Effective Microorganisms (EM) Technology in Bhutan

G.B. Chettri[1], Thinley[1], and Chado Temzin[1]
[1]Ministry of Agriculture, Thimpu, Bhutan.

Abstract

EM technology was introduced by the Ministry of Agriculture of Bhutan in 1993 with the objective of improving the effectiveness of the current organic farming. Initial trials on EM were started in May, 1994 on horticultural and field crops, and livestock at the national research centres and selected farmers' fields. Positive results of EM application were observed at several sites. Current ongoing programmes include long term Nature Farming (rice, wheat, maize, mustard. vegetable, fruit crops) using EM at RNRRC. Bajo; effect of EM on livestock and poultry, pot experiments on crops; Preparation of EM Bokashi from crop residues and kitchen wastes; effect of EM on sanitation (slaughter houses, recycling city wastes and public toilets).

Results of preliminary experiments on rice, maize, vegetables, and fruit crops have confirmed the usefulness of EM in promoting crop growth and yield. Positive results have also been obtained on preparation of EM Bokashi within 7-10 days, and by using EM on livestock.

Introduction

Located in the Eastern Himalayan zone of Asia, Bhutan is an isolated country bordered on the North by China (Tibet) and on the East West and South by India. The country has a rugged mountainous terrain rising from an elevation of about 160 meters above sea level in the south to more than 7,550 meters in the north. The abrupt changes in attitude are accompanied by dramatic climatic changes and great biological diversity. The rugged terrain imposes great restrictions on the scope for agriculture development.

Agriculture is the prominent sector, providing 45% of GDP and livelihood for over 85 % of the population. The agricultural economy is predominantly subsistence oriented. Bhutanese farmers have a long cultural tradition of living in harmony with the natural environment. Farming systems are largely organic in nature with abundant utilization of farmyard manure/compost. The use of chemical fertilizers and pesticides is minimal. Farmers (including perennial fruit and fodder trees), keep several types of livestock, and use forested areas to provide fuel, forestry constitute the closely integrated components of the mountain farming systems in Bhutan.

The Ministry of Agriculture is mandated to improve the well being of the people of Bhutan, to promote national self reliance, and to conserve the natural environment through the sustainable development of arable land, livestock and forestry resources of the country. Bhutan's strong commitment to enhancing food production while conserving the environment and natural resource base poses the greatest challenge.

For sustainable farming systems it is important to develop techniques that promote effective and efficient use of natural resource base. EM technology was introduced by the Ministry of

Agriculture with the objective of improving the traditional organic or nature farming.

This paper discusses the activities undertaken concerning the testing and promotion of EM Technology in Bhutan.

EM Technology in Bhutan

The concept on Effective Microorganisms was introduced to the Ministry of Agriculture (MoA) in 1993. During March-April 1994 the MOA sent two teams to study and receive training in EM technology in Thailand. The first group was led by the Secretary, Ministry of Agriculture and included senior research scientists. Intensive hands-on training on the application of EM Technology was received at the Kyusei Nature Farming Centre at Saraburi, Thailand. So far several study groups consisting of planners, administrators, researchers and extensionists have received training at the Kyusei Nature Farm in Thailand.

The first supply of EM solution brought by the first study group was used to conduct preliminary trials on horticultural and field crops, preparation of EM Bokashi at national research centres and selected farmers fields. Positive results of EM Application were observed in a few sites.

Studies on EM Technology

Systematic studies have been initiated with the objective of close monitoring. the efficacy of EM under Bhutanese conditions. Major on going work includes: Long term nature farming trial using EM, role of EM on crops, livestock and poultry, preparation of EM Bokashi from crop residues, forest litter, kitchen wastes, and effect of EM on sanitation (recycling of city wastes, use on slaughter houses, public toilets etc.). Long term experiments began only from 1994 and it is too early to draw concrete conclusions. Therefore, the presentation reports the progress on-going work an results obtained from some of the preliminary experiments.

Experiment 1: Nature farming using EM Technology

The objective of natural farming is to return to nature. It is a line with the philosophy of Mokichi Okada "respect nature and conform to its law, and allow living soil to exhibit is greatest potential abilities". EM is used to hasten the nature farming process and satisfy the above requirements.

A permanent plot for this long term study has been identified at RNR Research Centre, Bajo. Rice-based farming will be practiced at this centre and the crops include maize, various legumes, different tree species, and subtropical fruits. Inorganic fertilizers and pesticides will not be used. EM will be sprayed on all crops. Crop growth and yields from various crops will be determined every year. Soil health will also be monitored. The output of such a system is intended to be compared with that of an average farm under conventional practices. Inclusion of control plots without EM is still being discussed, Maintenance of strict control plots within the area appears to be difficult because of the migratory nature of the EM.

Results

Overall growth of rice during the year was very good. Yield was determined from 9 random samples of 5 sq m. In the first year, the average rice yield obtained was 8.7 t/ha. This is a very good yield which is comparable to the yield that could be obtained by using NPK fertilizers.

Maize yield was determined from six random samples of 9 sq. m. Average maize yield obtained was 6.3 t/ha. It also a good yield comparable to yield obtained from application of NPK fertilizers.

Experiment 2: Effect of EM Bokashi on rice yield

The objective of this experiment was to compare the benefits of EM Bokashi in contrast to FYM and NPK fertilizer. The trial was conducted at RNRRC Bajo. The following treatments were compared on large plots of 100 m square.

FYM 7t/ha
EM bokashi 7t/ha
NPK 70:40:30 kgs/ha

An improved rice variety IR 64 was used. Grain yields were determined from 3 samples of sq. m. plots (Table 1)

Results

EM Bokashi treated plots produced increased rice yields by about one t/ha (Table 1) which was comparable to that with chemical fertilizers.

Table 1. Effect of EM on grain yield of rice

Treatments		Grain yield (t/ha)	Plant height (cm)
T1	FYM 7t/ha	6.9	75
T2	NPK 70:40:30 kg/ha	6.2	82
T3	EM Bokashi 7t/ha	6.0	81

Experiment 3: Effect of EM on growth of maize

The objective of this experiment was to compare the effectiveness of EM with NPK, and FYM. The trial was established under screen house conditions at RNRRC, Bajo in August 1995.

Top soil, free of inorganic fertilizers and organic manure, was collected. The soil was mixed thoroughly and divided into 20 parts. Each heap of the soil was applied with the selected treatments replicated 5 times. The treatments were as follows.

T1 NPK (80:40:0 kgs/ha)
T2 EM fermented compost (Bokashi) (7t/ha)
T3 FYM (7t/ha)
T4 Control (0:0:0)

Each treated heap of the soil was put into perforated tins of 15 kg capacity. All tins were kept in a screen house. Maize seeds (variety Yangtshipa) were sown at the rate of 3-4 seeds per pot.

Adequate moisture was maintained in the pots to ensure germination. At 3-4 leaf stage, only one plant per pot was maintained and the rest were removed. In the NPK treated pots half N was applied at planting and the balance at knee height stage of the plants. Potassium (K) was not included since the soil at the station had adequate levels. Plant dry weight recorded after 110 days of seedling.

Results

Plants treated with EM fermented compost grew vigorously and were taller than those of the other treatments (Table 2). Use of EM fermented compost produced significantly taller plants as compared to control and NPK treatments. However, plant height of EM treated plants were not significantly different from those of the FYM treatment. Similarly, a higher dry plant weight was recorded in EM fermented compost and FYM treatments. Reasons for comparatively shorter plant height in the NPK treatment is not clearly understood.

Table 2: Effect of EM fermented compost on the growth of maize

Treatments		Plant height (cm)	Dry plant weight (g)
T1	NPK 80:40:0 (kg/ha)	141	210
T2	EM fermented compost (7t/ha)	159	230
T3	FYM (7t/ha)	146	230
T4	Control	134	155
LSD (P=0.05)		13.08	64.5
CV (%)		6.54	22.7

Experiment 4: Effect of EM on utilization of FYM in the growth of radish and mustard green

This trial was conducted at Simtokha, Thimpu (2200 m) in 1995. The following treatments were used in a completely randomized design with a plot size of 3 square meters.

T I FYM (2Kgs/Plot) as control
T2 FYM + EM Power
T3 FYIVI + EM Power + EM Fermented Plant Extract (FPE)
T4 FYM + EM Power
T5 FYM + EM Power + EM5
T6 FYM + EM5
T7 EM Bokashi + EM FPE

Results

The yield of EM treated plots were marginally higher than of the control plot (FYM alone). There is also a trend indicating a higher plant weight, increased root length and diameter due to supplementation of EM with FYM (Table 3). A trend similar to that of radish was observed in mustard green (Table 4). The EM treatments gave marginally yields compared to use of FYM alone. The effect of EM on soil enrichment will probably build over time. Therefore, significant effects on crop growth and yield will appear only after 2-3 years of continuous use.

This calls for properly designed long term trials.

Table 3. Effect of EM on growth and yield of radish

Treatment		Plot yield (kg)	Plant weight (g)	Leaves per plant	Root length (cm)	Root diameter (cm)
T1	FYM (control)	9.93	399	25	29	3.5
T2	FYM+EM power	10.90	512	20	30	3.8
T3	FYM+EMP+EM FPE	10.53	699	26	34	4.1
T4	FYM+EM FPE	9.93	532	23	31	3.8
T5	FYM+EMP+EM5	10.93	683	24	34	4.1
T6	FYM+EM5	11.97	537	22	31	3.8
T7	EM Bokashi+EM FPE	10.33	587	27	32	3.9
LSD value (P=0.05)		2.62	255	8.35	3.54	0.81
CV (%)		13.83	25.48	19.6	6.37	11.7

Table 4. Effect of EM on growth of mustard green

Treatment		Plot yield (kg)	Plant weight (g)
T1	FYM (control)	5.33a	146a
T2	FYM+EM power	6.43a	79a
T3	FYM+EMP+EM FPE	4.43a	108a
T4	FYM+EM FPE	6.06a	127a
T5	FYM+EMP+EM5	6.60a	95a
T6	FYM+EM5	7.00a	109a
T7	EM Bokashi+EM FPE	6.63a	75a
LSD value (P=0.05)		3.19	87.9
CV (%)		29.5	46.7

Experiment 5: Effect of different types of EM Bokashi on growth of mangoes

This study is being carried out at Baychu, Wangdiphodrang (1000m elevation) from May 1994. The following treatments were compared in a randomised complete block design with 3 replications.

T1 Manure Bokashi
T2 Rice Straw Bokashi
T3 Soil Bokashi
T4 FYM
T5 NPK 15:15:15
T6 Control

Different locally available sources of material were used to prepare Bokashi. The manure Bokashi contained a high proportion of cattle dung, while the straw Bokashi had high proportion of rice straw. The standard Bokashi preparation method was adopted. For each

treatment, 5 mango plants of the same size and age (2 years old) were selected. The site had a inherent problem of wilting-disease (suspected to be due to *Psendomonas mangifera*) and EM was also sprayed at the rate of 2ml/lit of water or fortnightly intervals.

Results

Quantitative data is not available at present. Nevertheless the observations made indicate positive effect of EM Manure Bokashi treated plants developed new vigorous flush. Plants with symptoms of the suspected disease indicated recovery. NPK treated plants had inward curling of young leaves and few twigs were withered.

Experiment 6: Effectiveness of EM in poultry broiler production

The experiments was conducted at Serbithanag, Thimpu. The main objectives were to observe growth performance, mortality trends, and control odour problems. A secondary objective of the experiment was to look at the inherent problem of coccidiosis encountered in broiler flocks.

The groups of Hubbard (Hubchix) day old chicks having an average weight of 40 gms were housed in two separate sheds, 100 meters apart. The control group consisted of 1004 chicks, while the experimental group had 225 chicks. The chicks were reared for 51 days. Feed and water was offered to both the groups were vaccinated with New Castle (Ranikhet) Disease vaccine and Gumporo Disease vaccine. The experimental group was given EM in drinking water and feed continuously. EM solution was applied in the ratio of one part EM solution (Expanded/reactivated) to 5000 parts of water/feed. The shed was sprayed using EM solution twice a week.

In the fourth week, it was observed that the birds in the control group showed comparatively slow growth resulting from lower feed intake. Therefore, this group was treated with codrinal, hostacycline, and furasol at recommended dosages.

Results

Table 5 reflects the overall comparative growth between the control and EM treated group. The growth of EM treated birds was observed to be much higher. On an average, over 600 live weight increase per bird was observed, due to EM.

Application of EM contributed to better (lower) feed conversion ratio (FRC) and cumilative lower mortality. Stool and litter samples were examined for oocyst count. Feacal and litter examination indicated lower oocyst counts towards the end of the experimental group can only be explained by he fact that EM has played analogous role.

One of the significant observations made during the trial was the disappearance of foul smell in the shed where the experimental group had been reared.

Table 5. Effect of EM on the growth of broilers

Observations		Control (without EM)	Experimental (with EM)
1	No. of chicks	1004	225
2	Initial chick weight (av)	43g	40g
3	Total feed intake (kg)	2757	767
4	Final number of birds	948	241
5	Final live weight per bird (kg)	0.970	1.625
6	FCR cumulative	3.1	2.2
7	Mortality % cumulative	6.4	5.8
8	Ocyts counts in litter per gms of sample:		
	-Initial	9664	3702
	-final	7303	5092

Other studies:

l. EM in livestock Rearing

In rurai areas, traditionally, cattle and pigs are usually reared in the ground floor of the house. Normally an offensive odour of the urine and dung is produced and the surroundings became unhygienic. There is a high incidence of files and the shed is often damp.

A study was undertaken to observe the effect of EM on minimising the offensive odour in the cattle shed and pig sty. A second objective was to prepare manure Bokashi using the bedding materials and fodder residues.

Two interested farmers were selected in Punakha in September 1994. One liter of EM in 300 liters of water was sprayed in their cattle shed and pig sty on a weekly basis for 3 months. The dung and bedding materials were used to prepare manure Bokashi.

Results

The offensive odour in the cattle shed and pig sty declined by the end of second spray. After the third spray, the odour was totally suppressed. The sheds were dry and the population of files were reduced by 90%. Good quality manure Bokashi was successfully prepared, Farmer cooperators were convinced on the usefulness of EM on livestock rearing and compost making.

2. Preparation of EM Bokashi

EM Bokashi has been successfully prepared at the research stations and farmers fields. Traditional FYM preparation takes over 60 days and the FYM is not of high quality. Since FYM is the major source of nutrients for most of the crops, the use of EM to prepare Bokashi of high quality within a short period of time has many advantages.

Other activities :

- EM production plan was established at the laboratory of National Plant Protection Centre,

Simtokha, Thimpu during the beginning of 1995 with the help of APNAN. EM solution is being prepared locally for trial purpose. Approximately 1500 liters of EM solution has been prepared and distributed.

- A training-workshop on EM technology was organized at RNRRC Bajo on 30-31 October 1995 for the Extension Agents and Farmers of the Punakha-Wangdi valley. A total of 25 Eas, 15 farmers, and 10 researchers attended the training-workshop. The objective of the workshop was to introduce the technology to extension system and the farmers. This will be followed by more demonstrations and trials in farmers' fields.
- A five years project on "Nature Farming using EM Technology" in collaboration with APNAN has already been finalized. This will further strengthen the capacity of the MoA to expand activities on EM Technology. The project will mainly focus on research, extension, training, study tours, and information exchange.

Conclusion

Preliminary studies undertaken so far indicate positive effects of EM in crop and animal production. EM technology could play and important role in the development of sustainable farming systems for Bhutan. However, further records are required to produce conclusive results. Testing of EM under field conditions calls for appropriate experimental designs to clearly detect effects due to EM. The longer term field studies began only last year and it is too early to draw concrete conclusions from these trials. However, positive effect of EM on crop growth and yield is already being observed.

EM Technology could play an important role in the development of sustainable farming system in Bhutan.