PN-AAW-983
ISN=49909

TRAINING TROPICAL PLANT PATHOLOGISTS AND THE FARMING SYSTEMS APPROACH

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Worldwide, most plant pathologists being trained to work in the tropics receive training which overemphasizes the scientific disciplines and does not give sufficient emphasis to other important discipline areas, especially those that consider the nature of small farmers and their farming systems in the tropics. The products of such training often have serious difficulties and make errors in planning and implementing their strategies for controlling plant diseases in the tropics, especially those that occur on the food crops of small farmers. It is not enough to understand the host, the pathogen, and the physical environment. An understanding of the fragile tropical ecosystems and their transformation into agroecosystems is also important. In addition, we must also understand much more of the human and socio-economic factors that impinge upon plant disease control. Plant pathologists (and other agricultural scientists planning to work in the tropics) should become aware of and more sensitive to the importance of the culture, customs, traditions, history, politics, sociology, religions, and economics of tropical regions in which we plan to work. Technical problems in the tropics are usually relatively simple in comparison to the socio-economic problems.

Why emphasize small farmers? It has been estimated that one-half of the people of the world depend on a subsistence (mainly traditional) type of agriculture, and that 40% of the world's land area is in the hands of the subsistence farmer (Wellhausen 1970). More recently, Haskell et al. (1981) stated that small farmers work about 65% of all usable arable land in the world. If significant increases could be made in production on this land, it should help to alleviate world food problems. We agricultural scientists know how to help educated farmers with access to land and credit engaged in modern agriculture, but we have had less success in improving the welfare of the small farmer. Poverty and socio-economic insecurity characterize the lives of a large sector of the rural populations in the tropics, and this is especially severe in that vast group with limited resources constituted by small, "traditional", and subsistence farmers.

One approach which is useful in understanding the socio-economic factors that influence small farmers is the farming systems approach. Many involved in international development believe that if there is to be an improvement in helping small farmers, such a new approach is required -- one which has its initial focus not only on crops and animals, but also on the farm family and its farm. The approach constitutes studying the farm household and its activities, both on and off the farm, looking at cropping and animal systems, the interactions between and within these as the farmers engages in practicing them, farmer's interactions with other farmers, the role of women in farming, the market, and the region in which the farmer lives. The goal of farming systems research (FSR) is to provide technologies that will increase production and incomes for peasant or limited-resource farmers of developing countries. In practice, FSR generally consists of four stages; description/diagnosis, design, testing,

Presented at the meeting of the Sociedad Mexicana de Fitopatologia and the Caribbean Division of the American Phytopathological Society, Guanajuato, Mexico, September 11-14, 1985.

and extension. There is currently disagreement among FSR practioners whether, for the description/diagnosis stage a rapid appraisal (characterized by some as a "quick and dirty" survey) is sufficient, or whether a longer, more thorough study (perhaps lasting years) is needed to provide a complete picture of the farm system. FSR involves problem identification with the active participation of the farm family, and thus provides a two-way flow of knowledge between farmers and researchers.

Most discussions of the conceptual origins of the farming systems approach suggest that the disappointing results of traditional commodity-oriented or discipline-oriented agricultural research to improve the production and incomes of small farmers with successful and useful new technologies stimulated the national research programs and international research centers to develop the farming systems approach. Mexico, especially through the Puebla Project (CIMMYT 1974), was one of the early leaders in the development of the farming systems methodology and philosophy. Although millions of small farmers are benefiting from the "green revolution" in agriculture which brought about the remarkable increases in the yields of staple crops such as wheat and rice in Asia, one of its most disturbing aspects was that it did not seem applicable to many small farmers, especially those of the tropics of Latin American and Africa. Constraints faced by these farmers often did not permit utilization of the new technologies, and indeed many recommendations did not appear to be relevant to their conditions.

It has become increasingly clear over the last few decades that much of the agricultural technology which has been so successful in temperate areas has only a limited application in the tropics. Small farmers are not always interested in maximizing yields, but rather in having stable, reliable yields. To do this they have to minimize risks and not take chances that may lead to hunger, starvation, or losing their land. Nevertheless, most agricultural projects are primarily concerned with maximizing yields and increasing production. There is also increasing evidence that many of the decisions made by small farmers are rational, that they innovate, and that they will change if agricultural innovations are sound and do not involve undo risk.

Much has been written on tropical farming systems (Harwood 1979, Ruthenberg 1971, Shaner et al. 1979), and many projects bearing the farming systems label are found in the tropics. It is far too early to be judgmental about the potential of the farming systems approach for helping small farmers, but the following is clear. First, the old style commodity or discipline-oriented agricultural research does not seem to be able to solve the problem of raising the incomes of small farmers while increasing food production, and secondly, the farming systems approach will not bring quick or easy solutions to the problems of small farmers. To date FSR has contributed little to the welfare of small farmers. Successful FSR projects will take even longer than traditional agricultural research projects to produce significant, measurable results and this is a reality difficult to accept for international and national aid agencies that want results in one or a few years. Nevertheless, some aspects of the farming systems approach are essential if the small farmer is to be helped. Plant pathologists (and other agricultural scientists) need to become familiar with the farming systems approach, and seriously consider incorporating some of its methodology and philosophy into the design of disease management strategies.

In order to illustrate how inadequate training can lead to errors in judgement when working with small farmers in the tropics, I will use a few examples from my personal experience. In June of 1954 I went to Colombia, South America as an Assistant Plant Pathologist with the Rockefeller Foundation. My knowledge of the country was essentially zero. I had to look up its location in an atlas and knew not one word of Spanish. Because of my lack of experience and training, I knew almost nothing of the culture, customs, traditions, history, religion, or sociology of Colombia. I had seen Andean peasants only in picture books and had no inkling that thousands of years of agricultural trial-and-error, observation, and natural selection were behind what seemed to me to be apparently haphazard or "primitive" farming systems.

I was hired by the Rockefeller Foundation to work in their agricultural program with the Colombian Ministry of Agriculture; specifically with potatoes. Fortunately, I did know something about potatoes, as I had received a M.S. degree in plant pathology from the University of Minnesota and had done my thesis on late blight of potatoes, a disease of worldwide importance. After a few months in Colombia (which included a severe case of culture shock), and after I had had time to see how potatoes were grown and to travel a bit, I decided that almost everything the farmers were doing relative to growing potatoes was wrong. They planted whole tubers and not cut seed as was done in Minnesota, they used very small tubers for seed (often 3-4 tubers per hill) rather than a single 30-40 g seed piece of optimal size as was done back home and, they planted seed 50-60 cm between plants rather than the 20-30 cm recommended in Minnesota. Rows were 150 cm apart rather than the 90 cm row spacing Minnesota growers used.

The fungicides used for disease control were ineffective, herbicides were not used, storage procedures were appalling, and so forth. Almost all cultural procedures were "a mano", ie. done by hand. On steep hillsides (where I eventually discovered that the vast majority of Colombian potatoes were grown) that was understandable, but in the level Sabana de Bogota where our experiment station was located I reasoned that large tractors and machinery such as that used in Minnesota were appropriate. Thus, I ordered a huge potato harvester that simultaneously dug two rows of potatoes and put them directly into a truck. The machine was the most useless thing one could imagine for Colombian potato farmers and their conditions. Labor was less than $1.00 (U.S.) per day, and thus obtaining inexpensive labor for harvesting was not a major problem. The machine lasted barely two years before it broke down and became useless for lack of spare parts. By that time I had come to realize that perhaps it was not "appropriate" technology for Colombia.

Another order was for a 300 gallon, 14 row, John Bean potato sprayer. Insects and late blight of potatoes (caused by the fungus *Phytophthora infestans*) are serious problems in Colombia, and potatoes had to be sprayed frequently in order to obtain economic yields. The sprayer was useful on our experiment station; we grew up to 100 hectares of potatoes on level ground, but using it for fungicide tests was not appropriate for most Colombian conditions. It took some time for me to realize that perhaps only 5% of the potatoes in Colombia could be sprayed with such a machine because of the steep slopes where most were grown. At that point we began using portable, back-pack sprayers for our fungicide tests as most growers in the country used them, and the data were obtained using them was much m· ·e meaningful to Colombian growers than that obtained with a 300 gallon sprayer hardly any of them could afford.

Almost all growers in the Andes of South America plant whole seed (tubers) rather than cut seed which is commonly used in the United States. It is well known that cutting seed is an excellent way to spread pathogens (especially bacteria and viruses), but we are able to use cut seed in the USA because of excellent seed certification programs and sound sanitation practices. Nevertheless, serious problems due to the use of cut seed still cause serious losses in the USA. With my temperate zone mind-set in 1954 I believed we should use cut seed as the growers in Minnesota did, especially so that we could use the tuber unit method for reducing viruses. This is a method whereby a tuber is cut into four pieces and planted with a space between it and other tubers. This practice greatly facilitates field removal of virus infected plants and in the 1950's was considered essential in the USA to a good seed certification program. In 1955 the potato program of DIA (Division of Agricultural Research of the Colombian Ministry of Agriculture) in cooperation with the Caja Agraria (a semi-official agricultural bank which was in charge of seed production for DIA), began increase of the improved variety Monserrate which held great promise for potato culture in Colombia because of its productivity, high degree of general resistance to Phytophthora infestans, yield, and other excellent agronomic characters. Incidently, Monserrate is still highly resistant to P. infestans today. By 1959 a total of 700 tons of Monserrate seed was available for use by farmers. Almost all multiplication was done using cut seed pieces, although customarily whole tubers were used in Colombia for planting. During the second growing season of 1959 about 30 hectares of Monserrate were planted by the Caja Agraria on the farm "Valmaria" near Bogota at an elevation of 8600 feet.

This planting represented about 50% of the Monserrate seed available for the entire country for the coming season. At harvest time approximately 30% of the tubers were infected with Pseudomonas solanacearum (the bacterium which causes bacterial wilt of potatoes). This disease, although common on potatoes in many countries at lower elevations, had only been reported a few times at high elevations in Colombia. This loss was a severe blow to the potato program of DIA since the infected seed from this farm had to be discarded or sold for human consumption. Similar seed in the hands of several private growers who cut their seed, following DIA recommendations, produced fields with 100% infection by P. solanacearum. As a result of these losses from bacterial wilt, growers and the Caja Agraria became convinced that Monserrate was highly susceptible to the disease and demand for seed declined drastically. In fact, the Caja Agraria almost terminated its national seed multiplication program. In subsequent years, when whole seed pieces were planted in the same fields, no detectable infection occurred. Our program reverted entirely to using only whole seed, and subsequently we never had another problem with P. solanacearum in our station (Thurston 1963). We finally came around to using a practice farmers knew was practical for their conditions.

Colombian farmers probably had discovered over the centuries that cut seed would not produce a crop. We scientists had to rediscover what the peasant farmers of Colombia already knew. Many (not all) of the practices of Colombian potato farmers had sound reasons for their existence which we could not initially discern. Most traditional methods of crop production -- and protection -- were probably developed empirically through centuries of trial-and-error, natural selection, and observation (Glass and Thurston 1978).

What I have attempted to do in this paper is illustrate that because of my early lack of education or experience relative to traditional farmers and traditional agriculture in Colombia, my judgement on technology recommendations and appropriate areas of research in my first years there was poor. Subsequently, I spent a total of 11 years in Colombia and am proud of my association with ICA (Colombian Agricultural Institute) and the Rockefeller Foundation. In later years I believe I became useful and productive to the Colombian agricultural program, especially after I gained respect and appreciation for the knowledge of small farmers and the basic soundness of their farming systems.

Most projects intending to improve the lot of small farmers have failed due to a lack of understanding of how and why traditional tropical agriculture works. I wish to emphasize the point that we in the temperate regions (our governments, universities, and private organizations) are still sending agricultural scientists to the tropics into difficult, complicated environments with the same lack of training and experience I had initially. Scientists are sent who have almost no understanding of or sensitivity to the agronomic and socio-economic problems of the tropical regions and with the same mind-set I had, ie. that the only way to make progress is to do it like it was done back home. Not only the USA, but most temperate countries of North America, Europe and Asia are doing the same to some degree. I suspect that Mexican plant pathologists trained in the temperate areas of Mexico have similar problems when they try to work with small farmers in the tropics of Tabasco, Chiapas, Quintana Roo, or Yucatan.

The tropics is a poorly understood region of the world, especially by those of us that come from temperate areas. It is strikingly diverse and includes forests, deserts, grasslands, mountains, and maritime regions. Although the seasonal temperature extremes of the temperate regions do not occur, considerable seasonal changes in rainfall occur and daily temperature fluctuations are common. Altitude greatly affects climate in the tropics. Climbing upwards about 100 m on the equator is equivalent to traveling 160 km towards the north in a temperate country (Wellman 1962). Tropical ecosystems are generally highly complex when compared to those in temperate areas. For example, Mt. Maquiling near Manila, a mountain about 1130 m high and about eight km in basal diameter, has about twice as many species of woody plants as the whole United States (Stevens 1932). Probably twice the number of crop plants are grown in the tropics as are grown in the temperate zones, and thus it is extremely difficult for plant pathologists to recognize and study all the diseases of potential importance in any specific tropical country.

The farming systems of most small farmers are highly complicated and their knowledge is often broad and impressive. A few examples can illustrate this statement. In a 30,000 hectare area of the Quimiag-Penipe project near Riobamba in Ecuador, over 100 different crop associations grown by peasants were found by Kirkby et al. (1980). Brush (1977) in describing the agriculture of an isolated mountain valley in Peru (Uchucmarca) states "There are more than 2,000 named potato varieties in Peru; in Uchucmarca alone, the peasants can identify 50 varieties". Describing the agricultural knowledge of a traditional tribe Conklin (1954) states: "The Hanunoo, a mountain people of Mindoro in the Philippines, know 10 basic and 30 derivative soil and mineral categories. They also understand the suitability of each for various crops as well as the effects of erosion, exposure, and over-farming. Their repertoire of 1500 useful plant types includes 430 cultigens". Mayan Indians in Mexico have their own comprehensive plant classification system. Berlin et al. (1974) describes the Mayan (Tzeltal) system as follows: "At this time, a total of 471 mutually exclusive generic taxa have been established as legitimate Tzeltal plant groupings".

Another illustration of the complexity and knowledge of small farmers can be gained by considering a traditional maize field near harvest in Mexico. Farmers in Mexico have been growing maize for perhaps 7000 years, so they have accumulated considerable experience with the crop. First, the maize varieties grown are native landraces, as they are best adapted to the area. The maize is not growing as a monoculture, but rather is being grown with squash and climbing beans. Numerous studies have shown that not only total economic yields, but nutritional yields are often superior with this cropping system. Other benefits may also occur; as, according to Van Rheenen et al. (1981), a cultural control of the major bean diseases in Kenya is effected by growing beans in association with maize. A temperate zone farmer might not approve of the appearance of the Mexican maize field, as it is near harvest time and the field is choked with weeds. Studies have found that farmers weed their fields for about 90 days and then let the weeds grow. Under their conditions little additional yield results from weedings after 90 days. Furthermore, the weeds are used as fodder for animals in the dry season, and the farmers have noted that there is far less wind and water erosion when weeds cover a field. Perhaps 40 species of weeds found in Mexico corn fields are also eaten as pot herbs by small farmers according to Ing. Efraim Hernandez X., and some are allowed to produce seed in order to encourage future seedings. Thus, the weeds in the fields are not there because of bad farming practices. The maize plants have been stripped of their leaves and tassels. This material was fed to animals as forage. In addition, the ears have been bent over (doblando la mazorca), as farmers have found that the grain dries better on the plant in the sun than in storage, is less accessable to rodents and birds, and reaches such a low moisture content that storage deterioration is reduced. To summarize, although the fields may look haphazard and poorly cared for to the temperate observer, the Mexican traditional farmers have sound reasons for their practices.

The above examples give a few insights into the often broad, accurate, and useful knowledge of traditional farmers.

The remarks of Haskell et al. (1979) summarize the complexity and challenge of traditional agriculture: "It is now becoming recognized that any attempt to import technological change in ignorance of, even in defiance of, the socio-cultural background of small farmer practice is a recipe for disaster. The basic reason is simple; traditional peasant systems of agriculture are not primative leftovers from the past, but are, on the contrary, systems finely tuned and adapted, both biologically and socially, to counter the pressures of what are often harsh and inimical environments, and often represent hundreds, sometimes thousands, of years of adaptive evolution in which the vagaries of climate, the availability of land and water, the basic need of the people and their animals for food, shelter, and health, have been amalgamated in a system which has allowed society to exist and develop in the face of tremendous odds".

Although the situation has improved in recent years, many plant pathologists (and other agricultural scientists) going to a tropical assignment still do not receive adequate training to work with small farmers or their tropical farming systems. They may be well prepared in their field of specialization as regards the temperature regions, but they seldom have a sound understanding of how to work most effectively in a tropical environment. It is important for those interested in tropical agriculture and development to receive special education and training in preparation for a career in the tropics. This education should include not only a sound professional training, but also language competence, courses and seminars dealing with the nature of the tropics especially as related to their subject matter field, courses on socio-economic aspects of the tropics, an introduction to the philosophy and methodology of the farming systems approach, and an opportunity to work and live in a tropical environment before graduation. When possible and appropriate, thesis research (especially at the Ph.D. level) should be done in a tropical environment.

The type of training should produce professionals with a real backgrond of competence, training, and aptitude for working abroad in the tropics. There is a saying that goes as follows: "almost everyone is good for something, you can always serve as a horrible example". Unless we make a serious effort to train plant pathologists in something more than the science of plant pathology, we will be sending out more "horrible examples" who may be good plant pathologists, but who are culturally insensitive and ill-prepared for solving the food production problems of the tropics.

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Y LA FILOSOFIA DE SISTEMAS AGRICOLAS

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En todo el mundo, la mayoría de los Fitopatólogos que son entrenados para trabajar en los trópicos reciben adiestramiento con demasiada énfasis sobre disciplinas científicas y no se le da suficiente atención a otras importantes áreas especialmente aquellas que consideran la naturaleza de agricultores pequeños y de sus sistemas de labranza en los trópicos. Como producto de tal entrenamiento a menudo se tienen dificultades muy serias y se cometen errores en planeación o implementación de sus estrategias para controlar enfermedades de plantas en los trópicos, especialmente en aquellos casos donde se trata de cultivos comestibles de agricultores pequeños. No es suficiente con entender al hospedante, al patógeno y al ambiente físico. También es importante entender a los frágiles ecosistemas tropicales y su transformación en agroecosistemas. Debemos entender mucho más de los factores humanos y socio-económicos que chocan con el control de enfermedades de plantas. Los Fitopatólogos (y otros científicos agrícolas que planean el trabajo en los trópicos) deben entender y ser más sensibles a la importancia de la cultura, costumbres, tradiciones, historia, política, sociología, religiones, y la economía de las regiones tropicales en las cuales planean trabajar. Los problemas técnicos en los trópicos en general son relativamente simples en comparación con los problemas socio-económicos.

¿Por qué enfatizar sobre agricultores pequeños?. Se ha estimado que la mitad de la población del mundo depende de un tipo de agricultura de subsistencia (principalmente tradicional) y que el 40% de la superficie de la tierra está en las manos de estos agricultores de subsistencia (Wellhausen 1970). Mas recientemente, Haskell *et al.* (1981) declararon que los agricultores pequeños trabajan aproximadamente el 65% de toda la tierra cultivable del mundo. Si se pudieran hacer aumentos significativos en la producción de esta tierra, se ayudaría a aliviar los problemas de alimentación en el mundo. Como científicos agrícolas, sabemos cómo ayudar a los agricultores educados que tienen acceso a la tierra y al crédito en una agricultura moderna, pero hemos tenido mucho menos éxito en mejorar las condiciones de vida del pequeño agricultor. La pobreza y la inseguridad socio-económica caracterizan las vidas de un gran sector de la población rural en los trópicos, y ésto es especialmente severo en aquel vasto grupo con recursos limitados, que constituyen los agricultores pequeños, "tradicionales", y de subsistencia.

Una estrategia que es muy útil en el entendimiento de los factores socio-económicos que influencían a los agricultores pequeños es el enfoque de sistemas agrícolas. Muchas personas involucradas en el desarrollo internacional creen que para lograr una mejoría en la ayuda de los pequeños agricultores, se requiere de una nueva estrategia que ponga su enfoque inicial no solo en cultivos y en animales, sino también en la familia del agricultor y su propiedad. La estrategia incluye el estudio de las actividades de toda la familia tanto dentro como fuera de su propiedad, observando los sistemas de cultivo y de explotación animal y como el agricultor se involucra al practicarlas, las interacciones del agricultor con otros agricultores, el papel de la mujer en la explotación agrícola, el mercado, y la región en la cual el agricultor vive. La meta de la investigación en sistemas agrícolas (ISA) es proveer de tecnología que aumente la producción y los ingresos de campesinos o agricultores con recursos limitantes de los países en desarrollo. En la práctica, la ISA generalmente consiste de cuatro fases: descripción/diagnosis, diseño, prueba y extensión. Existe en la actualidad un desacuerdo entre los promotores de la ISA referente a que para la primera fase, para algunos es suficiente con una apreciación rápida (caracterizada por algunos como una encuesta "rápida y sucia") mien tudio más prolongado, más profundo, que tal vez lleve años para lograr obtener un panorama completo del sistema agrícola. En la ISA se busca la identificación del problema, con la participación activa de la familia campesina y así provee un flujo en dos direcciones de conocimiento entre los agricultores y los investigadores.

La mayoría de las discusiones sobre los orígenes conceptuales del enfoque de sistemas agrícolas sugieren que los resultados desalentadores de la investigación agrícola convencional u orientada hacia las disciplinas, estimularon a los programas nacionales de investigación y a los centros de investigación internacionales a desarrollar las estrategias bajo el enfoque de los sistemas agrícolas. México, especialmente a través del Plan Puebla (CIMMYT 1974), fue uno de los primeros líderes en el desarrollo de las metodologías para el estudio de los sistemas agrícolas y su filosofía. Aunque millones de pequeños agricultores se están beneficiando de la "revolución verde" en agricultura, la cual trajo un aumento considerable en los rendimientos de cultivos básicos tales como trigo y arroz en Asia; uno de sus aspectos más preocupantes fué que parecía que no era aplicable a muchos de los agricultores pequeños, especialmente a aquellos de los trópicos de América Latina y Africa. Limitantes encaradas por estos agricultores a menudo no permitían la utilización de las nuevas tecnologías, y de hecho muchas recomendaciones no parecían ser relevantes a sus condiciones.

Ha resultado evidente en las últimas décadas que una gran parte de la tecnología agrícola que ha sido muy éxitosa en las áreas templadas tiene aplicaciones limitadas en los trópicos. Los pequeños agricultores no están siempre interesados en maximizar sus rendimientos, si no más bien en tener rendimientos estables y confiables. Para hacer esto, tienen que minimizar riesgos y no arriesgar en algo que pueda conducirlos al hambre, a la anición, o a perder sus tierras. A pesar de lo anterior, la mayoría de los proyectos agrícolas están enfocados primordialmente en maximizar los rendimientos. Hay una evidencia cada vez mayor respecto al hecho de que muchas decisiones hechas por pequeños agricultores son innovadores, y que indican que el agricultor va a cambiar si las innovaciones agrícolas son sensatas y no involucran ningún riesgo.

Se ha escrito mucho sobre los sistemas agrícolas tropicales (Harwood 1979, Ruthenberg 1971, Shaner *et al.* 1979), y se encuentran en los trópicos muchos proyectos que ostentan la etiqueta de sistemas agrícolas. Aún es temprano para juzgar en relación al potencial las estrategias desarrolladas bajo este enfoque para ayudar a los pequeños agricultores, pero lo siguiente es claro: Primero, el viejo estilo de investigación agrícola orientada o aumentar los rendimientos o hacia las disciplinas no parece ser capaz de resolver el problema de el incremento en los ingresos de los pequeños agricultores mediante incremento en la producción y segundo, las estrategias bajo el enfoque de sistemas agrícolas no traerán soluciones rápidas o fáciles para los problemas de los pequeños agricultores. A la fecha, el enfoque de ISA ha contribuido poco en el mejoramiento de los campesinos. El éxito de estos proyectos llevará más tiempo que los proyectos de investigación agrícola tradicional para producir resultados significativos y medibles, y ésta es una realidad difícil de aceptar por parte de la agencias de ayuda internacional y nacionales que requieren resultados en uno o varios años. No obstante, algunos aspectos de los sistemas de explotación son esenciales si se va a ayudar a los pequeños agricultores. Los Fitopatólogos (y otros científicos agrícolas) necesitan familiarizarse con los sistemas de explotación agrícola y considerar seriamente la incorporación de algunas de sus metodologías y filosofías en el diseño de las estrategias del manejo de enfermedades.

Para ilustrar como es inadecuado el entrenamiento y como nos puede conducir a errores de juicio cuando trabajamos con campesinos en los trópicos, usaré algunos ejemplos de mi experiencia personal. En Junio de 1954 fuí a Colombia, en Sudamérica, como un Fitopatólogo asistente de la Fundación Rockefeller. Mi conocimiento del país era esencialmente nulo. Tuve sabía una sola palabra de español. Debido a mi falta de experiencia y entrenamiento no sabía casi nada de la cultura, costumbres, tradiciones, historia, religión o sociología de Colombia. Había visto campesinos de los Andes únicamente en fotografías de libros y no tenía ni la menor idea de los miles de años en los que la observación, la prueba y el error en agricultura, y la selección natural, estaban detrás de todo eso que, para mí, parecían sistemas de agricultura primitivos o casuales.

Fuí contratado por la Fundación Rockefeller para trabajar en su programa agrícola con el Ministerio de Agricultura de Colombia; específicamente con papa. Afortunadamente sabía yo algo sobre papas, ya que había recibido mi Maestría en fitopatología en la Universidad de Minnesota, y había realizado mi tesis sobre "Tizón tardío" de la papa, una enfermedad de importancia mundial. Después de unos cuantos meses en Colombia (que incluyeron un caso severo de choque cultural) y después de haber tenido tiempo para ver como se cultiva la papa por allá, y de viajar un poco, decidí que casi todo lo que los agricultores hacían, con relación al cultivo de la papa, estaba equivocado. Sembraban tubérculos completos y no "semilla cortada" como se hacía en Minnesota, empleaban tubérculos pequeños como semilla, (con frecuencia sembraban 3 a 4 tubérculos por sitio) en lugar de sembrar 1 semilla (fragmento óptimo de 30 - 40g) por sitio como se hacía en mi tierra y, sembraban a una distancia de 50 - 60 cm entre plantas y no a 20 - 30 cm como se recomendaba en Minnesota. La distancia entre surcos era de 150 cm y no de 90 cm como lo hacían los agricultores de Minnesota.

Los fungicidas empleados para el control de enfermedades eran inefectivos, los herbicidas no se usaban, los procedimientos de almacenamiento eran hechos a mano; sobre las laderas de montañas (donde eventualmente descubrí que se realizaba la mayor parte del cultivo de papa en Colombia) era entendible, pero en las sabanas planas de Bogotá, donde se ubicaba nuestra estación experimental, consideré que sería apropiada la maquina

Minnesota.

Entonces, ordené que se trajera una cosechadora de papa gigantesca que simultáneamente podía excavar dos surcos de papa y ponerla directamente en el camión. Esta máquina era la cosa más inútil que uno pudiera imaginar para los cultivadores de papa colombianos y sus condiciones. El costo de mano de obra era menos de un dólar norteamericano al día, por lo que obtener mano de obra barata para cosechar no era mayor problema. La maquinaria duró escasamente dos años antes de que se rompiera y de que se convirtiera en algo inútil por falta de refacciones. En ese tiempo me dí cuenta que tal vez esa no era la tecnología apropiada para Colombia.

Otra orden fue que nos enviaran una aspersora con capacidad de casi 1,200 litros, para asperjar 14 surcos de plantas de papa. Dos problemas serios en Colombia son los insectos y el tizón tardió (causado por el Hongo *Phytophthora infestans*) Por lo que la papa tenía que asperjarse frecuentemente para obtener rendimientos económicos. La aspersora fué útil en nuestra estación experimental; cultivamos hasta 100 hectáreas de papa en un terreno nivelado, pero el usarla en pruebas de fungicidas no era apropiado para la mayoría de las condiciones colombianas. Me llevó algún tiempo darme cuenta que tal vez solo el 5% del área cultivada con papa en Colombia podría ser asperjada con una máquina como ésa porque las pendientes eran muy pronunciadas en la mayor parte de los lugares donde se cultivaba papa. En ese momento empezamos a utilizar aspersoras portátiles, que se podían cargar en la espalda, para nuestras pruebas de fungicidas, como la mayoría de los cultivadores de maíz lo hacen, y los datos que se obtuvieron usando estas aspersoras eran más significativos para los agricultores colombianos que aquellos obtenidos con la aspersora de más de los 1000 lts. que difícilmente hubiera podido comprar alguno de los agricultores locales.

Casi todos los cultivares en los Andes de Sudamérica plantan semilla com cortada que es comúnmente usada en los Estados Unidos de Norteamérica. Es bien sabido que la semilla cortada es una manera excelente de dispersar a los patógenos (especialmente bacterias y virus), pero nosotros somos capaces de utilizar semilla cortada en Norteamérica por los programas tan excelentes de certificación de semilla y por las prácticas tan firmes en el aspecto fitosanitario. No obstante, aún persisten serios problemas en los Estados Unidos debido al uso de semilla cortada que causan pérdidas considerables. Con mi mente aún ubicada en las zonas templadas, en 1954 pensé que podríamos utilizar semilla cortada como lo hacen los agricultores de Minnesota, especialmente de tal forma que pudieramos utilizar el método de la unidad de tubérculo para reducir la incidencia de virus. Este es un método donde un tubérculo se corta en cuatro partes y se coloca en el suelo dejando cierto espacio entre unos y otros tubérculos. Esta práctica facilita enormemente la eliminación en el campo de plantas infectadas de virus y en la década de los 50's se consideraba esencial en Estados Unidos de Norteamérica para un buen programa de certificación de semilla. En 1955 el programa de papa de DIA (División de Investigación Agrícola del Ministerio de Agricultura de Colombia) en cooperación con la Caja Agraria (es un Banco semioficial agrícola que tiene a su cargo la producción de semilla para DIA) empezaron a incrementar la variedad mejorada Monserrate, que era muy prometedora para el cultivo de papa en Colombia debido a su productividad, alto grado de resistencia horizontal a *Phytophthora infestans*, rendimiento y otras características agronómicas excelentes. Incidentalmente Monserrate es aún altamente resistente al hongo hoy en día. Para 1959 se disponía de un total de 700 toneladas de Monserrate para los agricultores. Casi toda la multiplicación se hizo usando fragmentos de tubérculos, aunque por lo general se usaban tubérculos completos para las plantaciones en Colombia. Durante el segundo período de crecimiento de 1959 se plantaron alrededor de 30 hectáreas de Monserrate por parte de la Caja Agraria en el Rancho "Valmaria" cerca de Bogotá a una elevación de poco más de 2,500 mts. sobre

Esta plantación representó cerca del 50% de la semilla de Monserrate disponible para todo el país para la siguiente fecha de siembra. Al momento de la cosecha aproximadamente el 30% de los tubérculos resultaron infectados con *Pseudomonas solanacearum* (la bacteria que causa el marchitamiento bacterial en papas). Esta enfermedad, aún cuando es común en la papa en muchos paises a bajas elevaciones sobre el nivel del mar, solo se había reportado unas cuantas veces en las tierras altas de Colombia. Esta pérdida era un golpe severo para el programa de papa del DIA debido a que la semilla infectada de este Rancho tenía que ser eliminada o vendida para consumo humano. Semilla similar, en manos de algunos productores privados que cortaron su semilla, siguiendo las recomendaciones del DIA produjeron rendimientos con 100% de infección por la bacteria. Como resultado de estas pérdidas por marchitez bacteriana, los agricultores y la Caja Agraria se convencieron de que Monserrate era altamente susceptible a la enfermedad y la demanda por esta semilla disminuyó drásticamente. En años subsecuentes, cuando se sembraban tubérculos completos en los mismos campos no se detectó infección. Nuestro programa tuvo que cambiar y usar únicamente semilla completa, y subsecuentemente nunca tuvimos otro problema con *P. solanacearum* en nuestra estación experimental (Thurston, 1963). Fuimos entonces nosotros quienes finalmente cambiamos nuestras prácticas hacia aquellas que los agricultores sabían que eran las apropiadas para sus condiciones.

Los agricultores colombianos posiblemente a lo largo de varios siglos habían descubierto que la semilla cortada no producía un cultivo. Nosotros los científicos tuvimos que redescubrir aquello que los campesinos colombianos ya sabían. Muchos (no todos) de los procedimientos de los agricultores paperos colombianos tenían razones de peso para su existencia, que nosotros no podíamos discernir inicialmente. La mayoría de las prácticas culturales tradicionales en la producción y protección, se fueron desarrollando probablemente en forma empírica a través de los siglos en prueba y error, selección natural, y observación (Glass y

Thurston, 1978).

Lo que he intentado hacer en esta exposición es ilustrar el hecho de que debido a mi falta de educación o falta de experiencia inicial relativa a los agricultores tradicionales y a la agricultura tradicional en Colombia, mi juicio sobre las recomendaciones tecnológicas y áreas apropiadas de investigación en mis primeros años fué erróneo. Subsecuentemente, permanecí un total de 11 años en Colombia y estoy orgulloso de mi asociación con el ICA (Instituto Colombiano Agropecuario) y con la Fundación Rockefeller. En los últimos años creo haber resultado útil y productivo para el programa agrícola de Colombia, especialmente después de haber aprendido a respetar y a apreciar el conocimiento de los pequeños agricultores y lo saludable y apropiado de sus sistemas agrícolas, para sus condiciones.

La mayoría de los proyectos que pretenden mejorar a la gran mayoría de los agricultores pequeños han fallado debido a la falta de entendimiento de el cómo y el por qué de cada una de las labores de la agricultura tradicional tropical. Deseo enfatizar el punto de que nosotros, en las zonas templadas (nuestros gobiernos, universidades, y organizaciones privadas) aún estamos enviando científicos agrícolas a los trópicos, a ambientes difíciles y complicados, con la misma carencia de entrenamiento y experiencia que yo tenía inicialmente. Los científicos que son enviados carecen del entendimiento y la sensibilidad a los problemas agronómicos y socio-económicos de las regiones tropicales y con la misma actitud que yo tuve la de considerar que el único camino para lograr progreso es el hacer las cosas como se hacen en mi tierra. No solamente los Estados Unidos, sino la mayoría de los paises templados en Norteamérica, Europa y Asia están haciendo lo mismo hasta cierto punto. Sospecho que los Fitopatólogos Mexicanos entrenados en las áreas templadas de México tienen problemas similares cuando tratan de trabajar con pequeños agricultores de los trópicos en Tabasco, Chiapas, Quintana Roo, o Yucatán.

Los trópicos son una región pobremente entendida del mundo, especialmente para aquellos de nosotros que venimos de áreas templadas. Es impresionantemente diversa e incluye bosques, desiertos, praderas, montañas, y regiones marítimas. Aún cuando no ocurren en ellas los extremos estacionales de temperatura, se presentan cambios por temporadas considerables en el régimen de lluvia y son comunes las fluctuaciones diarias de temperatura. La altura sobre el nivel del mar también afecta grandemente el clima en los trópicos. Subir alrededor de 100 metros en el Ecuador es equivalente a viajar 160 kms. hacia el norte en un país templado (Wellman, 1962). Los sistemas tropicales son generalmente complejos cuando se les compara con aquellos de las zonas templadas. Por ejemplo, el monte Maquiling cerca de Manila, que es una montaña de aproximadamente 1130 mts. de altura y que tiene aproximadamente 8 kms. de diámetro basal, tiene aproximadamente el doble de especies de plantas leñosas del que tiene toda la parte continental de Estados Unidos (Stevens 1932). Probablemente se duplica el número de cultivos que se siembran en los trópicos en relación a los que se siembran en las zonas templadas, y de aquí que es extremadamente difícil para los Fitopatólogos reconocer y estudiar todas las enfermedades de importancia potencial en cualquier país tropical.

Los sistemas de explotación agrícola de la mayoría de los agricultores pequeños son altamente complicados y su conocimiento es a menudo amplio e impresionante. Unos cuantos ejemplos pueden ilustrar esta afirmación. En una área de 30,000 hectáreas en el proyecto Quimiag-Penipe cerca de Riobamba en Ecuador, Kirkby *et al.* (1980) encontraron más de 100 asociaciones diferentes de cultivos practicadas por los campesinos en esa área. Brush (1977) describiendo la agricultura de un Valle aislado montañoso en Perú (Uchucmarca) afirma que "hay más de 2,000 variedades de papa en Perú: simplemente en Uchucmarca, los campesinos pueden identificar 50 variedades". Describiendo el conocimiento de la agricultura tradicional de una tribu, Conklin (1954) declara: "Los Hanunoo, que son gente de

(PN-AAL-49909)

COMMODITY/DISCIPLINE LINKAGES WITH FARMING SYSTEM RESEARCH

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9/26/86

Most discussions of the origins of the farming systems approach suggest that the disappointing results of traditional commodity-oriented or discipline-oriented agricultural research to improve the production and incomes of small farmers with successful and useful new technologies stimulated the national research programs and international research centers to develop the farming systems approach. Although millions of small farmers are benefiting from the "green revolution" in agriculture which brought about the remarkable increases in the yields of staple crops such as wheat and rice in Asia, one of its most disturbing aspects was that it did not seem applicable to many small farmers, especially those of the tropics of Latin American and Africa. Constraints faced by these farmers often did not permit utilization of the new technologies, and indeed many recommendations did not appear to be relevant to their conditions. The goal of farming systems research (FSR) is to provide technologies that will increase production and incomes for peasant or limited-resource farmers of developing countries. FSR involves problem identification with the active participation of the farm family, and thus provides a two-way flow of knowledge between farmers and researchers.

It has become increasingly clear over the last few decades that much of the agricultural technology which has been so successful in temperate areas has only a limited application in the tropics. Small farmers are not necessarily interested in maximizing yields, but rather in having stable, reliable yields. To do this they have to minimize risks and not take chances that may lead to hunger, starvation, or losing their land. Nevertheless, most agricultural projects are still primarily concerned with maximizing yields and increasing production. There is also increasing evidence that many of the decisions made by small farmers are rational, that they innovate, and that they will change if agricultural innovations are sound and do not involve undo risk.

Much has been written on tropical farming systems and many projects bearing the farming systems label are found in the tropics. It is far too early to be judgmental about the potential of the farming systems approach for helping small farmers, but the following is clear. First, the old style commodity or discipline-oriented agricultural research does not seem to be able to solve the problem of raising the incomes of small farmers while increasing food production, and secondly, the farming systems approach will not bring quick or easy solutions to the problems of small farmers. To date FSR appears to have contributed little to the welfare of small farmers. The time frame in which FSR was to deliver great results was not realistic, and often more was promised than could be delivered. Successful FSR projects will take even longer than traditional agricultural research projects to produce significant, measurable results and this is a reality difficult to accept for international and national aid agencies that want results in one or a few years. Nevertheless, some aspects of the farming systems approach are essential if the small farmer is to be helped. Commodity and discipline oriented agricultural scientists need to become familiar with the farming systems approach, and seriously consider incorporating some of its methodology and philosophy into their teaching, research, and extension.

The following are some of the accomplishments of farming systems research relative to the linkages between commodity/discipline oriented scientists and farming systems research:

- Most agricultural scientists in both developed and third world countries have become aware of the farming system approach and the need to thoroughly understand the systems used by small farmers. However, many commodity/discipline oriented scientists still do not differentiate between cropping and farming systems research and many are still opposed through ignorance to the approach.

- No longer can human factors be ignored and only the technological factors be considered in teaching, research, and extension in agriculture. Much of the progress made in this regard has been due to the farming systems approach.

- Training in farming systems research has been incorporated into the curricula of many U.S. universities. This should have a positive effect in the long run on commodity/discipline oriented scientists.

The following are some of the needs to improve the interaction between commodity/discipline oriented agricultural scientists and farming system research:

- FSR is perceived by many commodity/discipline oriented scientists as becoming far too theoretical and complicated and the domain of agricultural economists and rural sociologists. This perception needs to be changed by incorporating more commodity/discipline oriented scientists into teaching and FSR projects.

- In looking at the literature, it appears that some important groups (ie. foresters, fish and wildlife scientists, natural resources, agricultural engineers, nutrition, etc.) have had little interaction and made few contributions to FSR.

- Few commodity/discipline oriented agricultural scientists can receive recognition for or publication "credits" (essential for tenure or advancement) for FSR research.

- Most of the emphasis of the farming systems approach has been on research and little emphasis seems to have been given to the dissemination of the results of research to the farmer target groups. In addition very few of the commodity/discipline oriented scientists ever see or have access to the FSR literature. In my discipline (plant pathology) the words farming systems research are almost never found in our professional journals and very few talks have been given at meetings that ever mention the subject. We could do a much better job of educating commodity/discipline oriented scientists about the concepts and philosophy of the farming systems approach.

• Far too much jargon has entered into the FSR literature. This sometimes annoys and often inhibits communication with commodity/discipline oriented scientists. "Upstream" and "downstream" are notorious examples of confusing, unclear, unnecessary jargon which is meaningless to most agricultural scientists. Jargon needs to be eliminated as much as possible from farming sytem vocabularies and literature.

My colleague Dr. Tully Cornick has pointed out that these terms hold another danger. They suggest a position held by many FSR practictioners that the on-farm phase of FSR can be separated from the largely commodity-oriented research of the international centers and universities. We artificially separate integral parts of the same research process, much as we might break up a farm system and look at crop or livestock systems without recognizing their function in supporting the farm system. This leads to methodological disputes and the flippant way in which FSR and commodity researchers dismiss the other's methods and approaches to research as irrelevant to their own work. Rather than recognizing that we are all applying different approaches to related problems, one could get the impression that even the technical aspects of FSR and commodity research are mutually antagonistic and incompatible. One of the reasons why FSR is failing is because ties to more basic agricultural research have been lost, and the basic research foundation upon which sucessful FSR depends is simply not there.

• Many commodity/discipline oriented scientists feel they have been "left out" of FSR projects and research. It is obviously impossible to have a representative of each important commodity (ie. corn, beans, squash, cassava, cabbage, plantains,etc.) and each important agricultural discipline (soils, plant pathology, entomology, nematology, weed science, statistics, nutrition, natural resources, forestry, engineering, etc.) incorporated into each project and course taught on FSR, but serious thought should be given to means of tapping these resources and making them feel they are a part of the farming system approach The alternative is too see FSR become entirely the domain of economists and sociologists.
(The primarily social science disciplines of the staff of the FSSP project illustrates this point very well).

• Probably the greatest need for the farming systems approach is the need for continuity of effort. Positive, measurable results from FSR projects will probably take decades, not a few years to achieve. Unfortunately international and national funding agencies have already lost much of their initial enthusiasm for the approach since it is becoming obvious that significant results can seldom be acheived in a few years. This is a tragic situation and FSR practitioners should make every effort to continue and strengthen linkages; not only with each other, but also with the commodity/discipline oriented scientists who at least got a fleeting glimpse of how the small farmers of the world might be helped in a realistic and significant manner. A few carefully selected regional efforts with adequate funding and good linkages with the commodity/discipline oriented researchers are needed to continue to develop methodology and research agendas.