USAID TECHNICAL CONSULTANCY REPORT IND085

PROMOTING BIODYNAMIC FARMING PRACTICES IN UTTARANCHAL, INDIA

OCTOBER 16-27, 2002

For

Organizational Name Non-Disclosed
DEHRA DUN, UTTRANCHAL STATE, INDIA

And

Organizational Name Non-Disclosed
NAINITAL, UTTRANCHAL STATE, INDIA

By

Steve Diver, Agriculture Specialist
National Center for Appropriate Technology's
ATTRA (National Sustainable Agriculture Information Service) Program
Fayetteville, AR 72701, USA
steved@ipa.net

Submitted to

FARMER-TO-FARMER PROGRAM (USAID)
Winrock International

January 14, 2003

Table of Contents

INTRODUCTION

1. BACKGROUND 3
2. OBJECTIVES 4

ACTIVITIES, OBSERVATIONS, AND SUGGESTED IMPROVEMENTS

1. BENEFICIARIES 5
2. THOSE INVOLVED 5
3. FARM VISITS, MEETINGS, PRESENTATIONS, TOPICS, AND SUGGESTED IMPROVEMENTS 5

OBSERVATIONS AND SUGGESTIONS FOR IMPROVED ORGANIC AND BIODYNAMIC FARMING

1. COMPOST PILE MODIFICATIONS, BIOMASS STORAGE, AND COMPOSTING TEACHING AID 14
2. BIOLOGICAL FARMING PRACTICES, HUMUS MANAGEMENT, SOIL BIOTA, AND SOIL FOODWEB 17
3. BIODYNAMIC FARMING CONCEPTS, QUALITATIVE BIOASSASYS, AND SCIENTIFIC VERIFICATION 18
4. COMPOST TEAS 20
5. EM - EFFECTIVE MICROORGANISMS 20
6. IM - INDIGENOUS MICROORGANISMS 22
7. MISCELLANEOUS ORGANIC FARMING PRACTICES: ROCK DUSTS, RAISED BEDS, ORGANIC MULCHES, MIXED CROPS, LIVING MULCHES, AND COVER CROPS 23

CONCLUSIONS & REFLECTIONS 25

APPENDIX

1. BIODYNAMIC LITERATURE MADE AVAILABLE IN PRINT 25

ANNEXURES

I. BIODYNAMIC FARMING & COMPOST PREPARATION (ATTRA) 28
II. NOTES ON COMPOST TEAS (ATTRA) 45
III. SOIL BIOLOGY: COMPOST, HUMUS MANAGEMENT, AND THE LIVING SOIL (STEVE DIVER, ATTRA) 56
IV. LIST OF PEOPLE MET 61
V. TRAVEL PROGRAM FOR FIELD VISITS TO UTTARANCHAL & RAJASTHAN 62

INTRODUCTION

1. BACKGROUND

Farmers in Uttaranchal are being encouraged to adopt organic farming for ecological benefits and market opportunities.

Uttraranchal, formerly part of Uttar Pradesh, is one of three newly created states in India – along with Chattisgarh and Jharkhand. These new states are rich in natural resources, yet they have limited infrastructure and economic development. Uttaranchal, located in the Western Himalayas, is characterized by hillside farming with steep terraces, mountain topography, forest reserves, rich plant biodiversity, small farms, limited rural infrastructure and economic development, and remote farms and villages. Management of water, soils, crops, pests, farm animals, and forests are closely interconnected activities that hillside farmers deal with on a daily basis.

Historically, India is an agrarian civilization based on thousands of years of sustainable agriculture. The historical literature of India — such as the Vrksharyurveda — provides a glimpse into ancient sustainable farming practices, including integrated crop-livestock agriculture, animal manures, green manures, intercropping, crop rotations, seed treatments, and plant-based pest control. Yet, the advent of Industrial Agriculture and Green Revolution Agriculture has brought many changes to India, including the widespread adoption of commercial fertilizers, synthetic pesticides, and hybrid seeds. At first, results in crop yields and pest control were highly favorable in response to these purchased inputs. However, now, after several decades of chemical use, farmers are expressing concern about declining soil health and water quality, increased incidence of pests, reduced food quality and shelf life, and related negative impacts.

Sustainable agriculture, a movement that gained worldwide recognition in the 1970s and 80s, has a goal of sustaining the environmental and economic health of farms and rural communities through eco-friendly farming practices, by emphasizing on-farm resources and biological processes, and by reducing or eliminating chemical fertilizers and pesticides. Organic farming is a sustainable farming system that completely eliminates chemical fertilizers, synthetic pesticides, as well as GMO seeds. As a consequence, organic farming has a defined market opportunity because consumers are seeking assurance that foods are wholesome and free of contamination. Biodynamic farming is an advanced organic farming system that places special emphasis on biodynamic preparations to enhance biological and dynamic forces in nature. Yet, biodynamic farming is much more; for example, biodynamic farming views the farm as an organism and recognizes the need for social and economic support for agriculture. The Community Supported Agriculture method of marketing, in fact, grew out of the biodynamic farming experience.

The government of Uttaranchal has initiated a three-prong programmatic approach to promotion of organic farming in this hillside state.

1. Uttaranchal Diversified Agricultural Support Project-Uttaranchal (DASP-UA). DASP-UA is a World Bank sponsored project coordinating NGO, University, and Private Industry efforts to serve Uttaranchal farmers and rural communities through a multi-scheme approach. Uttaranchal is home to G.B. Pant University of Agriculture and Technology at Patnagar, Nainital District, which is the premier land-grant university in India, established in 1960, which DASP-UA draws on for resource assistance. While the programs and services of DASP-UA are broad and address many different aspects of Agriculture, Horticulture, Animal Husbandry, Dairy, Sericulture, and Rural Infrastructure, the organic farming schemes specifically include: Bio-Village, NADEP compost, Vermicompost, BD compost, CPP, and EM.

2. Rural Development Project. This includes income generation projects (e.g., Bio-Compost) and Technology Transfer Training Development Centers (TTDC).

3. Agricultural Line Department. This is the standard agriculture department of Uttaranchal, providing Extension Services, farmer training, and coordination of government programs.

Uttaranchal is divided into two broad regions: Garhwal region with Dehradun as the major district, and Kumaon region with Nainital as the major district.

In the Kumaon region, biodynamic farming is promoted as an organic farming approach. Supa Biotech managed by Ms. Binita Shah is the primary company making and selling biodynamic products, as well as providing expert training.

In the Garhwal region, EM or Effective Microorganisms is promoted as an organic farming approach. Maple Organics managed by Mr. Sanjay Aggarwal is the primary company making and selling EM products, as well as providing expert training.

This particular Farmer-to-Farmer trip was focused on biodynamic farming and therefore this report will primarily focus on biodynamic methods and techniques to enhance organic farming success and adoption. Yet, farm visits did include discussions on EM usage; in addition, we had an opportunity to meet with Maple Organics. Since differences and similarities between BD and EM are on the minds of Uttaranchal farmers and NGO workers, a brief comparison of BD and EM is also provided.

Biodynamic farming practices promoted in India include biodynamic compost (BD compost), biodynamic preparations (BD preps), cow pit pat (CPP), liquid manures, and vermicompost. These are practical methods, they rely on local and on-farm resources, they turn organic wastes into useful soil and foliar amendments, and they provide fertility and pest control.

Biodynamics is an advanced organic farming system, based on the teachings of Rudolf Steiner in mid-1920s Europe, yet it is relatively new to Indian agriculture. A distinguishing feature of biodynamic agriculture is the use of nine BD preps. The BD preps consist of fermented mineral, plant, and animal manure extracts. They are applied in small proportions – similar to homeopathic preparations – to compost, manures, the soil, and plants after dilution and stirring procedures called dynamizations. The BD preps are inserted into BD compost and CPP to enhance metabolic processes (biological effect) and to focalize cosmic and terrestrial energy forces (dynamic effect). Thus, biodynamics can simply be understood as biological-dynamic agriculture, or bio-dynamic farming. The popular slogan "muck and magic" is another way to characterize the bio-dynamic continuum.

Yet, the unique nature of BD preps raises many questions amongst farmers and NGO workers regarding the philosophical and scientific basis of biodynamic farming in general. Specific questions were posed on the unusual methods by which BD preps are made, as well as composition, efficacy, and methodologies surrounding the BD preps.

This report will summarize observations and suggestions for improvements to the biodynamic practices noted above, as well as address certain questions raised during farm visits. Since BD compost is a fundamental component of biodynamics, special emphasis is placed on the composting process and associated knowledge about humus management, soil biota, and the soil foodweb.

Hopefully, my observations and suggestions, as well as the printed resources I shared during my visit, will provide useful guidance to project participants. In sustainable agriculture, we try to understand that each farm operates under its own unique set of circumstances with respect to on-farm resources and farm family goals. Therefore, these guidelines should be viewed from a general perspective.

2. OBJECTIVES

The objectives of the assignment were to:

1) Gain a broad view of biodynamic farming implementation in Northern India, in particular the tri-part programmatic efforts of DASP + NGOs + Supa Biotech to disseminate BD practices to farmers in Uttaranchal

2) Provide background resources on the scientific and practical basis for biodynamic agriculture, and share ideas and resources on complementary sustainable farming concepts and practices such as humus management, soil biota, and soil foodweb
3) Suggest improvements to BD compost making and related organic farming practices such as soil management and pest control.

ACTIVITIES, OBSERVATIONS, AND IMPROVEMENTS

1. BENEFICIARIES

Number of individuals directly participating in technical assistance or training.

Male: 75
Female: 19

Number of individuals that you anticipate may benefit from your assistance.

Male: 550
Female: 350

2. THOSE INVOLVED:

Volunteer:
Steve Diver, Agricultural Specialist
ATTRA - Appropriate Technology Transfer for Rural Areas
P.O. Box 3657
Fayetteville, AR 72702
479-442-9824
steved@ncatark.uark.edu

ATTRA
http://www.attra.org

Rhizosphere II: Publications, Resource Lists, and Web Links from Steve Diver
http://ncatark.uark.edu/~steved/

Facilitator and interpreter:
Rajat Sharma, Administrative Assistant-FTF, Winrock International, New Delhi
Aleen Mukherjee, Asst. Country Manager-FTF, Winrock International, New Delhi

3. FARM VISITS, MEETINGS, PRESENTATIONS, TOPICS, AND SUGGESTED IMPROVEMENTS

I was accompanied to Uttaranchal by Mr Rajat Sharma, Administrative Assistant at Winrock Farmer-to-Farmer, New Delhi. Ms. Binita Shah of Supa Biotech was the primary host in Nainital and Champawat Districts. Mr. Pawan Kumar of DASP-UA was the primary host in Dehradun District.

In the lower portion of Nainital District, Dr. H.C. Joshi and Dr. B.S. Negi of GEKVS (Grameen Evam Krishi Vikas Samiti), an NGO, organized two educational meetings on biodynamics with GEKVS staff located in different locations, and coordinated farm visits and farm meetings around Haldwani and Kotabagh.

- The two educational meetings with GEKVS staff on biodynamic farming included 45-minute presentations on biodynamic agriculture, humus management, soil biota, soil foodweb, BD compost, liquid manures, vermicompost, biological and dynamic components of biodynamic agriculture, concepts and examples of "dynamic" forces and effects associated with BD preps, and qualitative bioassay methods to ascertain the effect of BD practices on soil health and food quality. All of the meetings noted in this report were additionally followed by Question and Answer sessions.

- Site visit to a Bio-Compost store in a rural town where bio-compost is sold in 1 kg, 5 kg, 10 kg, and 25 kg bags. The bag labels included brief, yet effective educational information on benefits of bio-compost and usage rates for bio-compost, in both Hindi and English. Bio-Compost is an income-generating scheme underway in Uttaranchal based on a public-private sector initiative. Farmers in Uttaranchal make the BD compost, often in remote locations, and then it is collected, shipped, bagged, and distributed to town markets where it is sold to local gardeners. For the startup phase, farmers are contracted for the production of so many BD compost heaps, with the cost of BD preps being subsidized by DASP-UA.

- Two site visits related to silk worm raising facilities. We observed a nursery for mulberry trees, intercropping of mulberry trees on bunds and fence rows, and the two different phases of silk worm raising: hatching and cocoon spinning. Silk worm production is being promoted as a value-added farm enterprise to generate supplemental income. Mulberry tree agroforestry and silk worm raising methods are viewed as complementary activities to Uttaranchal farms, and the quality of silk is considered very good from Northern India.

- Site visit to a TTDC, Agriculture Information Centre. This is a rural agricultural information centre that provides posters and educational leaflets on organic farming, biodynamic farming, pest control, fertilizers, and horticultural techniques such as seed planting and preservation. It also has a meeting room for educational training. One of the posters was a board game – like "Monopoly" – with pictures of farmers advancing along the path as they adopt organic farming practices, yet losing spaces when they land on a square that displayed a chemical farming practice like pesticides.

- GEKVS progressive farms and farmer meetings. We observed production of ginger, turmeric, peppers, and numerous other crops (brinjal, pulses, amaranth, rice, etc). Intercropping of ginger-turmeric-pepper was promoted as a strategy for pest control by a previous Winrock Farmer-to-Farmer volunteer, Dr. Paul Hepperly (formerly Research Plant Pathologist for USDA-ARS Pacific Basin Agricultural Research Center, Hilo, Hawaii). Problems noted by farmers were fusarium, pythium, plant-parasitic nematodes, and nutrient deficiency. Suggested pest control strategies centered around non-host crop rotations, cover crops, biofumigation with mustard family cover crops, disease-suppressive composts and compost teas, and commercially-available microbial antagonists. Soil testing was badly needed at one of the farm sites. It apparently has a combination of micronutrient (B, Cu, Zn) and calcium deficiencies.

  In the mountain bio-village of Supi Bhatelia, we met with farmers in Supi Tok and conducted farm visits, as well as visited the BD preparation facilities at Supa farm.

- The farmer meeting at Supi Tok included a fascinating exchange of farm-based experiences and observations between the hillside farmers and the visiting Winrock volunteer consultant, who owns an 11.5 acre farm himself, also located in a hilly region (the Ozark mountains in Arkansas, USA). A tok, it may be noted, is a collection of 4-6 farms, with several toks comprising one village. The primary cash crops in this belt were potato (summer) and cabbage (winter). Due to mild weather conditions in this hillside farming belt, the taste and quality of potatoes and cabbage are considered very good and thus the produce has place-based label recognition and sells very quickly in the marketplace. Yet, a major constraint was identified. There is a conflict between the short rotation cash crops raised on the same ground year-after-year and the soil-building advantages of a complex crop rotation. The farmers remember mixed cropping agriculture practiced by their fathers and grand-fathers, but the economics of cash cropping have forced them to forgo the benefit of mixed cropping. Mixed crop options in this region include wheat, finger millet, amaranth, corn, pulses, grams, peas, and cannabis. The negative impact of short rotation cropping on soil health and pest occurrence can be understood more clearly when you drive through

mountain belt after mountain belt for miles in all directions, yet see the same crops being grown in a continuous pattern. This presents an agroecology imperative that pests and soil depletion will occur. For example, white grubs and fusarium were identified as problematic pests, with increasing frequency, in cash crops at Supi Tok. The farmers asked for advice on pest control as well suggestions for high-value alternative crops that would enable them to implement mixed cropping once again. Pest control suggestions focused on finished compost versus raw manures and FYM. The white grub results from a moth that lays her eggs in fresh cow dung. Several farmers who have been making BD compost for 2-3 years confirmed this observation. The grub is an indicator of raw manure application, and when the manure is transformed into a stable humus product known as compost, the grubs are no longer a problem. This kind of on-farm observation is the best kind of confirmation one can hope for. The biodynamic method, ultimately, is a practical approach spread farmer-to-farmer through these kind of observations. Alternative crop suggestions alluded to medicinal herbs and legume-grams from the mountain region, yet this topic is best addressed by local farm advisors who are familiar with the region.

♦ Supa Farm is a hillside farm and apple orchard, which also serves as the location of biodynamic preparation making by Supa Biotech, with facilities for careful storage and packaging. Here, over 25,000 cow horns are stuffed with either cow dung to make Horn Manure (BD 500) or ground quartz slurry to make Horn Silica (BD 501), buried in 30 soil pits approximately 3.5' wide, 8' long, and 2' deep at appropriate times of the year. In addition, the complete line of biodynamic preparations are made at Supa Farm, including:

- BD 502 Yarrow blossoms (*Achillea millefolium*)
- BD 503 Chamomile blossoms (*Matricaria camomile*)
- BD 504 Stinging nettle (*Urtica parvifolia*)
- BD 505 Oak bark (*Quercus dillitata*)
- BD 506 Dandelion flowers (*Taraxacum officinale*)
- BD 507 Valerian flowers (*Valeriana officinalis*)

Ms. Binita Shah is an expert maker of biodynamic preparations, and one of only two principle sources of BD preps in India. She studied under Peter Proctor of New Zealand who is viewed as the pioneer biodynamics teacher in India, and follows the specified methods indicated by Rudolf Steiner. In addition, she is a member of the Biodynamic Farming Association of India, and participates and teaches at the annual advanced BD preparation training workshops sponsored by BFAI. It should be noted that while Binita sells BD preps, she also teaches farmers how to make their own BD preps. Biodynamics is, therefore, a decentralized organic farming approach.

To obtain herbs and cow dung from lactating cows needed for the BD preps, Binita coordinates purchases from local farmers. For example, farm women gather stinging nettle and farm children gather dandelions. In addition to BD preps, Binita makes large quantities of CPP. Finished CPP (which is made from fresh cow dung, basalt rock dust, egg shells, and BD preps) is mixed with a selection of dried herbs and sold to larger-scale farmers as a microbial-inoculant style compost starter.

Binita also sells a pest control product made from dried stinging nettle. Dried stinging nettle leaves are mixed with cannabis and chrysanthemum leaves, then stacked in a pyramid shape. CPP is inserted into the leaf stack as a prep, which facilitates breakdown; the leaf material looks like dried tea leaves when it is finished. This material is bagged and sold as dried stinging nettle. Farmers use half a packet and soak it in water. The resulting herbal tea is mixed one part tea to nine parts water to make a 1:10 dilution ratio and sprayed on plants. The formic acid from stinging nettle irritates insects and results in pest control, and the bioactive substances extracted the plant materials include plant-growth promoting hormones such as indoleacetic acid (auxin).

For its own use, to restore the old apple orchard, Supa Farm makes BD compost, CPP, vermicompost, liquid manures, and a live-worm bin watery extract known as vermiwash.

Vermiwash is a worm-extract that is somewhat unique to the natural farming movement in India. Natural farming techniques focus on local resources and natural remedies. Other NF techniques include liquid manures and fermented plant extracts. Vermiwash is made by dripping water through an active worm bed, with an outlet at the

bottom to collect the vermiwash. In some instances, the vermiculture bedding material may include only certain herb plant material rather than manure-based bedding. It is, essentially, "worm bath water" because it washes and collects the bodily excretions from worms. The vermiwash is foliar applied and functions as a foliar fertilizer, biostimulant, and prophylactic pest control. Vermiwsh is sometimes mixed with cow urine and plant extracts to make a complete foliar recipe.

In the mountain village of Khaiskhande, Satkhal Tok, near Lohaghat in Champawat District, we were accompanied by Mr. Shivdutt Joshi, Asst. Development Officer for Agriculture (Uttaranchal government), and Mr. Lakshman Singh Adhikari of Om Nagrik Samiti, an NGO, as well as Master Trainers from the DASP biodynamic agriculture project. We visited a progressive farm and met with local farmers. The forest canopy in this region includes groves of pines and cedars, including the magnificent Deodar Cedar.

- The farmer meeting at Satkhal Tok took place on a progressive farm. The farm featured intercropping of trees with crops, increased diversity of crops and trees, and shrubs and flowers for beautification. This type of tree-crop agroforestry seems well adapted to India, which enjoys a year-round growing season and is a center of genetic plant diversity, yet is not practiced very widely. In discussion with the farmers, NGOs, and government workers, it was said that farmers need education on the ecological, economic, and subsistence food benefits of tree crops, they need tree seedlings, they need skills at raising trees, and they need methods to protect trees from grazing animals.

The farmers listened patiently to introductory remarks about biodynamics, composting, and soil biology, and then they quickly jumped into their problems. The women, especially, were eager to learn how to control the voracious white grubs and termites. The women showed us potatoes that were literally riddled with holes from termite damage. The termites attack roots of plants and they attack roots crops.

The details on the white grub have already been noted. The adult moth lays her eggs in fresh dung, including FYM applied to the field. The biodynamic approach is to build a BD compost pile using dung and biomass, thus transforming these raw organic materials into humified organic matter, or finished compost. Compost is a mature humus product, so the adult moth goes looking for raw dung elsewhere.

There are two approaches to termite control that come to mind:

1. One idea is to make a home recipe based on products like citrus oil, pine oil, turpentine, and ammonia. Interestingly, this region has two trees which may provide raw ingredients for termite control: Pine and Deodar Cedar. Some research and experimentation will be required to learn more about these products, preparation methods, and efficacy studies for termite pest control. The product should be compatible with soil application. There is an NGO called Bio-Integral Resource Center in California that has general information on least-toxic pest control for structural pests such as termites. See: http://www.birc.org/

2. The second idea is based on Indigenous Knowledge agriculture in India. There are two indigenous knowledge data sources in India that capture farmer experiences with plant-based pest control:

Indigenous Knowledge News
Centre for Indian Knowledge Systems || Chennai, India
http://www.ciks.org/archives.html

Honeybee Network & Innovation Database
SRISTI || Ahmedabad, India
http://www.sristi.org/honeybee.html

The Indigenous Knowledge News from CIKS is an especially rich online source to learn about plant-based pest control. This newsletter was formerly titled "Pesticide Post."

The Centre for Indian Knowledge Systems, in addition, publishes a series of booklets called "Plants in Pest Control."
http://www.ciks.org/agpub.html

The following items address termite control:

Termite control: Herbal pesticide made in manure pit
Honey Bee, Vol. 7 (1): January-March (1996): page 16.

A recipe based on calotropis and 'kheemp' (*Leptadenia pyrotechnia*) mixed with salt and urine.

Spirit of Anonymous Creativity
Honey Bee, Vol. 11 (2): April-June (20002): page 1.

A recipe based on burnt teak leaves (*Tectona grandis*), whey milk, and cow urine.

Termite control using natural products
Indigenous Agriculture News, Vol. 1, No. 1-3: July (2002): page 9.

A recipe based on plant extracts from fermented juice of banana.

Termite control
Pesticide Post, Vol. 9, No. 2: March (2001).

A collection of short recipes.

In the mountain region of Mukteshwar in Nainital District, we were hosted by Chirag, Central Himalayn Rural Action Group, an NGO, where we interacted with Mr. Arvind Rana and Mr. Lokendra Singh and others. Later, we also met with Dr. Kenai Lal, the founder of Chirag. This portion of the trip included meetings with Chirag agricultural advisors and a visit to the Chirag demonstration research farm.

- At Chirag headquarters, we had a meeting on biodynamic agriculture with Arvind, Lokendra, and several other Chirag workers. This resulted in an hour long discussion on the scientific and practical basis of biodynamic farming. An outcome, in the minds of the Chirag workers, is that biodynamics must be viewed as a whole farm system.

Indeed, the BD preps are but one tool in a series of practices that help facilitate the organic farming approach to soil fertility, pest control, crop quality, and economic viability. The composting process can be understood in a number of different ways, including the **breakdown** and **buildup** phases, with each phase being dominated by a particular group of microorganisms and temperature ranges. In the early phase, when temperatures may reach 130º-160º F., thermophyllic bacteria dominate the pile. In the latter phases of composting, after temperatures have dropped to moderate, warm temperatures and the pile is curing, fungi and actinomycetes dominate the pile. The actinomycetes are particularly important because they produce antibiotics which give disease suppressive characteristics to compost. The BD preps should not be viewed solely as a microbial inoculant, a magic bullet for compost. Rather, the BD preps help facilitate both biological and dynamic aspects of composting. Compost piles may require additional management – such as aeration (turning) and moisture (adding water) – after the initial pile is built. The ultimate goal is a stable, finished, biomature, well humified compost with beneficial attributes. Compost provides: a slow-release organic fertilizer, a supply of beneficial microbes, a source of antibiotics, disease suppression, improvements to soil structure improvements, enhanced water holding capacity, among others. Thus, BD compost is one part of a holistic farming system known as biodynamic farming. It so happens that biodynamic farming is a premier humus management system, based on decades of experience, and thus has a long history of ecological soil management as the basis for a healthy farm with healthy crops and livestock and nutritious food products. The dynamic aspect of biodynamic farming is said to impart vitality to the farm and its

food products. Qualitative bioassay methods developed to ascertain the quality of biodynamic compost, biodynamically-managed soils, and biodynamically-grown produce include: circular chromatography, sensitive crystallization (known in the modern scientific literature as biocrystallization), and capillary dynamolysis.

The site visit to the Chirag research and demonstration farm visit included further opportunities to observe BD compost piles, CPP, liquid manures, vermicompost, and NADEP compost.

Earlier, Chirag workers set up an experiment with six compost piles. They put BD preps into three compost piles, and left three compost piles as a check. They will examine compost quality when they are finished to determine any differences due to the BD preps. In passing, they asked me to identify the BD compost piles. In fact, on my first guess I did correctly identify one of the BD compost piles. In India, BD compost piles are completely enclosed with a dung+soil paste to function as a "skin" and moderate the composting process inside the skin. Compost piles treated with BD preps radiate a form of dynamic energy that results in more defined cracking pattern in the dung+soil paste; i.e., the BD piles have more refined and defined cracks than those appearing as a normal consequence of drying; it was demonstrably noticeable and therefore a tell tale sign that this pile in particular had been treated with the BD preps.

In addition to the organic farming and biodynamic farming methods, other technologies demonstrated at Chirag farm included polytunnels for season extension of market vegetables, water reservoir storage tanks dug into the earth, nursery production, medicinal herbs, vegetable production, and fruit tree production.

In the lower portion of Dehradun District, Ms. Vinita Kumar, District Project Coordinator with DASP, accompanied Mr. Pawan Kumar, Social Scientist with DASP, on visits to progressive farms around Village Rudrapur, Block Vikasnagar. On these farm visits, we were accompanied by Mr Dinesh Rana, District Coordinator with Himalayan Inst. Hospital Trust Rural Dev. Inst. and Mr Ashish Srivastava with Maple Organics. We attended a farmer's meeting on Integrated Plant Nutrition, and we met with farmers at Village Rudrapur.

- At a large gathering of farmers meeting on Integrated Plant Nutrition, we attempted to discuss biodynamic farming and composting, as well as interact via Questions and Answers, but the translation was difficult and overall our efforts were not too effective given the limited amount of time we had on the program. Holistic concepts, even the notion that compost has multiple benefits, including nourishment and shelter for soil microbes, rather than simply existing as a bagged fertilizer product that substitutes for NPK fertilizer, take time to explore. When asked for his view on any positive impact, Mr. Pawan Kumar said … with some humor … "20%," and then he quickly added, "our next stop will be better."

Indeed, our next stop was excellent. We visited a progressive farmer, Mr. Surya Prakash Bahuguna, who raises 9 acres of organic and transitional crops including rice, sugar cane, chili peppers, and mushrooms. We observed BD compost, CPP, liquid manure, vermicompost, and NADEP compost. All of these methods were working quite well. Mr. Bahuguna showed us chili pepper plots and explained that BD compost and CPP were performing better than NADEP compost in terms of early yield, fruit quality, and pest control. He had 2.5 acres of organic rice nearing harvest. His farm is looked upon with great interest, because the pest control he is achieving through organic methods is remarkable in light of the fact that pesticides are the standard pest control treatment in the region.

Later, we visited a small farm at Village Rudrapur where we observed BD compost and vermicompost. The compost pile was not working well; the sal leaves were still intact 1.5 months into the process and the temperature was ambient instead of warm. This provided an opportunity for the farmers present to discuss the composting process. By now, a theme was emerging on my farm visits that compost piles should go through breakdown and buildup phases, with a goal of developing well humified compost, not just decomposition of organic matter. To achieve that goal you may have to manage the pile after it is built. One suggestion that that I shared was co-composting with worms. First, you build the BD compost pile. After peak heating has occurred and the temperatures have dropped to a moderate level, you can add worms to the compost pile and let them finish working over the material. A second idea is to pile the leaves in a leaf corral, moisten them down, and let them partially decompose for several months to a year prior to using this leaf material in a new compost pile. Leaves

are very high in carbon, and therefore break down slowly. Thus, aged and partially decomposed leaves will naturally facilitate more biological action in a new compost pile than young, dried leaves.

At Village Rudrapur, we also met with about 15 local farmers. In addition to Mr. Bahuguna, a progressive women farmer was in attendance. She had achieved excellent results with BD compost and CPP. She applied CPP to tomatoes, and one tomato vine yielded 75 Kg in tomato fruits. The farmers at Village Rudrapur were receptive and eager to discuss biodynamic and organic farming. Several farmers observed that cow dung makes better quality CPP than buffalo dung. The farmers said buffalo dung had "40%" power of cow dung.

In Dehradun, an Organic Agriculture conference had been organized, featuring Mr. Steve Diver from Winrock Farmer-to-Farmer speaking about Biodynamic Agriculture and Mr. Umesh Chandrashekar from IMO speaking about Organic Certification. The meeting was hosted by Dr. R.S. Tolia, Forest Development Commissioner, Government of Uttaranchal. Those in attendance included Mr. Rajesh Thadani, Executive Director of Chirag, Ms. Binita Shah, CEO of Supa Biotech, Mr. Sanja Aggarwal, CEO of Maple Organics, and representatives from DASP-UA, several NGO's, and B.P. Pant University.

- My lecture included slides and descriptions of organic farming, biological farming practices, root health, soil health, food quality, humus management, soil biota, soil foodweb, rhizosphere, phyllosphere, biodynamic farming, composting making, BD preps, and qualitative bioassay methods, among other topics.

On the latter part of the assignment, I was accompanied to Alwar district of Rajasthan by Mr. Aleen Mukherjee, Winrock International, Farmer-to-Farmer, New Delhi. We traveled to Ajit and Royina Grewal's farm, which is popularly known on the web as IndianOrganic.com.

- Ajit Grewal started the farm about 20 years ago. The region is located on the edge of the Thar desert and can be characterized as barren, arid lands with sand dunes, elephant grass, shrubs and native aromatic plants such as artemesia, pastoral grazing with sheep and goats, and irrigated agriculture. The farms and villages exist in a harsh environment with extreme heat and drought in the summer. When the Grewals first arrived, few trees existed, and the only birds present were crows and vultures. Now, 20 years later, the farm is a tree-covered oasis with tree crops and annual crops blended together, a forest farm where 85 species of birds visit and dwell amongst the trees and greenery. What happened is that Ajit decided to use his farm as a demonstration site for ecological restoration, wherein he proceeded to plant 10s of thousands of trees, establish an organic farm based on agroforestry and intercropping, employ innovative methods of irrigation, and utilize humus management practices such as BD compost and vermicompost.

Irrigation

Flood irrigation is the common method of irrigation in Alwar District of Rajasthan. Ajit has developed modified irrigation methods to raise tree crops (large tree wells, with soil heaped around trucks) as well as field crops like wheat. For cereal crops, the field is diked and irrigated several days before planting to create a moisture reserve in the soil. The aim is to encourage plant roots to peg down deep in the ground and seek deeper layers of soil moisture. Rapid germination and optimum seedling growth are very important outcomes. The second and third irrigation, while the crop is growing, are aimed at and take place at critical growth stages.

In addition, Ajit has implemented a novel drip irrigation system that is based on gravity-fed distribution. Four 500-gallon water tanks, elevated about 5 feet above the ground, are located in a central position in a large field that is arranged in four blocks. Each block consists of a couple dozen rows of vegetables, flowers, and medicinal herbs about 60-80 feet long each. The tanks are connected, by valves, to manifold distribution lines, which deliver water to the four adjacent blocks. Netafilm® drip irrigation lines were obtained from Israel, especially selected because they work under low pressure. Each tank and associated valves, manifold lines, and drip lines are known as a module. Each module can operate independently from one another. The system is simple, but effective. Electricity in Alwar District is unreliable and only available during limited times of the day. Thus, the tanks can be quickly filled during peak electrical periods, and later, the drip system can run as a gravity flow system.

Biodynamic concepts

Ajit shared three concepts on the dynamic aspects of biodynamic farming which stand out. First, the purpose of BD preps is to enhance the influence of celestial energy (i.e., astrology) on microorganisms. Microorganisms control agricultural processes such as nutrient cycling, soil structure, and disease control. This is one of the reasons biodynamic farming emphasizes humus management, coupled with BD preps, because humus management provides the terrain – food and shelter – for soil microbes. Second, when birds flap their wings they create waves that radiate beneficial resonance patterns and further enhance ecological restoration and ecological balance. Third, nature is the ultimate model. Whenever the farmer can model proceeses on nature, or mimic patterns in nature, they will bring their farm closer to sustainability.

BD compost recipe

The composting process at IndianOrganic.com is highly developed. The following notes are lengthy, but in view of their value I will summarize them here as *one* model for biodynamic compost making in India. Productivity at IndianOrganic.com is testament to the success of this method.

The biodynamic compost pile is really a compost windrow, measuring 2 m wide by 5 m long by 1.5 m high. A finished compost windrow (which, as we will see, is two windrows combined into one after decomposition reduces biomass volume of the original windrow by 50%) will yield approximately 3 tons of mature, high quality biodynamic compost.

To promote aeration, a bundle of reed grass stalks 6-12" in diameter is laid on the ground oriented to the length of the compost windrow, with about a foot sticking out at each end. The reed grass, locally known as elephant grass, has thick, durable stalks and does not break down during the composting process, thus enhancing air flow into the compost windrow. The stiff stems or reeds are bundled together from reed grass leaves themselves, so it is a local technology based on local resources. The bundle is placed in the middle of the windrow to promote static aeration.

The first compost feedstock is a layer of pre-moistened leaf litter, laid on the ground about 6" thick. The leaves will mark the boundary of the compost windrow.

Next, a layer of dried crop residue (straw, hay, crop residue) is laid on top of the leaves.

Next, a slurry of cow dung is poured over the raw biomass.

To make the cow dung slurry:

Per 200 liter barrel:
50 kg cow dung
or, approximately
¼ cow dung
½ water
Stir, and pour as slurry

Next, a layer of green leaves is laid on top of the existing feedstocks.

Next, slake lime is sprinkled over the green feedstock. The lime should be pre-moistened a couple of days prior to use (to allow for any heating from chemical oxidation that may take place).

This layering process is the initial feedstock recipe.

Next, the layering process will be repeated in this order:

Dried crop residue/leaves
+ Cow dung slurry
Fresh green residue/leaves
+ Sprinkling of slaked lime on green layer

In addition, sometime during the compost pile building process, golf-ball size pieces of cow dung are randomly placed at 8-10 different locations in the compost windrow. This is a technique that Ajit learned from Peter Proctor. Peter thinks the manure pieces provide habitat and nutrients for microbial colonization.

When the compost windrow reaches 4' in height, it is sprinkled with 30 kg of rock phosphate.

The process continues, in a repeated pattern of layering.

At 4.5' in height, a mixture of soil clay (from ponds) is mixed with cow dung to make a paste and seal the heap. The paste is made from 1/3 soil + 1/3 clay + 1/3 cow dung. A space of 3 inches is left un-plastered near the ground, to allow air infiltration and promote aeration.

The BD compost preps, No. 502 to No. 507, are inserted into the BD compost windrow. Liquid Valerian extract, BD Prep No. 507, is poured in five holes made in the pile, with the remaining 20% of the liquid sprinkled over the total length of the compost windrow.

At 4 weeks into the composting process holes are punctured in the paste, about 12" apart, to allow for addition of water to the compost windrow. The amount of water may vary depending on how dry the material looks and feels inside. A guide will be 15 liters or 3 buckets of water. The paste itself retains moisture, and that is one its principle benefits.

The BD compost windrow should be checked every morning for cracks that appear in the paste. These cracks should be re-sealed with new dung+soil paste. The skin helps retain moisture and modify the compost environment and therefore it is important to make a good paste and retain a complete paste cover. Ajit said that good paste preparation, application, and maintenance will result in a compost pile that will be ready in half the time as a compost pile with no paste. The reason the cracks appear is that microbes use up moisture.

At 6 weeks total, the whole compost windrow should be broken down and rebuilt. When reconstitution of the windrow takes place, two windrows that were started at the same time are combined into one windrow. Due to the breakdown process, the size of biomass is reduced. By combining two piles, the biomass dimensions of an ideal compost windrow can be met. The process of breaking windrows apart and reconstituting them provides for a lot of mixing and aeration. When the windrow is reconstituted, it should be done by mixing and moistening, followed by plastering.

Thereafter, every 2 weeks, the process of breaking apart and re-building the windrow, accompanied with mixing and moistening and replastering, should be done. A total of 4 turnings is the goal. The windrow will be ready in 90 days by following this procedure.

However, 1 month before the compost is mature, at the 2nd or 3rd turning, biofertilizers will be amended during the turning and mixing process. The three biofertilizers that Ajit uses are: Phosphorus Solubilizing Bacteria (PSB), Azotobacter, and Rhizobium. He may look into Azospirillum after we discussed the situation, because Azospirillum is another free-living nitrogen fixing bacteria — similar to Azotobacter — which is used in some parts of India.

In some instances, Ajit places special emphasis on the addition of certain leaves during the compost building process, including: Neem, Callitropsis, and Marigold.

The temperature of a good compost pile will reach 70-80º C.

The IndianOrganic.com website has a section that features organic farming, with a summary of the 17-step process for making biodynamic composting.
http://IndianOrganic.com/organic_farming/bio_dynamic_composting/bd_composting.htm

Vermicompost recipe

Vermicompost is also made in large quantities at IndianOrganic.com.

Interestingly, the principle feedstock for vermicompost is cow dung. Again, a good size windrow is built, though it is about 1/3 lower in height than a standard BD compost pile. The cow dung is obtained from nearby dairy farms. It is moistened during the windrow building phase. The C:N ratio of cow dung is close to the ideal ratio of 30:1, so it therefore heats up and goes through a thermophyllic phase. This is important because the thermophyllic heat kills pathogens and weed seeds. Essentially, it is treated like a thermophyllic compost windrow, followed by co-composting with worms.

Following peak heating, when the compost windrow temperatures have cooled to below 100º F., worms are added to the windrow in sufficient numbers to inoculate the pile and initiate co-composting.

When the pile has been thoroughly digested and bioprocessed by worms, the material is carefully harvested to sift and keep the worms. The end result is a good quality worm compost.

Agni Hotra + Rishi Krishi

Agni hotra is an ancient Hindu practice in India, originating in the Vedic period. It combines Sanskrit slokas with the burning of ghee. The ashing and the pronouncement of slokas are performed at a precise time of the day, near dusk. According to agni hotra, the resonance patterns created by this vagya are very beneficial to the land. Ajit and Rowina obtained an astro-geography chart from an organization in Germany that lists these precise timings based on your exact location.

Agni hotra and Vrksharyurveda are practices that fall under the larger category of Rishi Krishi (rhishi = saint, krishi = agriculture), the ancient science of spiritual agriculture in India. Ajit and other farmers, as well as NGO's, are exploring the history of Rishi Krishi for clues to organic farming practices indigenous to Indian agriculture.

Food quality

Organic wheat on the IndianOrganic.com farm has yielded 16% protein. By comparison, conventional wheat is typically 8%. Enhanced food quality is one of the results Ajit attributes to organic farming. He is interested in exploring certain medicinal herb crops, specifically aryuvedic plants native to Rajasthan, as high quality organic crops.

OBSERVATIONS AND SUGGESTIONS FOR IMPROVED ORGANIC AND BIODYNAMIC FARMING

1. COMPOST PILE MODIFICATIONS, BIOMASS STORAGE, AND COMPOSTING TEACHING AID

Following site visits to Nainital, Mukteshwar, and Dehradun, it became apparent that compost pile management is an important improvement to the biodynamic method in India. The ultimate goal of the BD compost process is to produce a well-humified compost in a 3 month timeline, though it may take longer in Northern India.

BD preps alone do not provide assurance that the composting process will be complete or result in stable humus. Rather, BD preps facilitate and enhance the biological and dynamic aspects of the composting process.

Indications that compost piles need management include: raw materials used to build the pile; i.e., compost feedstock (e.g., tree leaves) are still visible (it has not broken down), temperature of the pile has not warmed (microbes are not active; C:N ratio is out of balance), or the temperature has cooled too rapidly.

Three Compost Pile Modifications

Co-Composting with Worms. In addition to using worms in vermicomposting, worms can be integrated with thermophyllic compost piles to facilitate further digestion and bioprocessing. The worms add a biological dimension to organic matter decomposition and transformation. This can be especially helpful in compost piles that have not heated well or completed digestion. The worms should be added to the pile following thermophyllic heating, when temperatures are moderate (below 100º F.). Several holes can be made on top of the BD compost pile by peeling away the dung+soil paste; after the worms are inserted the holes should be plastered over.

Aerated Static Pile. The aerated static pile uses perforated pipes to increase convective air flow into the internal portion of a compost pile. As compost layering takes place, pipes are laid perpendicular to the length of the compost windrow, about 3-6 inches above ground, followed by additional layering. The perforated pipes can be hallowed-out bamboo, or it can be 3-4" PVC pipe with holes drilled along the side. Air flow will naturally occur and facilitate oxygenation and aeration of the pile. The goal is to increase the aeration effect *without* turning the pile. Alternatively, instead of perforated piping which may not be readily available, a bundle of reeds, canes, or sticks may be laid on the ground oriented to the length of the compost windrow, sticking out on each end.

Aerated Turned Pile. The aerated compost pile is simply a BD compost pile that is turned and mixed on a periodical basis. Turning provides oxygen, it mixes the feedstock ingredients, it mixes microbial colonies throughout the pile, and it is known to enhance the composting process. Turning is a very important management technique in compost production, yet the aim is to limit the number of turnings because it does involve time and labor.

Procedure for the Aerated Turned Pile: Build pile as usual but do not apply paste. Instead, use a gunny sack or straw for skin. About 5-7 days after building pile, remove skin and lay to one side. Turn pile to adjacent spot, using a manure rake. Additional water can be sprinkled during turning, if needed, to maintain optimum moisture. Mixing of raw materials and aeration will be accomplished. Re-apply skin. Repeat turning on a weekly or bi-weekly basis for a total of 3-5 turnings. Inserting a metal rod or stick to monitor temperature can be helpful. When the temperature drops, turn the pile. The idea is to keep high temperatures for a longer period, to mix materials, to aerate, and to provide management and control over the composting process. In biodynamics, the compost pile is covered with a dung+soil paste, straw, or compost cover (such as a fleece material or burlap sack material). The "skin" moderates the composting process (temperature, moisture, microbial communities, preservation of nutrients which may otherwise be lost to volatalization) and it holds and circulates dynamic energy within its boundary. The point here is that other materials may be used as a skin in addition to dung+soil paste.

Advanced Composting Modifications: Four Amendments Worth Exploring:

CPP:
Sprinkle CPP while layering compost pile, in addition to the regular insertion of BD preps. The CPP may be viewed as a microbial inoculant.

Finished BD Compost:
Sprinkle finished BD compost while building layers, as an alternative to CPP. Finished compost may be added up to 10% by volume. The Controlled Microbial Composting process, developed in Austria, makes regular use of finished compost. When finished compost is used as an amendment, it provides a storehouse of microbes, it quickly handles offending odors, and it modifies and regulates the whole composting process.

Clay Soil:
Use clay or clay subsoil, not topsoil. The clay should be dried & ground, not cloddy. Sprinkle at 5-10% by volume throughout the layers. The aim is to produce well-structured, humified compost with increased clay-humus crumb formation. Yet, it also involves excavation of soils. Therefore, it may only be practical on farms that have access to clay from constructions sites, water reservoir pits, and related activities that involve digging.

Rock Dust:
Explore native ground rocks in region. Crush to fine mesh. Use the compost process to solubilize and mineralize bio-available mineral nutrients. Organic acids, a byproduct of microbial decomposition, are the key factors that promote biological weatherization. Rock dusts possess secondary elements (Ca, Mg) and trace elements (micro-nutrients) as well as a huge surface area, which enhance microbial activity. Micro-nutrients serve as catalysts for important microbially-driven enzymatic reactions. The addition of rock dusts will therefore enhance microbial activity as well as increase the bio-available mineral content of finished compost.

Supplemental Biomass Storage

Leaf corral:
It is often observed that tree leaves, especially Sal, do not decompose well in a compost pile. Leaves are high in carbon, and species that resist decomposition can create a C:N ratio imbalance in the compost pile. To facilitate the partial decomposition of tree leaves prior to their use in a compost pile, it can be helpful to store leaves in a leaf corral. A leaf corral is simply a bin or cage, constructed from bamboo or reed or sticks, to hold leaves and keep them from blowing away. Chopping leaves prior to storage, as well as moistening leaves while herding them up and pinning them down in a leaf corral, are techniques that enhance partial decomposition. This way, leaves can be kept for 6 months to 1 year prior to use in a compost pile. Leaf material that has gone through partial decomposition is known as leaf mould. Aged and partially decomposed leaves will naturally facilitate more biological action in a new compost pile than young, dried leaves.

Supplemental Composting Teaching Aid:

John Crockett, a commercial composter with Mother Nature's Farm in Carmel, New York, promotes **The Star Concept of Composting** for optimal microbial performance in the compost pile. The image of a 5-pointed star with accompanying text at each point representing the five fundamental factors effecting the composting is an easy-to-understand educational tool:

- C:N Ratio
- Temperature
- Oxygen
- Moisture
- Fluff & Homogenize

For a detailed explanation and summary of these points, see:
http://www.magicsoil.com/star.htm

Summary

The bottomline is that composting is a process that can be enhanced through management. Simply building a pile, inserting BD preps, and covering with paste does not ensure success 100% of the time. When farmers understand the composting process (C:N ratio, moisture, temperature, oxygen, microbial activity, breakdown and buildup phases, humification) as well as the end goal (stabilized humus, nutrient retention, exchangeable nutrients, food and shelter for soil microbes), it should be easy to understand that techniques such as turning, mixing, aeration, irrigation, and worm integration can be helpful processes to arrive at a good quality compost. Additionally, the BD preps can be understood more clearly to enhance microbial processes as well as focalize dynamic energy forces.

2. BIOLOGICAL FARMING PRACTICES, HUMUS MANAGEMENT, SOIL BIOTA, AND SOIL FOODWEB

Biodynamic farming is the oldest ecological farming system of the modern organic farming era. It evolved in the 1920's in response to widespread adoption of chemical fertilizers around the turn of the 20th Century. Biodynamics thus provides an example of successful organic farming over a long period. The success of biodynamics can largely be attributed to its special attention to compost making, soil humus, crop rotations, holistic farm management, and healthy, *vitalized* soils, crops, and food products. The following terms are helpful to understand because they provide the fundamental scientific basis for organic farming and biodynamic agriculture.

Biological Farming Practices

Organic farming is based on a series of biological farming practices such as cover cropping, green manuring, composting, crop rotations, legumes, animal manures, grazing, and related activities that maintain and build soil organic matter, disrupt pest life cycles, and provide nourishment to crops and livestock.

Humus Management

Humus management is a holistic term that describes a philosophical and practical approach to organic farming. Humus management employs biological farming practices to generate organic amendments and feed the soil. The purpose of humus management is to provide food and shelter for soil microbes, and to build clay-humus crumb structure in soils. Clay-humus is critical in plant nutrition because this organo-mineral complex is negatively charged and holds soil nutrients like calcium, magnesium, and potassium. Indeed, humus crumb plays so many critical roles in soils, including soil structure, moisture retention, and microbial shelter.

The applied principle of humus management is the soil foodweb. It takes soil biota to create humus and it takes humus management to provide food and shelter for a healthy soil foodweb.

Soil Biota

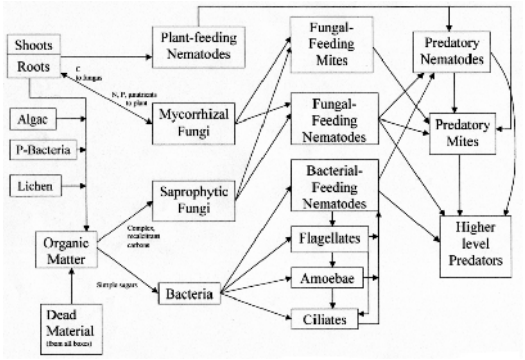
To understand the importance of the soil foodweb, it is important to have a working knowledge of different types of soil organisms, their size, their habitat, and their function. Soil creatures are classified as soil flora or soil fauna, and range in size from micro to macro. Soil microbes of special importance to soil foodweb analysis include bacteria, fungi, protozoa, and nematodes.

Soil Organism Classification

Classificatio	Width	Examples
Microflora	<10 um	bacteria fungi
Microfauna	<100 um	protozoa nematode
Mesofauna	100 um to 2 mm	acrai collembola
Macrofauna	2 mm to 20 mm	earthworms millipedes

The edaphon is the living soil. Soil creatures either "stay put," swim, crawl, or burrow. Typical habitats include crevices, channels and pores left from old roots, the rhizosphere, and micro-aggregates and biofilms.

Soil Foodweb



The soil food web is the community of organisms that live in the soil and feed on organic matter residues, and since it is akin to a food chain, they also feed on each other. A food web diagram shows a series of conversions of energy and nutrients as one organism eats another organism. Looking at all the types and functions of soil organisms — shredders, graziers, decomposers, mutualists, fungal-feeders, bacterial-feeders, predators, ecosystem engineers — and their collective impact provides increased understanding of the vital role a healthy, complex soil foodweb plays in agriculture.

Soil foodweb diagram by Elaine Ingham, www.soilfoodweb.com

The key to a healthy soil foodweb is an **abundance** and **diversity** of soil biota. Humus management, the practice of continually amending soils with organic matter, is the way farmers manage and promote a complex soil foodweb.

A balanced soil foodweb will:

1. Suppress disease-causing pathogens and root-feeding nematodes
2. Produce good soil structure, improving water infiltration, oxygen diffusion, and water-holding capacity
3. Retain nitrogen and mineral nutrients such as calcium, magnesium, potassium, and phosphorus
4. Make nutrients available for plant growth at the times plants require, at the rates plants require
5. Decompose plant and animal residues rapidly
6. Produce hormones that help plants grow
7. Biodegrade toxins and pollutants that find their way into the soil

3. BIODYNAMIC FARMING CONCEPTS, QUALITATIVE BIOASSAYS, AND SCIENTIFIC VERIFICATION

Previously in this report I have referred to the concept of biological-dynamic agriculture. There are three additional points on biodynamic farming I would like to add to this report.

Individuality of the Farm

A basic ecological principle of biodynamics is to conceive of the farm as an organism, a self-contained entity. A farm is said to have its own individuality. Emphasis is placed on the integration of crops and livestock, recycling of nutrients, maintenance of soil, and the health and wellbeing of crops and animals.

There is a dynamic practice that supports the concept of the farm organism. It can be helpful to walk or mark the boundaries of the farm, or build a small fence around the home garden, and thus contain the psychic energies broadcast by the farmer, which is full of good intention for the welfare of the crops and livestock inhabiting the enclosed area. A farmer naturally thinks about young plants and whether they need water or care. This good intention builds up within these boundaries like water contained in a reservoir. The effect is subtle, yet it is an example of the cumulative effect bio-dynamics brings to bear on the organic farm.

Qualitative Bioassays

Three qualitative bioassays have been developed to ascertain the quality of biodynamic compost, soil humus, and food products raised on the biodynamic farm. These tests provide insight to biological and mineral components,

as well as vital qualities. These bioassay tests include: circular chromatography, sensitive crystallization (known in the modern scientific literature as biocrystallization), and capillary dynamolysis.

In my estimation, it will very helpful for Supa Bio-Tech and G.B. Pant University to investigate and refine the BD preps, BD compost, BD soils, and BD food products (grains, fruits, vegetables, milk) with these bioassay techniques, along with standard soil tests and laboratory procedures. For example, I draw your attention to biodynamic research in Southern India that used circular paper chromatagraphy as a means of evaluation:

Utilization of Local Alternative Materials in Cow Horn (BD 500) Preparations: A Case Study on Biodynamic Vegetable Cultivation by K. Perumal & T.M. Vatsala | Shri A.M.M. Murugappa Chettiar Research Centre | Tharamani, Chennai, 600 113, India
http://www.biodynamics.net.au/resources/

The following websites can be visited to view and read about these techniques.

Capillary Dynamolysis by Adam McLean
First published in the *Hermetic Journal*, 1980.
http://www.levity.com/alchemy/kolisko.html

Capillary Dynamolysis by David J. Heaf
Science Group of Anthroposophy in Great Britain
http://www.anth.org.uk/Science/capdyn.htm

Sensitive Crystallization Anaylsis
Hagalis Assoziation, Switzerland
http://www.hagalis.de/PuretecEnglisch/Kristeng/ppframe.htm

The Renaissance of Farming: A Vision for Organic Farming in the 21st Century, Conference Proceedings
Soil Association Conference, 7-9 January 2000
Royal Agricultural College, Cirencester (UK)
Go to:
Soil Association | Library | Conference Papers
http://www.soilassociation.org

Measuring Food Quality
Peter Segger for Dr Ursula Balzer-Graf - Institute of Vital Quality, Switzerland
5-page paper, PDF download

APPENDIX III: Dr Ursula Balzer-Graf's Slides, Institute for Vital Quality
15-pages of accompanying slides, PDF download
Side-by-side comparisons of sensitive crystallisation, capillary dynamolysis, and circular-paper chromatography for different samples of food and the influence of farming practices.

There is a Difference! - Famous Chromatograms from Dr. Ehrenfried Pfeiffer
Galaxy Nutrients
http://www.galaxynutrients.com/Difference.html

Circular Chromatography Images: A Comparative Look at Natural vs Synthetic Products Using the 'Chroma' Method
Reprint from Human Dimensions Institute
http://ncatark.uark.edu/~steved/chromas.html

Scientific Papers on Biodynamics

It is common for university-trained agricultural specialists to ponder the scientific veracity of biodynamic farming methods, since the BD preparations, for example, are prepared in such an odd way: stuffed in cow horns and animal intestines and buried in the ground. The following citations point to a few scientific assessments of the biodynamic approach:

Carpenter-Boggs, L., J.P. Reganold and A.C. Kennedy. 1997. Effects of biodynamic preparations on compost development. Biological Agriculture & Horticulture. Vol. 17. p. 313-328.

Koepf, Herbert H. 1993. Research in Biodynamic Agriculture: Methods and Results. Bio-Dynamic Farming and Gardening Association, Kimberton, PA. 78 p.

Pettersson, Bo. D., E. von. Wistinghausen, and William F. Brinton. 1988. Organic, Biodynamic and Conventional Cropping Systems: A Long Term Comparison. Woods End Agricultural Institute, Mt. Vernon, ME. 44 p.

Reaganold, J.P. et al. 1993. Soil quality and financial performance of biodynamic and conventional farms in New Zealand. Science. April 16. p. 344-349.

4. COMPOST TEAS

The four practices that were commonly employed on biodynamic farms were (1) BD compost, (2) CPP, (3) Liquid manures, and (4) Vermicompost.

In my view, Compost Tea should be added as the 5th element.

Compost teas are one of the hottest topics in organic farming in the United States and Australia. Compost teas are valued because they provide plant nutrition as well as plant disease control. Compost teas are suitable to indigenous agriculture because they can be made from farm-produced BD compost.

Compost teas provide soluble nutrients, humic substances, beneficial microorganisms, and bioactive substances that promote plant growth. When compost teas are sprayed on young plants, the beneficial microorganisms coat the plant leaf (phyllosphere) and root (rhizosphere) surfaces and thus provide inoculation with microbial antagonists which fight plant pathogenic diseases. Plants that are treated with compost teas are noticeably greener and produce greater yields.

For further information on compost teas, see:

Notes on Compost Teas
Steve Diver, ATTRA
http://www.attra.org/attra-pub/compost-tea-notes.html

Compost Teas for Plant Disease Control
Steve Diver, ATTRA
http://www.attra.org/attra-pub/comptea.html

5. EM - EFFECTIVE MICROORGANISMS

EM, or Effective Microorganisms, is being promoted in Garhwal District as an organic farming technology. Maple Organics is the primary company providing EM products and technical expertise.

EM is a liquid culture consisting of mixed aerobic and fermentative anaerobic microorganisms. I have summarized the background and uses of EM in my paper below. It contains an extensive listing of print- and web-based resources which provide further documentation and details.

Nature Farming and Effective Microorganisms
Steve Diver, ATTRA
http://ncatark.uark.edu/~steved/Nature-Farm-EM.html

In brief, EM contains around 80-120 microorganisms. The main species of microorganisms in EM include: [1] Lactic acid bacteria: *Lactobacillus plantarum*, *Lactobacillus casei*, *Streptococcus lactis*; [2] Photosynthetic bacteria: *Rhodopseudomonas palustrus*, *Rhodobacter spaeroides*; [3] Yeasts: *Saccharomyces cerevisiae*, *Candida utilis*; [4] Actinomycetes: *Streptomyces albus*, *Streptomyces griseus*; and [5] Fermenting Fungi: *Aspergillus oryzae*, *Mucor hiemalis*.

The online booklet titled *EM Application Manual for APNAM Countries* is an especially noteworthy source to gain a practical understanding of EM's many uses around the farm, see:

EM Application Manual for APNAM Countries
---------- three online sources ----------
http://www.agriton.nl/apnanman.html
http://www.emfsafe.com/em/app/
http://www.plantsfood.com/bm.htm

There are two aspects of EM that I would like to address in reference to the Winrock assignment IND085.

EM-Fermented Plant Extracts

Liquid manures, also known as herbal teas and fermented plant extracts, are made from local herbs and garden plants. Sometimes, the plant-based extracts are part of a complete recipe that may include cow urine, cow dung, molasses, or wood ashes. The solution is sprayed on plants and provides soluble nutrients, plant growth-promoting substances, and bioactive compounds that promote plant growth and help control insect pests and diseases.

These liquid manure solutions are a powerful tool in organic farming, biodynamic farming, and natural farming in India. In fact, India is a world leader in this technology.

EM, integrated with liquid manures, results in a product known as EM-Fermented Plant Extract. EM is a microbial tool that can facilitates and enhances the botanical extraction process.

Margarita Correa, working at Auroville near Pondicherry in Southern India, published a notable paper that describes the use of EM, biodynamic preparations, and related organic farming practices for India. Of special interest are her notes on EM-Fermented Plant Extracts (EM-FPE) for pest management.

The Impact of Effective Microorganisms (EM) in Various Organic Farming Systems
http://www.auroville.org/environment/EM_impact.pdf
13-page PDF

Margarita Correa also published a paper describing EM-FPE.

Go to HTML Source:
AuroAnnam - Research & Development Farm at Auroville
http://www.auroville.org/research/auroannam_research_farm.htm

Download EM presentation as a zip file and open.....

Experiences with Effective Microorganisms in Disease and Pest Control in Farms and Gardens in India
C. Margarita and L. Dengel

In summary, liquid manures are a common practice in biodynamic farming and EM is a tool that can be integrated with plant-based extracts to result in EM-FPE. BD and EM are compatible technologies that organic farmers may want to explore.

Fermented Biomass - The EM "Composting" Process

To understand the difference between EM and BD, it is important to understand the three microbial pathways of organic matter decomposition:

1. Aerobic
2. Putrefactive anaerobic
3. Fermentative anaerobic

BD compost is an aerobic, thermophyllic composting process. When animal manure is added to a compost pile with proper C:N ratio, moisture, and windrow management, it is quickly degraded and transformed into stable, humified organic matter. There are no flies and odors. Beneficial microorganisms predominate this process.

When animal manure is allowed to sit out in the open, it will often attract flies and create odors. This is putrefactive anaerobic decomposition. This is what we are trying to avoid in organic farming. Pathogenic microorganisms, such as *E. coli*, commonly occur in this process.

EM, in contrast, is a fermentative anaerobic process. It is a beneficial microbial pathway. When EM is sprayed on animal manures, the EM microbes facilitate microbial remediation and deter flies and odors. Thus, EM can be used as a pre-treatment of raw organic materials before they are added to the BD compost pile.

Some confusion has emerged with respect to BD compost and EM compost. These are two different microbial pathways and processes.

BD compost is managed as an aerobic, thermophyllic compost pile, and results in stable, humified organic matter. BD compost is rich in humic substances, it contains slow-release nutrients, it helps build soil structure, etc.

EM compost, in contrast, is managed differently and it results in fermented biomass. The fermented biomass provides a slow-release organic fertilizer, but it does not have humified structure. Maple Organics has expertise with EM-treated compost piles and can be consulted for details in how to manage these piles.

In summary, it is perfectly suitable to combine BD and EM on the same farm. They both have uses and features that are desirable. Yet, it is important to understand how each one works and how they differ. BD compost is humified organic matter; EM compost is fermented biomass.

6. IM - INDIGENOUS MICROORGANISMS

The Korean Natural Farming Association (KNFA) employs microbial cultures known as Indigenous Microorganisms, or IM. These are made from on-farm indigenous microorganisms, isolated from native soils through the use of special cultures. For example, boiled rice is laid on the forest floor with leaf litter. Forest soils are known to host 5,000 species of fungi. IM's grow onto the rice for one week. Next, molasses is added to the rice to encourage the proliferation of these beneficial microorganisms. After another week 1 part rice is added to 19 parts water to make a 1:20 dilution ratio. The IM-cultured rice is allowed to sit in the water, then it is strained.

The strained solution is concentrated IM microbial stock. To use, 2 tbs are of IM stock are added to 1 gallon of water. The IM solution can be sprayed on plants, compost, or soils.

How does this relate to biodynamics? The preparation of Horn Manure (BD 500) and CPP can be viewed as an IM practice. CPP is raw manure that is laid in a brick-lined pit. Horn manure is raw manure that is stuffed in a cows horn and buried in the soil. Native microorganisms grow into these "special cultures" and inhabit the earthy, humusy BD preps that result.

By matching the concepts and practices of KNFA and BD, farmers in Uttaranchal can enhance the microbial power of CPP and Horn Manure. For example, prior to placing the CPP recipe in the brick-lined pit, farmers can line the bottom of the pit with a few inches of soils and leaf litter from certain places on the farm. The aim is to collect soils from the best producing fields, and forest soils + leaf litter from the healthiest and most productive part of the forest. When Rudolf Steiner said that Horn Manure should be buried in "good" soil, perhaps he had some of this soil biology in mind.

In addition, the KNFA has recipes to make fermented plant juice, fermented fruit juice, lactic acid bacteria serum, fish amino acid, and Oriental herbal nutrients. Research and adoption of these on-farm practices could be very beneficial for the organic farming movement in Uttaranchal.

7. Miscellaneous Organic Farming Practices: Rock Dusts, Raised Beds, Organic Mulches, Mixed Crops, Living Mulches, and Cover Crops

Rock Dusts

Rock dusts should be investigated as a remineralization practice that can be integrated with organic farming in Northern India.

Rock dusts are finely ground rock powders that contain trace elements and secondary mineral nutrients. They provide mineral nutrition to crop plants and livestock, and the huge surface area is said to promote microbial proliferation. Some of the trace elements function as important catalysts for microbial activities, including enzyme reactions.

Rock dusts may be especially helpful as an amendment to compost piles. Organic acids, which are byproducts of microbial decomposition of organic matter, help to solubilize and mineralize the mineral nutrients in rock dusts, thus making the mineral nutrients more bioavailable. A mineralized compost will thus provide enhanced nutrition to crop plants. Rock dusts can also be added to compost teas, foliar brews, and animal manures.

For background information, see:

Rock Dusts in Agriculture: Remineralization and Paramagnetism
Steve Diver, ATTRA
http://ncatark.uark.edu/~steved/rock-dust.html

Raised Beds

Raised beds and permanent beds are an organic farming approach that may be suitable to some organic farms in Northern India, especially for high value crops (vegetable crops and medicinal herbs) on limited acreage. Permanent beds are known to impart many benefits including improved soil structure, increased humus levels, moisture holding capacity, and soil foodweb biodiversity.

Auroville is a city-in-the-making in Southern India based on the teachings of Sri Aurobindo and The Mother. Auroville has several farms and organic farming and gardening projects.

Here is a 4-page PDF leaflet on raised beds from Auroville.

A Manual for Raised Beds, A Form of Permaculture for the Dry and Wet Tropics
Go to HTML Source .....
Ecological Agriculture at Auroville
http://www.auroville.org/environment/agri.htm
Download the zipped PDF file at .....
http://www.auroville.org/environment/farms_news/Raised%20Beds.zip

The manual is based on the work of a dutch farmer, Paul Teuben, who stayed at Auroville for two years. Previously, vegetable production in the region was not considered feasible. The costs of production were high and market prices were low. India has a hot climate with wet and dry seasons and the farm and soil undergoes hardship under these conditions.

But after people starting using the raised bed technique, they realized there are many benefits of this farming system approach, including:

permanent raised beds
soil covered with organic mulches and cover crops
nutrients from liquid manures, green manures, foliage of legumes
water management
soil improvement
use of local resources
simple method to teach
seedling production and transplanting techniques
aesthetic and enjoyable gardens
beneficial insect and butterfly habitat
high yield food production
economic returns

John Jeavons at Ecology Action in California is one of the world's leading proponents of raised bed, intensive agriculture. He refers to his technique as Grow Bio-Intensive. See the following resources for further information:

Ecology Action Publications
http://www.growbiointensive.org/

"Grow Biointensive" books and research booklets
http://www.bountifulgardens.org/growbiointensive-books.html

What is the GROW BIOINTENSIVE Food-Raising Method?
http://www.growbiointensive.org/biointensive/GROW-BIOINTENSIVE.html

Organic Mulches, Mixed Cropping, Living Mulches, and Cover Crops

Ecological soil management is closely tied to vegetation management (mixed cropping, crop rotations, living mulches, and cover crops) and residue management (mulching). Some of the soils we observed were obviously over-tilled and over-exposed to the sun and weather. The subsequent loss of organic matter through oxidation offsets the positive gains from BD compost making and application. In general, cover crops, living mulches, crop rotations, and mixed cropping were under-valued and under-practiced on most farms in Uttaranchal. Few farmers understood cover crop species, planting dates, seeding rates, and cropping system approaches. Research and demonstration on cover crops, soil management, and tillage systems to enhance soil quality through the cropping system approach would be a great benefit to organic farming efforts in Uttarhanchal. This type of research is the role of NGO's and university programs, working in cooperation with progressive farmers.

CONCLUSIONS AND REFLECTIONS

Biodynamic agriculture and organic farming are relatively new to India. Yet, farmers have quickly adopted these practices.

This report summarizes the activities and topics that were covered at each site visit, including technology transfer and advice.

The BD practices employed by farmers, the BD prep making process at Supa Bio-Tech, and the BD compost making venture as an income generating scheme were all very impressive.

Yet, there are several concepts and practices that can enhance the success of biodynamic and organic farming in India, and these are summarized in this report.

The Winrock-sponsored trip to Uttaranchal and Rajasthan was personally and professionally gratifying to me. Agriculture in India is one of my long-standing interests, and this trip helped me gain insight and experience that I can use to share further resources with Winrock, host organizations, and related NGO's.

In addition, it was a great pleasure and opportunity to meet Binita Shah with Supa Bio-Tech, Sanjay Aggarwal with Maple Organics, Pawan Kumar with DASP-UA, Dr. Kanhai Lal with Chirag, and especially, to observe hillside farms and farming systems in Uttaranchal as well as Ajit Grewal's organic farm in Rajasthan.

APPENDIX

Biodynamic resources, in print, given to Supa Biotech, Maple Organics, and DASP-UA:

General Booklets and Lecture Notes:

Biodynamic Farming, PowerPoint lecture notes by Mardi Dodson and Steve Diver. 5 p.

The Soil Biology Primer booklet from USDA-NRCS. 56 p.

Gardening for Life – The Biodynamic Way, book by Maria Thun. 127 p.

Biocrystallization Analysis, booklet from Hagalis Association (Switzerland). 23 p.

Using Quality Compost to Build Humus in Soil, booklet from Pike Agri-Lab Supplies (Maine). 28 p.

Note: complete journals citations below

* *Applied Biodynamics*, Journal of the Josephine Porter Institute for Applied Biodynamics.

* *Biodynamics*, Journal of the Biodynamic Farming and Gardening Association of North America.

In the Biodynamic Garden series:

Courtney, Hugh J. 1993. Spring in the biodynamic garden. Applied Biodynamics. Issue No. 7 (Spring). p. 3-7.

Courtney, Hugh J. 1994. Summer in the biodynamic garden. Applied Biodynamics. Issue No. 8 (Summer). p. 1, 3-4.

Courtney, Hugh J. 1994. Fall in the biodynamic garden. Applied Biodynamics. Issue No. 9 (Fall). p. 1, 3-7.

Biodynamic Preparation series:

Brinton, William F., Jr. 1997. Dynamic chemical processes underlying BD horn manure (500) preparation. Biodynamics. Vol. 214 (November-December). p. 1-3.

Courtney, Hugh J. 1994. Seed soaks with the biodynamic preparations. Applied Biodynamics. Issue No. 7 (Spring). p. 1, 8-9.

Courtney, Hugh J. 1994. Further thoughts on making BD #500. Applied Biodynamics. ssue No. 9 (Fall). p. 9-10, 13.

Courtney, Hugh J. 1995. BD #501 – The horn silica preparation. Applied Biodynamics. Issue No. 12 (Summer). p. 3-7.

Courtney, Hugh J. 1998. The Michaelmas preparation: BD #504 – stinging nettle. Applied Biodynamics. Issue No. 24 (Fall). p. 3-7, 10-11.

Courtney, Hugh J. 2000. The valerian preparation – some additional notes. Applied Biodynamics. Issue No. 29/30 (Spring-Fall). p. 7-11.

Courtney, Hugh J. and Michael Green. 2001. Practical observations: Observing the forces inherent in the dandelion preparation. Applied Biodynamics. Issue No. 34 (Fall). p. 4-6.

Courtney, Hugh J. 2002. Achillea millefolium esoterica. Applied Biodynamics. Issue No. 37 (Summer). p. 9-11.

Gardener, Malcolm. 2002. Are we collecting the best oak bark? A contribution to the discussion of prep quality. Biodynamics. Vol. 241 (May-June). p. 3-10.

Goldstein, Walter. 2000. Experimental proof for the effects of biodynamic preparations. Biodynamics. Issue No. 231 (September-October). p. 6-13.

Gregg, Evelyn Speiden. 1999. Making the biodynamic preparations. Biodynamics. Vol. 223 (May-June). p. 14-15.

Jeyakaran, C. 2001. Kurinji's experience in growing biodynamic herbs and making biodynamic preparations. Biodynamics. Vol. 238 (November-December). p. 17-19.

Korrow, Christy. 2002. Prep making efforts at Dogwood Spring Farm. Applied Biodynamics. Issue No. 37 (Summer). p. 11-12.

Lisle, Harvey C. 2002. Taking a hard look at our horn silica. Biodynamics. Vol. 241 (May-June). p. 19-21.

Smith, Patricia. 2000. How to make the valerian preparation (BD #507). Applied Biodynamics. Issue No. 29/30 (Spring-Fall). p. 3-11.

Smith, Patricia. 2002. How to make the yarrow preparation (BD #502). Applied Biodynamics. Issue No. 37 (Summer). p. 3-9.

Stevens, Joseph. 2001. Prepared valerian: The secret of finished compost. Applied Biodynamics. Issue No. 33 (Summer). p. 8-10.

Williams, Hugh. 1994. Horsetail herb, Equisetum arvense – BD 508. Applied Biodynamics. Issue No. 8 (Summer). p. 8-11.

York, Alan. 1997. Working with preparation 500 (Part I). Biodynamics. Vol. 213 (September-October). p. 1, 4.

Miscellaneous:

Leaflet: Description of *Sequential Spraying* technique using the biodynamic preparations to balance forces of plant growth. Excerpt from Applied Biodynamics. 1 page.

SUPPLEMENTAL RESOURCE

The **Biodynamic Agricultural Calendar for India** is available through:

Biodynamic Association of India
C/o Taura Business Centre
51, St. John's Road (Near Commercial Street)
Bangalore 560 042
INDIA
Tel: 0091-80-5541461 / 62
Fax: 0091-80-5367702
E-mail: bdai@vsnl.net