"Previously we learned that farmers knew much about insect pests, although they misunderstood certain key ideas like insect reproduction and predator-pest relations. We found that teaching missing information in a farmer-useful way enabled people to overcome knowledge barriers and improve their farming. On the basis of our experience with the insect course, we started a pilot effort to help farmers resolve plant disease problems." A report from Nicaragua.

Photo: Mario Ardón

Rural farmers explore causes of plant disease

Stephen Sherwood and Jeffery Bentley

In 1994, our integrated pest management (IPM) programmes in Honduras and Nicaragua gave 15 courses lasting about two days to over 200 resource poor farmers. Our goal was to help farmers better understand the environment and to enable them to improve their farming.

Local knowledge

Central American farmers are often competent at explaining abiotic diseases such as agrochemical burn, drought, or waterlogging. For example, farmers use the words *quemarse* (verbally "to burn oneself") to describe the effects of fertiliser or herbicide toxicity and *aguachinarse* ("to die because of excess water") for waterlogging of roots. Farmers are less proficient in explaining biotic plant disease. Hondurans organise plant disease into two broad categories, *hielo amarillo* or *hielo negro* (yellow ice or black ice) and Nicaraguan producers often speak of *chamusco* (burn), terms referring to leaf symptoms. Due to the invisibility of host-pathogen interactions and limited access to information in rural areas, Central American farmers do not know about the causes of biotic plant disease: plant pathogens. Consequently, rural people have created folklore to explain crop problems. For example, farmers commonly accuse weather fluctuations, astrological activity, human and other animal behaviour, or mystical energies as causes of plant disease. Epidemics became common in rural areas over the last fifteen years, when agrochemicals and other influences changed traditional farming. Some farmers believe that companies selling fertilisers and pesticides seeded insect pests in products.

Extensionists don't explain

In the best circumstances agricultural extensionists can identify the name of a disease, but usually they only provide information on chemical control. Rarely do extensionists understand or attempt to explain disease life cycles to farmers, the key to unlocking the mystery of plant disease.

During one course Simón Hernández, a farmer from the North Coast of Honduras joked, "It's like someone telling you to hate your girlfriend's mother, but you do not understand until she becomes your mother-in-law. They (extension agents) have been telling us to rotate crops for years, but no one really ever explained why." Simón is not a sexist man, and in fact, he grew to like his mother-in-law. His point was that one cannot truly understand a relationship one has not experienced. Likewise, people do not immediately understand the complex relations between plants and pathogens.

Last dry season Máximo Sánchez, a progressive farmer from the central highlands of Honduras, decided to grow tomatoes for the first time. His harvest was so successful that he immediately planted a second crop of tomato on the same plot, leaving the old plants to dry on the soil's surface. During our visit we found tomato plantlings covered with target spots associated with early blight and old plants in the rows covered with fungal spores, the source of his problem. When asked why he lined the old plants in the rows, Máximo explained that they were so hearty they would ward off disease. Despite repeated applications of fungicides, Máximo lost most of his second crop to early blight.

Without clear understanding of the cause of problems, farming may be a mixture of useful, useless, and even harmful practices.

Teaching through experience

We do not directly explain disease to farmers, since we feel that they must take responsibility for their own learning. Instead, we expose them to new information, ideas, and situations to stimulate thinking, and then we ask them to explain what they have learned.

Like most people, Central American farmers know about the intoxicating effects of alcohol. We use drama to examine alco-

If farmers understand the cause of plant problems, they will invent technologies to deal with the problem

hol abuse as a way of treating social issues and introducing the concept of disease. During this activity a participant pretends to drink *guaro* (a local moonshine). Farmers enjoy the skit, which curbs technical talk. By analysing the immediate cause of illness (alcohol) and its effects (a hangover), farmers learn to distinguish between disease-causing agents and symptoms. By discussing certain indirect causes of alcohol abuse (frustration, depression, poverty), they learn about environmental factors (soil, water, sunlight) that influence plant health and disease.

Course participants form small groups and we assign each a plant diseased by a particular pathogen type, like fungus, bacterium, nematode, or virus. Groups draw diseased plants and make comparisons. Drawing is a way for people to internalise what they observe. Farmers study symptoms with their eyes, interpret what they see with their mind and reproduce the effects of disease with their hands. Comparing helps farmers reach generalisations about symptoms. Then they practice new skills by walking through fields and diagnosing plant problems.

Later, course participants learn that pathogens are alive. They extract nematodes from the soil and observe them under stereoscope. They isolate fungi and bacteria from diseased tissue and culture pathogens in petri dishes. They inoculate healthy hosts and non-hosts to learn about specificity. Afterwards, we compare and contrast pathogen types, and we associate symptoms and explain pathogen and disease life cycles. Following the course, farmers watch fungi and bacteria grow in petri dishes and they observe the development of disease in inoculated plants.

After reflecting on disease and making generalisations about disease types, we apply our new knowledge to specific crop problems. Table 1 shows how one group of farmers applied new knowledge of early blight in tomato and compares their recommendations with those of experts. The table illustrates that farmer recommendations can be scientifically wise.

What have we learned?

Early on we presented disease as living (biotic) and non-living (abiotic), which led to confusion. Water, that we labeled "non-living", was "living" according to most farmers. They grounded their perception in spiritual beliefs far older than our perceptions based on biological science. As well, a major environmental campaign in Honduras advertised *Agua es vida* (water is life). Subsequently, we adopted a more holistic view of life and disease. Thanks to

Table 1: Control of early blight in tomato (caused by the fungus Alternaria solani)

General disease control strategy	Expert recommendations[1]	Farmer recommendations[2]
I. Exclusion prevent dispersal before pathogen reaches the field	• select seed from disease-free fruit • sterilize or fumigate seedbed • plant only disease-free transplants	• select seed • disinfect seedbed • select healthy plants from seedbed
II. Eradication prevent survival of pathogen in the field	• treat seed with hot water or chemicals • destroy or remove crop remains after harvest • plow in plant debris	• disinfect seed with bleach or vinegar • observe field and act fast • remove sick plants and fruit and burn or bury them • use plant debris in compost piles
III. Avoidance prevent inoculation (i.e., before pathogen reaches the plant)	• crop rotation with non-solanaceous crops • avoid planting near other solanaceous crops • adjust timing of planting to avoid high inoculum periods. • minimize injury to plant • control insects and their damage	• where tomato was planted, plant corn or beans • do not plant seeds deep (when direct planting) • plant many crops in one field to confuse the pathogen • study planting dates • use windbreaks to block fungal seed • use mulch to prevent soil splash • adjust distance between plants • work during the afternoon when plants are dry • limit entry into the field and keep animals out
IV. Protection interfere with pathogen penetration activity	• fungicides (protectants) • monitor, predict, and prevent disease problems using computer-aided forecasting and fungicide sprays.	• fungicides (protectants)
V. Resistance prevent or suppress susceptibility to penetration, infection, etc.	• maintain plant vigor by providing adequate nutrition and moisture • limit leaf wetness periods by avoiding shade and timing irrigation to allow for leaf drying • resistant and tolerant varieties	• feed plants • use gravity irrigation and wet only the foot of plants and not leaves • irrigate during the morning so leaves are not wet very long
VI. Therapy mitigate symptoms and suppress colonization	• fungicides (eradicants or systemic)	• use fungicides (systemics)

[1] Taken from A.F. Sherf and A.A. MacNab. 1986. Vegetable diseases and their control. John Wiley and Sons, New York. pp. 634-640.

[2] Created by farmer course participants from Quebrada Honda, Comayagua, Honduras.

error and honest feedback from farmers and extensionists our course grew more effective and useful.

Many farmers misuse pesticides. Course participants commonly admitted applying fungicides for viral diseases. New knowledge explaining the biology of pathogens should help curb ineffective applications.

Participants confirmed at least two notions. First, farmers are eager to understand plant disease. Many said disease problems were progressively worse year after year. Consequently, farmers were glad to discuss plant health and they participated enthusiastically in our course. Second, farmers can master abstract concepts such as plant-pathogen interactions and disease. For example, by the end of phase II farmers could diagnose common diseases in their crops by pathogen type and explain disease life cycles. Whether or not they remember details will likely depend on the usefulness of the information.

Conclusion

Participants learned that certain trends such as monocropping, cultivating exotic crops and pesticide use aggravated natural balances and they suggested alternative farming strategies. During the present season we are building on specific disease knowledge, practicing on-farm experimentation and studying the impact of farming changes.

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