2347.8
2	1847.8	2332.5
3	1830.3	2363.4
Average	1836.2	2347.9
Difference		+27.90%

Table 8. Analysis of soil nutrient (July-Sept., 1993)

Treatment	Organic matter (%)	Available P (ppm)	Alkali hydrolysis N (ppm)
7.5 t/ha EM compost	1.05	13.6	105.9
7.5 t/ha conventional compost	0.98	10.2	98.2
15 t/ha EM compost	1.06	16.6	105.8
15 t/ha conventional compost	1.05	11.7	95.5
0.3 t/ha urea	0.96	9.8	114.4

The increase of effective microbes in the rhizosphere not only raises the content of the

available nutrients but secretes more vitamins and growth hormones, which further improve plant growth. These may raise the photosynthetic ability of the crops, and thus increase the output. Table 9 shows the influence of EM on photosynthetic area (leaf area) and corn yield. Table 10 shows the influence of EM to the apparent photosynthetic rate of the egg plant leaves and yield.

Table 9. The influence of EM compost on corn leaf area and yield

Parameter	EM compost	Conventional compost	Chemical fertilizer
Maximum leaf area index	3.54	3.07	2.41
Weight/100 grain (g)	23.1	21.4	21.4
Yield (t/ha)	6.98	5.84	5.1
Increase over con. Corp. (%)	19.5		
Increase over chem. Fert. (%)	16.9	14.5	

Table 10. The influence of EM on egg plant

Concentration of EM Solution (%)	Rate of apparent photosynthesis Of leaf CO_2 ($mg.dm^{-2}.hr^{-1}$)	Yield (t/ha)	Yield increased (%)
0.2	19.18	23.2	15.1
0.1	18.54	22.4	11.2
0.05	16.92	20.85	3.5
Water (control)	14.96	20.15	0

For more than 100 years, feed with microbes has been used to cure the diseases of animal and poultry. Many beneficial microbes, such as photosynthetic and lactic acid bacteria, contain not only protein and amino acids but also rich in vitamins. They also contain carotenoid pigment, coenzyme Q10, anti virus material, growth improving factor and active materials to raise the body's immune ability. Therefore, they may be used as the foodstuff additive to strengthen the disease-resistant ability and improve the growth of animal, poultry and fishes.

EM contains many beneficial microbes such as photosynthetic bacteria, lactic acid bacteria and saccharomycete. There are both oxybiotic microbes and anaerobic microbes. After entering the body of animal as foodstuff, these microbes may multiply rapidly and they not only check the growth of other pathogenic microbes, but also form the normal microbial group within the host body to produce the main vitamins for the host, provide nutrient and prevent the attack of the malignant bacteria.

After the microbes enter into a micro-ecological system of the animal body, whether they can survive, propagate, become normal microbial group to form a stable micro-ecological system with the ecological balance among the microbes, host and environment, depends on whether both microbes and host have the setting-in conditions. In general the animal and poultry easily accept external beneficial microbes at their early stages of growth. In the course of these experiments, it was found that the best benefit was obtained when EM treated feed was used in young chicks.