Nature Farming with Effective Microorganisms – Impact Analysis

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Abstract: *Although we may feel a certain satisfaction at meeting the nutritional needs of many millions, we cannot overlook the challenges posed by high-input agriculture. We do have an obligation, as concerned citizens, to develop additional solutions that can contribute to the elimination of the disgraceful food insecurity still experienced by about 90 million people in the world today. Pakistan is a good example of social consciousness of the green revolution. Although it was benign in intent, the green revolution evolved into a massive social experiment in which safety nets for many social groups and for many women were full of holes and our understanding of the holistic character of nature was revealed to be far from complete. Nature Farming with EM-Technology was introduced in Pakistan as an alternative to restore the dameged soil and ecology. Eight years, successful experimentation in agro-environments sector and practical innovation of EM Fermenter (Bio-fertilization) and EM-Generator (biological treatment of sodic water) have emerged as elements of change in the paradigm shift being experienced by thousands of resource poor farmers of this country.*

Introduction Effective Microorganisms (EM) are used by farmers. Its impact is to be examined in not only economic terms but also in terms of sustainability. What has never been quantified is the effect of EM on naturally degraded soils or on man created degradation. The much talked of green revolution is under threat. It is under threat because Pakistan has thirteen of the nineteen possible causes of soil degradation. The most serious threats are from water logging, salinity, sodicity, erosion and the imbalance of nutrients in soils caused by the use of synthetic fertilizer. These are the major factors not allowing farmers to increase their yields. The yields have been pretty much stagnant. With rising population and nutrients not in balance in soils this outcome is not surprising. Ever increasing and intensive use of synthetic chemical fertilizer without any integration of organic counterpart meant the land going into degradation. Steps are necessary to arrest this ever increasing threat. Again, the use of marginal quality ground water also contributed to the build up of salts in soils.

To this scenario, alternate agriculture had to be brought in. The route taken was the diffusion and effective use of Effective Microorganisms. Seven years data is now available and despite the opposition from powerful multinationals all those who are involved with this technology are aware of its importance and its economic benefits to the farmers. Not only has the soil been effectively made sustainable but also its use in improving sodic ground water to become useable in agriculture is one of the major benefits. Pakistan's water has problems. Its subsoil water has salts harmful to the farmers. Besides this EM_z-Ceramics has improved the efficiency of the water pumps. Efficiency has improved from 15 to 30 percent. Table 1 indicates the malaise in Pakistan's agriculture. Is this the optimum fertility of the soils? Is this the potential? Obviously not, for in the case of wheat, range of productivity can vary

between 5 t/ha to 0.8 t/ha. So the range is more than five times between the small and the large farmer, or if you like between the resource poor and the resourceful farmer. This obviously indicates, among other things, that resource poor farmers are unable to increase their productivity. This is where alternate agriculture has its real clientele. A look at the agrarian structure indicates that 93 percent of the farmers cultivate less than 5 ha and of these 60 percent are farmers with slightly above one hectare. The options are therefore obvious. The rich, resource endowed feudal will not get into this act. Where the targeting has to be is at the small, resource poor farmer.

Table 1. Yield of Major Crops (1995-1998) in Pakistan

Crop	1994-95	1995-96	1996-97	1997-98
Wheat t/ha	2.01 (8.1)	2.01 (8.3)	2.05 (8.1)	2.23 (8.3)
Rice t/ha	1.62 (2.1)	1.83 (2.1)	1.91 (2.2)	1.87 (2.3)
Cotton kg/ha	557 (2.6)	601 (2.9)	507 (3.1)	528 (2.9)

Figures in parenthesis are the area under each crop in million hectares.

The Benefits of EM

Alternate interventions of EM must take into consideration the impact of their technology. EM has been around for seven years. Data is now available and an analysis of this indicates the advantages. The wheat data indicates that the yield in terms of t/ha varies with various treatments from 2.22 percent to 38.23 percent. The lower end of the range is with chemical fertilizer. With simple EM this increase is 18 percent while with fermented compost it jumps to 38.23 percent. With green manure this increase is of the order of 26.5 percent. If the law of diminishing returns were analyzed then the resource poor farmer would get into productivity increase without incurring the costs of chemical fertilizer. The results show that those farmers that are the lower end of the wheat yield (producing 0.8 t/ha on an area of roughly 2 million ha) could easily go to 2 t/ha and in the long run (2 to 3 years) to 3.5 t/ha. In simple arithmetic terms it means producer welfare of some significance. With the yield at 2 t/ha (conservative) the addition to national wealth would be 2.4 m/tons and in the medium term 5.4 million tons. This addition to the national exchequer could mean the end of wheat imports. It also means the country having enough reserves and some surplus for exports. In terms of producers it could mean that the farmer could trade in this commodity. At the moment wheat is a tradable as well as a non-tradable good. The tradable part being with the large farmer. They in turn affect policies because of their influence in government circles.

Table 2. Effect of EM on Rice Grain Yield (kg ha^{-1})

Treatment	EM	No EM	Average
Control (without N)	1335.67c	1516.33b	1426.00 c
100% Mineral N	1631.00a	1620.33ab	1625.67 a
75% Mineral N+25% Organic N	1563.00ab	1553.67ab	1558.33 ab
50% Mineral N+50% Organic N	1626.67a	1625.00ab	1625.83 a
25% Mineral N+75% organic N	1591.33ab	1550.00ab	1570.67 ab
100% Organic N	1570.00ab	1526.00ab	1548.17 b
Average	1552.94	1565.28	

Means in a column bearing similar letter(s) are statistically alike at 5% probability level

What is forgotten is that the grain as well as the straw increase. This means that the farmer has surplus for straw export to Middle East. That in fact was what was going to happen. The farmer would have gained about Rs. 2 per kg. The country would have gained precious foreign exchange if 100 000 tons had been exported. An established market for surplus fodder would have been with us.

Economically the farmer would have spent less financial resources. His indebtedness to the banks and to the moneylenders would have been less. A bag of urea and two bags of DAP cost Rs. 1500 if available. This is the minimum requirement. Intensive agriculture would mean much more. As against this the maximum input for EM would be Rs. 500 for five applications. So, a straight saving of three times in terms of inputs. Since productivity would be added to the farmers income this could be another three fold increase in income. Does this not spell a win – win situation? The farmer and the nation are beneficiaries. Some of the other spin-offs of this technology were application of manure and EM improved the physical properties of the topsoil (0-5cm) and bulk density and dispersion ratio of the topsoil was reduced by addition of organic matter and EM. (Karim et al., 1993).

Influence on Yields

Wheat-Cotton cropping pattern is the most restrictive cropping pattern for wheat. So work was done on this. It was found that the results were consistent with earlier findings though the increase in the control experiment was maximum (Hussain et al., 1994). Better fermenting efficiency led to absolute increase in using green and farmyard manuring. Better nutrition was possible because of enhanced N uptake (See Table 3 & 4).

Ibrahim et al (1994) examined the long-term effect in the quality of rice and wheat. In the case of rice there was an increase in protein (14.9 percent) and Diazotroph (14.4 percent). In the case of wheat only the yield increased (Table 3).

A more detailed economic survey at the farm level is required. That would be authentic and would give an impetus to the technology and its assimilation. Rice (Table 3) indicates a similar enhanced activity with the added spin-off that the paddy stem was straight and not bent. Also the fruiting of paddy was 7-10 days earlier. The effect on bacterial leaf blight was also significant when Biocontrol and Bioaab were applied. A significant decrease in affected leaf area was noticeable. There was virtually no application of chemical fertilizers.

Table 3. Effect of EM on Wheat Grain Yield (kg ha^{-1})

Treatments	EM	No EM	Average
Control (without N)	2450.60	2412.13	2431.37 d
100% Mineral N	2758.33	2565.53	2661.93 a
75% Mineral N+25% Organic N	2673.77	2503.50	2588.63 bc
50% Mineral N+50% Organic N	2747.40	2552.07	2649.73 ab
25% Mineral N+75% Organic N	2692.87	2493.13	2593.00 bc
100% Organic N	2666.07	2436.37	2551.22 c
Average	2664.84 a	2493.79 b	

Cotton is Pakistan's internationally traded crop. About 70 percent of the total foreign exchange are provided to the national budget. Its significance is substantial. As a crop it has a pest regime which can break the heart of many entomologists. Yet EM-Biocontrol has been in great demand because of its effectiveness on *Heliothus armigera* and white fly, two pests which have assumed epidemic proportions.

Table 4. Effect of EM on Cotton Yield (Kg/ha)

Treatments	Average Yield
Control (No addition)	1493.07 e
Rec. NPK Fertilizer@170:85:60 kg/ha	2652.65 a
½ Rec. NPK Fertilizer + Fermenter Water	2523.99 a
¼ Rec. NPK Fertilizer + Fermenter Water	1853.61 cd
Fermenter Water only	1755.66 d
FYM+SFC @ 10 t/ha	1970.70 c
FYM + SFC @ 10 t/ha Fermenter Water only	2331.86 b

In terms of increase in productivity it has a range of between 18 percent to 34 percent. In absolute terms, it almost reaches 2 t/ha when EM is used in conjuncton with green manure. With farmyard manure, the increase is about 24 percent, which translated in absolute terms means that production is about 1.64 t/ha. There is increase in boll weight, and seed cotton. Boll weight in the case of EM+FYM was 13.3 percent. However Jamil's (1998) results on the effect of 50 percent mineral and organic sources of 'N' indicate less productivity.

Perhaps the greatest impact is on vegetables. The significance is for two reasons. First, it adds to the income of the farmers. Second, it adds to the nutrition of the poor. The poor have been thrown out of the protein market due to rising prices. Inflation has taken its toll. The vegetables studied were peas, potatoes, raddish, peanut, carrot, solanaceous crops (capsicum, eggplant, tomato), soybean, cucumber and red pepper.

In the case of peas the maximum increase was from chemical fertilizer, followed by FYM+EM. In potato tubers the maximum yield was in EM+FYM and the yield was as much as 15.86 t/ha. In the case of raddish the maximum yield was from poultry manure +EM (9.67 t/ha). FYM+EM yield was next highest (8.05 t/ha). A similar picture emerges for the other crops. In short the benefits to the environment, to the producers and to the consumers can be substantial.

The innovation of EM-Fermenter (Biofertigation) has almost brought a revolution in subsistence farming as it utilizes minimum and almost all kinds of manures /wastes available (FYM, poultry manure, sugarcane pressmud, liquid and solid municipal wastes) in our agro-eco-system as a source of biofertigation.

The assumptions of the green revolution technology no longer hold. The green revolution was based on inorganic methodology and its long-term consequences were not known. We now know that for sustainable agriculture it maybe better to examine other alternate systems. Ecological destruction by chemical agriculture and

by indiscriminate and intensive use has abused the soils. The medium has developed soil toxicity. The EM process enhances the use of local resources for agriculture productivity.

The Need for Diffusion

The issue now is about diffusion of this technology. The problem that arises is partly because of the existing technology and partly because all new technologies are difficult to adapt. For EM there has to be a different organizational level. The existing organizational structure will not do. The route to productivity must be known by the front line workers. Unless there is a continuous training program the effects of diffusion will be slow. The reason is the very nature of the target group. The target group cannot be the influential. They will only be for demonstration purposes. It has to be the resource poor farmer.

The resource poor farmer, who is really a subsistence farmer, is risk averse. To him all that matters is the low yield rather than no yield. That is how he sees the picture. So confidence of the farmer has to be gained and the credibility of the front line worker established. There are no short cuts. The target group needs to understand the benefits of the technology. That will only be possible if the technology is dealt with as a theme and consistently persistent. The refresher courses for the front line workers should be on a yearly basis. The technology is so cheap and effective that the costs of this extra training can be easily added to the costs of the product.

Again in Pakistan sugarcane mud is being utilized by farmers after treatments with EM for their fields. When any new product or substance is added the matter requires a fresh look. The farmer has to be guided not only on short-term basis but also on long term consequences. His fears have to be removed. Every society has its cultural factors.

Pakistan has its own peculiarities. For instance it may be more difficult to diffuse this technology in the existing strongholds of chemical technology. However it may be easier to take this as organic technology to new areas where Pakistan is to operate if it has to feed its explosive population growth. The route to be so taken will be different. EM must gear up for that. As much as 2.5 million hectares of virgin land has to come into productive use. Land which is not under the plough at the moment. At the same time in the existing areas the need is for working out the interventions for hydroponics and other intensive agriculture options. The days of plough and hoe are limited given the population demands. These in Asia will be particularly strong. All these new interventions can be a source of energizing the existing agricultural productivity.

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