THE NEED FOR, STRUCTURE, AND POSSIBLE FUNCTIONS OF A GEOGRAPHIC DATA-BASE IN THE PROCESS OF TECHNOLOGY TRANSFER TO THE SMALL FARMER

AGRO-ECOLOGICAL STUDIES UNIT - CIAT

Simon E. Carter

August 1984

THE NEED FOR, STRUCTURE, AND POSSIBLE FUNCTIONS OF A GEOGRAPHIC DATA-BASE IN THE PROCESS OF TECHNOLOGY TRANSFER TO THE SMALL FARMER

a) Agricultural Research and the Small Farmer

Concern for the increasing world food/population crisis has led to the allocation of resources by many organisations, private and public, to research into agriculture, with the goal of increasing the worlds supplies of food. At the primary level of research are the International Agricultural Research Centres (IARC's), of the CGIAR, each with research responsibility in specific crops, crop .systems or livestock systems. Their research is aimed primarily at food production on small farms.

Research into small-farm crop production can be justified on moral grounds, with the aim of increasing social equity amongst societies characterised by large proportions of the population having very low levels of living, and on economic grounds, with the aim of increasing production of basic food crops amongst the sector which is most efficient in producing those crops and which currently provides the majority of them in developing countries (see for example Crouch and de Janvry 1980).

In deciding to undertake research which will be of benefit to the small farmer, a research body has to be aware of the great range of factors that affect small scale agriculture, usually negative factors beyond the control of the farmer. This state of affairs ultimately controls the approach researchers can take in attempting to alleviate his problems and increase his well-being. Whether an overall success or

failure, the inapplicability of the technology developed in the "Green Revolution" to small farmers was a result of a failure to consider the conditions under which small farmers had to grow their crops. (Griffin 1979, Dahlberg 1979).

Nowadays the limitations on the resources of the small farmer are more fully understood, and acknowledged in the scientific research undertaken in agriculture (eg CIAT 1981). Technology development specifically for the small farmer is a reality. Furthermore, successes, and failures, are being analysed so that a deeper understanding of the requirements of the farmer vis new technology at a specific location is emerging. There are now a number of methodologies for dealing with the problem of incorporating farmer requirements into agricultural research programmes. Both Farming Systems Research, as described by Shaner et al. (1982) and more recently the so called Adaptive Agriculture Research of CENDA/Wageningen (CENDA 1983) present sensible approaches. I believe that it is now true to say that one could take any specific and small scale area of small farmers and, by applying a farming-systems, agrometeorological, and rural-sociological analysis to the area, define the precise requirements for agricultural technology aimed at improving their productivity and welfare utilising research undertaken at Regional, National and International levels.

The problem which arises at this point is that of involvement of Agricultural Research bodies in the process outlined above. From the point of view of the IARC's, the writer's particular concern, it is not possible for Research at the International scale to be organised in accordance with localised analysis of the small farmer's situation, for the obvious reasons of limited resources over the enormous areas

included in the mandate of these centres. Yet the acquisition of reasonably detailed information, on the broad changes in physical characteristics of the environment affecting crops and on socio-economic characteristics affecting farmers, is still crucial to developing successful research strategies in IARC's. It is hoped here to try and formulate a feasible approach to collecting and organising data on small-farmer agriculture for use in Agricultural Research, through a system which can be of use both to the IARC's and to National Agricultural Research bodies.

b) Provision of Information for Agricultural Research

Within the IARC's the role of Agrometeorological and environmental sciences has increased, both in providing detailed information on climate, soil and water-relations, and in various agro-ecozoning studies for the centres' crops. Crop-breeding programmes, agronomists, as well as physiological, entomological and phytopathological sub-sections within crop programmes all require information on the range of environments thoughout which a crop is grown. Such studies are essential in assessing the range of variations which must be considered in the development of new plant material and cultural practices.

Generalised inventories of areas with sufficient potential for the production of a crop are of little use in this process of information provision. Studies of existing land and climate resources, such as those of the FAO's agro-ecozones project (FAO 1980a), are of no use when detailed information on the changes in day-night temperatures which affect the incidence of a particular plant specific disease are required to assess the likely distribution of its occurrence, for example. Nor

are such inventories, based often on insufficient data, of relevance when we are supposed to be examining the conditions of the small farmer, often at the poorest extreme of the range of conditions found within any zone or mapping unit. It is not the purpose of this report to describe the precise data requirements relating to the physical environment needed in Agricultural Research. There is, however, a strong argument, in terms of efficiency and effectiveness of data collecting and processing, in basing information gathering or ecozone definition on the areas where a particular small-farm crop is being cultivated. In this way, provision of environmental data to researchers will be based soundly on the variation in conditions experienced amongst farmers in spatially separate areas. If this information can then be linked to that on farming systems, socio-economic conditions, markets and infrastructure, the various components of a crop research programme all begin to use common terms of reference.

The need for data on the areas where IARC programme crops are grown was given serious consideration by the TAC Farming Systems Research study (CGIAR-TAC 1978, 29-32), as base-data analysis, which was seen as the platform of information on which to build the strategies recommended to IARC's for conducting FSR, namely development of methodologies and of technology with wide applicability. Here, and developed further by Gilbert et al (1980) the question of utility of FSR in Agricultural Research at various levels was discussed, particularly in relation to the division of labour, in carrying out FSR, between the different organisations.

A full FSR programme, such as that described by Shaner et al (op. cit.) is a very lengthy process, and from the point of view of the IARC's is out of the question as a direct method of technology development and transfer. Yet numerous studies have pointed to the necessity of carrying out this sort of work prior to attempting to introduce new technology (for example see Navarro 1979, 1980; Barlow et al. 1983).

In addition, something not considered in these F.S.R. reviews was the role of social scientists in defining the constraints on technology development for small farmers. (eg Strobosch 1976, Spikers 1982, CENDA (op.cit). The necessity of these 2 approaches in a combined form for successful technology development was outlined by Dusseldorp (1977) when he suggested a relational framework for cooperation between social and agricultural scientists over the common ground between disciplines, ie production practices and inputs. This framework aimed at tailoring potential improvement of the system through technological development to the need to avoid increasing inequality in rural areas. De Janvry and Crouch (1980) echoed these sentiments, in suggesting technology diffusion through a framework of FSR within its socio-economic context. The need for this sort of approach at the level of the farmer is undoubted if one wishes to assess the requirements of new technology to comply with the aim of promoting welfare and equality in rural areas. ICRISAT's village level studies present one approach to integrating socio-economic factors with crop improvement, by assessing the reasons why the farmer adopts certain production strategies, and tailoring research to fit these. (ICRISAT 1980).

Given these requirements, the problem which faces Agricultural Research at all levels is adequately summed up by Gilbert et al (op.cit)) "At issue is not only the relationship of national programmes to FSR, but also the appropriate division of responsibilities among national, regional and international centres across the entire range of agricultural research activities" (p. 65). Detailed work such as FSR to determine farmers' requirements and socio-economic analyses, should theoretically be carried out at the level of national programmes, yet IARC's have a strong need for these types of information in the development of crop-breeding, utilisation studies, and general agronomic research. Furthermore, it is questionable whether many national agricultural research programmes have the resources, or often training and manpower, to carry out such work.

If we take seriously the comments and suggestions from the above mentioned studies, we are faced with a problem of collecting and collating vast amounts of information, for detailed use at the level of the farmer, and National Programme and for more generalised research policy design in IARC's. Mention has been given to the requirement of Base Data Analysis within IARC's as a back up to their own work, as laid down by CCIAR-TAC (op.cit). Yet given the overall connectivity of the problem of developing and diffusing new agricultural technology, it would seem logical to search for an information system geared to research at all the relevant levels, and on the basis of the farming system and socio-economic context, so that each stage in the research process can be based on the definition of the problem, to a greater or lesser degree of detail, at the farm-level.

c) A Comprehensive Data-Base System for Agricultural Research

Faced with the complexity of information requirements to assist in the development and diffusion of appropriate agricultural technology for the small farmer it has been necessary to examine the reasons why data provision is now so crucial to such agricultural research. Work at CIAT on Agroecozones and on the definition of cropping areas, has forced us to think more deeply about the potential role of a data base, within the crop programme approach, which might increase the effectiveness of the research process.

c.1) The Micro-Region Approach.

The answer appears to lie in the development of a system of homogeneous crop-specific regions or micro-regions, given their likely size. Homogeneous in the sense that they are defined on the basis of uniformity of climate and soils, reflected in the physiological behaviour of the crop, and on uniformity of the farming system or systems in which the specific crop of interest is present. Information is not solely limited to these areas, however, as will be described below.

Delimitation of homogeneous areas as a method with which to provide information on agriculture, specifically for purposes of research, is a relatively new technique. Specific regional descriptions of agriculture are certainly not so; as early as the eighteenth centery with the development of geography as an academic discipline, accounts of regional similarities between areas were being made. Regional Geography, as it is understood today, and Geography as a discipline were synonymous, the French being perhaps the greatest advocates of this approach.

The idea of delimiting areas of similar geographical and agricultural characteristics as an aid to planning and research policy, and the coining of the phrase "micro-regions," seems to have first been presented in the Brazilian Geographical and Statistical Institute's "Divisao do Brasil em Micro-Regioes Homogeneas" (Fundacao IBGE, 1968). This divided the country's federal states into geographically similar units, based on the municipios, the smallest administrative units, each micro-region consisting of one or more of these units, supposedly alike in character. Despite the fact that using the boundaries of administrative units to define such a zoning, which undoubtedly introduces some artificiality given their political rather than ecological boundaries, these micro-regions have formed the basis for the collection of data on Brazilian agriculture, including the census, and for planning and policy making studies. Later, in the "Areas de Concentracao da Agricultura Brasileira" (Vol's I-IV, Ministerio de Agricultura. Undated - Post 1972), an attempt was made, using their micro-region framework, to delimit the areas of production concentration for the country's major crops. This zoning aimed to create a system on which to base further data collection, and which would provide the necessary information in the design of agricultural support programs and resource allocation.

Arising from the recommendations of the CGIAR-TAC review on farming systems within the IARC's (op. cit), CIAT began the task of data-base analysis in the late 1970's. Already, the need for an Agroclimatology Study for the Bean Program had been recognised, and within the 1978 Annual Report (CIAT 1979) a method was suggested, based on an idea from the Brazilian study, for defining "... more or less uniform,

bean-growing, micro-regions as a basic unit for data collection and analysis." (p C-49). The purpose of this was to be goal orientation of research and to assist in production dispersal of genetic material and new technology, by revealing the extent of current practices and problems, and the possible agronomic consequences of changes to the system. Since then, the idea of a micro-region type data base has been accepted within CIAT for its other crop programmes, rice and cassava, as necessary to aid in the allocation of research resources, germplasm transfer and response evaluation, and comparative socio-economic studies. "This system will enable both ex-ante and ex-post assessments of the impact of new technology, in particular within the small farm sector, so that the research process can be further focussed on real needs" (CIAT 1981, p 145).

The concept of homogeneous zones has also been taken to a more detailed level within the field of Farming Systems Research, as a framework within which to conduct a FSR Programme, and as a means of delimiting crop-specific "Recommendation Domains" (Collinson 1981), or meaningful groupings of small farmers within the literature on Techniques of Rapid Rural Appraisal (Chambers 1980 a,b). Collinson's work for CIMMYT in East Africa develops a technique for defining units of similar farming systems through zoning, using questionaires to extension people, the addition of further detail from secondary sources, and a rapid survey of the farming systems which can be checked if necessary by more formal survey. Shaner et al (op. cit.) describe the full process of "Target Area Selection" in detail for a F.S.R. programme within a National Agricultural Research organization, and much work has been undertaken at CATIE, Costa Rica, on the same theme. (Navarro 1980).

c.2) Framework for broader scope and purpose in a Micro-Region type data base.

The required characteristics, derived from the discussions in sections a and b, for a micro-region data base are as follows:

a) Provision of information on the physical environment which is of direct use to crop breeders, physiologists, agronomists, phytopathologists, entomologists, agrometeorologists and other disciplines involved in crop breeding and improvement of cropping systems. (Climatic data of weekly or monthly mean form; soil types on semi-detailed survey; topographic form within land-systems framework).

b) Provision of information on the status of the farmer, his land, income, cropping system, and the actual constraints facing him as an agriculturalist.

c) Description of the agricultural infrastructure of the micro-region, from land tenancy to transport facilities and extension.

d) Illustration of the range of spatial variation in all the above for a particular crop.

e) Identification, or description where previously identified, of homogeneous zones which should correspond to those zones which would be delimited for a National Programme's F.S.R.

f) Provision of the relevant data for economic and socio-economic analyses, at the level of the IARC, concerning generalized technology and methodology development for the technology transfer process.

Clearly the requirement for cropping system and socio-economic information at the IARC's can be met by a data-base which has as its

basic structural component the working unit of F.S.R. at the National Programme level, as envisaged by Shaner et al. (op.cit.)

Theoretically, micro-region definition should proceed as follows:

(i) The distribution of the specific crop of interest should be determined, from agricultural census and other secondary information, and mapped as accurately as possible. This then serves to delimit the geographic areas of interest. Examples include the maps of rice growing areas in South and South East Asia (Huke 1982) produced by IRRI. In CIAT, a similar study has been done for Cassava in South America, and preliminary bean and rice growing zones have been deliminated (unpublished).

(ii) Agro-climatic relations for the crop and for important pest and disease complexes should be determined from previous research, so that significant climatic cut-off points within the range of growing areas can be defined. Using knowledge of plant-soil relationships, the range of soil types within these areas can be ordered, either according to a crop-specific suitability classification such as that suggested by Sys and Riquier (FAO 1980b), or inherent fertility classification (Garrity 1984, Sanchez and Buol 1984).

(iii) Using the information from this, growing areas should be divided up into homogeneous units, using available climatic and soils data. In doing this, we are not attempting an agroclimatic classification or agro-ecozoning along traditional lines, but merely indicating likely areas with a similar growing environment for the crop to assist in breeding and research strategies.

(iv) The climate-soil homogenes should then be examined in terms of agricultural production, by identifying small-farm farming systems; for the purpose of research on a specific crop, or even cropping association, only those farming-systems in which that crop is found are used to define the micro-regions, individual micro-regions being based on a uniform farming system.

(v) This is followed by the addition of "auxiliary" information for each micro-region, which can be divided into: information on other agricultural activities and land tenancy structure; socio-economic structure and infrastructure description; and description of constraints to the farming system.

Completion of stages (iv) and (v) is dependent in their completion on collection and analysis of secondary data sources, liason with National Programme research, and a certain amount of primary data collection. The final stage, (v), represents the beginnings of analysis, in that precise information content is dependent on problem identification stemming from F.S.R. and socio-economic research at the farm-level. Whilst National programmes should be concerned with the specific details of the whole farming system, and their improvement within the socio-economic context, information of both types specific to the crops of interest to the IARC should flow from the FSR work directly to the researchers at this level, hence completing the information link.

c.3) Problems in constructing the system

Three problems still exist. Firstly, the precise form which agro-ecozones should take is difficult to define since it depends on the existing knowledge of crop-climate and crop-soil relations, and the

availability and reliability of data on climate and soils. Given sufficient research data on the responses to climate and soils of a crop, the problem of agro-ecozoning is theoretically simple. However, the more precise such data is, the more detailed an agro-ecozone definition must necessarily be, and the greater the amount of secondary information required to accurately delimit zones. Since such work is the primary interest of the IARC, it must commit itself to extensive data-searching for existing secondary data, from soil maps at the semi-detailed level, to monthly or even daily climatic records. Often such information does not exist, or is in a form which is either unuseable without extra work input, such as soil-map classification correlation, or which doesn't provide sufficient detail for the task, for example monthly, rather than daily rainfall figures where water-balance studies are of significance to the definition of zones for a crop. The type of study undertaken by Reddy for India (1983/4) would be impossible in much of Latin America due to a lack of detailed rainfall data. When we begin to try and group together small homogeneous units we are therefore limited by data availability, which conditions the degree of detail and accuracy possible in our agroecozones. The opinion in CIAT on this problem is that we should simply aim to achieve as much detail as possible, and initial agro-ecozones can be refined by the results of field trials in the different zones, testing genetic material with different physiological characteristics or pest and disease relationships.

The second problem is that of the collection of primary information. For the purposes of the IARC, the characterisation of homogeneous units wold be reliant on acquisition of data from secondary

sources, such as meteorological data, soil maps, agricultural and population census, and other environmental and socio-economic studies. Theoretically, data from farming-systems studies, studies of farmer-constraints, use of inputs, income levels, land tenancy and so on should be acquired from the work of National Programmes. Where they are not actively engaged in the compilation of these types of information, the IARC is faced with collection of primary data, at the minimum in relation to the farming system in the area of interest. Since resources for this type of work will undoubtedly be limited, the most effective way of doing this is undoubtedly to use the types of methods bracketed under "Rapid Rural Appraisal." For the collection of information on farming systems, the types of methods described by Collinson (op.cit) Carruthers (1981) or Hildebrand (1981) provide quick and relatively accurate methods of assessing the problems facing the farmer engaging in the production of a specific crop or cropping system, which is the major interest of the IARC in collecting primary data. Involvement in such work would, I feel, not only ensure a deeper understanding of the farmer's requirements of new technology within IARC's, but also provide a useful component for the training programmes held in the IARC's for the benefit of National Programmes. If agricultural researchers and extension workers at the National level could be encouraged to use these methods of data collection, and at the same time a farming systems approach to their research, chances of increasing the flow of agricultural information from farmers to researchers at all levels would be greatly increased.

Thirdly, having acknowledged the role of socio-economic research within Agricultural Research, we must assess the most useful way of

including the results of such research in the data base. At the local level, this socio-economic research can be incorporated into the characterisation of the micro-regions, whether conducted with specific reference to local farming systems or more general studies such as analyses of local labour markets or markets for agricultural produce, land, credit and so on. The role of socio-economic research at the international level, within the IARC's, is a rather different question. Dusseldorp (op. cit), Box (1982), Spijkers and Box (1981) and Spijkers (op.cit) have all made reference to the need for increased sociological research in the IARC's, and the problems involved in incorporating sociological work in Agricultural Research. Within the micro-region framework described above, it should be possible for a much greater degree of information to flow from sociological researcher to Agricultural Researcher, on the requirements of new technology in a given location.

However, the criticism of location - specificity which has been leveled at new technology developed within the IARC's can equally be leveled at sociological research concerned with the failure of farmers to adopt such technology. What is required is a recognition amongst sociological researchers of the generality of the task facing the IARC's; perhaps it is time it was acknowledged that it is very easy to criticize the attempts made by IARC's to deliver acceptable technology to the farmer, yet far more difficult to solve the problems involved in developing such generalizable technologies and methodologies as their mandates require of them.

By using such an information base as that proposed here, the requisite features of such generalized technologies, if they are to be

acceptable to the farmer once modified to suit specific circumstances, could be defined within the terms of reference which govern the work of the IARC's. Sociological and economic researchers could begin their analyses by examining the range of different conditions faced by farmers, utilising a greater or lesser degree of detail within the data base according to the task at hand. As well as contributing to the development of acceptable technology, such interaction might also throw some light on the possibilities of negative effects stemming from the introduction of technologies in a given set of circumstances.

References cited

Barlow, C., Jayasuriya, S., Price, E.C.; 1983. Evaluating Technology for New Farming Systems: Case Studies from Philippine Rice Farms. IRRI., Los Baños, Philippines.

Box, L.; 1982. Food, Feed or Fuel? Agricultural Development Alternatives and the Case for Technological Innovation in Cassava (Manihot Esculenta Crantz) Cultivation. Quarterly Journal of International Agriculture Special 1982, p. 34-38.

Carruthers, I.; 1981. A Mental Construct for Unstructured On-Farm Interviews for Use in Rapid Rural Appraisal. Agricultural Administration 8, 271-278.

C.E.N.D.A. (Centro de Desarrollo Agropecuario Zona Norte); 1983. Adaptive Agricultural Research on Small Scale Cassava and Rice Cultivators in the Dominican Republic. Annual Report 1982. C.E.N.D.A., Ap.700, Santiago, República Dominicana.

Chambers, R.; 1980a. The Small Farmer is a Professional Ceres, 13(2), 19-23.

Chambers, R.; 1980b. Shortcut Methods in Information Gathering for Rural Development Projects. In: Agricultural Sector Symposia. Washington D.C. 1980. Proceedings. Washington D.C. World Bank 1980 pp. 393-408.

CGIAR-TAC (Consultative Group on International Agricultural Research - Tactical Advisory Committee); 1978. Farming Systems Research at the International Agricultural Research Centres. World Bank. Washington, D.C.

CIAT (Centro Internacional de Agricultura Tropical); 1979. Annual Report 1978. CIAT, Cali, Colombia.

CIAT 1981. CIAT in the 1980's. A Long Range Plan for the Centro Internacional de Agricultura Tropical. CIAT. Cali, Colombia.

Collinson, M.; 1981. A Low Cost Approach to understanding Small Farmers. Agricultural Administration 8, 433-450.

Crouch, L., de Janvry, A.; 1980. The Class Basis of Agricultural Growth. Food Policy 5, 3-13.

Dahlberg, K.A.; 1979. Beyond the Green Revolution. Plenum Press, New York.

de Janvry, A., Crouch, L.; 1980. Technological Change and Peasants in Latin America. In: Technical Change in the Small Farm Sector First Workshop of PROTAAL, Second Phase B. Chorlavi, Ecuador, July 1980.

Dusseldorp, D.B.W.M. Van; 1977. Same Thoughts on the Role of Social Sciences in the Agricultural Research Centres in Developing Countries. Netherlands Journal of Agricultural Sciences 25, 213-228.

FAO (Food and Agriculture Organisation of the United Nations); 1980a. Report on the Agro-Ecological Zones Project. World Soil Resources Report 48. FAO, Rome, Italy.

FAO; 1980b. Land Resources for Populations of the Future (Appendix II: Ratings of FAO/UNESCO Soil Units for Specific Crop Production). FAO, Rome, Italy.

Fundacao IBGE; 1968. Divisao do Brasil em Micro-Regioes Homogeneas. Ministerio do Planejamento e Coorderacao Geral. Rio de Janeiro.

Garrity, D., Agustín, P.C.; 1984. A Classification of Asian Upland Rice Growing Environments. Paper presented at the Workshop on Characterization and Classification of the Upland Rice Environment, Centro Nacional de Pesquisa-Arroz. Feijao, EMBRAPA, Goiania, Brasil. 1-3 August 1984.

Gilbert, E.H., Norman, D.W., Winch, F.E.; 1980. Farming Systems Research: A Critical Appraisal. Michigan State University Rural Development Paper No.6. Department of Agricultural Economics, M.S.U.. East Lansing, Michigan 48824.

Griffin, K.; 1979. The Political Economy of Agrarian Change. 2nd Edition. Macmillan, London.

Hildebrand, P.E.; 1981. Combining Disciplines in Rapid Appraisal: The Sondeo Approach. Agricultural Administration 8, 423-432.

Huke, R.E.; 1982. Rice area by type of culture: South, Southeast, and East Asia. IRRI, Los Baños, Laguna, Philippinnes.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics); 1980. Proceedings of the International Symposium on Development and Transfer of Technology for Rainfed Agriculture and the SAT Farmer, 28 August-1 Sept. 1979, Palancheru, AndraPradesh, India. (Chapter by Binswanger and Ryan).

Ministerio de Agricultura, Brasil; (Undated-post 1972). Areas de Concentracao da Agricultura Brasileira. Vols 1-4. Ministerio da Agricultura. Secretaria Geral. Subsecretaria de Planejamento e Orcamento Rio de Janeiro.

Navarro, L.A.; 1979b. Generación, Evaluación, Validación y Difusión de Tecnologías Agrícolas Mejoradas y Apropiadas para Pequeños Agricultores. Documento presentado en el "Seminario sobre los Aspectos Socio-Económicos de la Investigación Agrícola en los Países en Desarrollo, Santiago, Chile. 7-11 mayo 1979. CATIE, Turrialba, Costa Rica.

Navarro, L.A.; 1980. Caracterización de las Circunstancias en que Opera el Pequeño Agricultor como Base para el Desarrollo de Tecnologías Agrícolas Apropiadas. Documento preparado para ser presentado en el "Seminario sobre Investigación de Producción de Pequeños Agricultores." M.A.G.-Costa Rica/CATIE. San José, Costa Rica, 8 de mayo 1980.

Reddy, S.J.; 1983/4. Agroclimatic Classification of the Semi-Arid Tropics. I-IV. Agricultural Meteorology 30, 185-325.

Sánchez, P.A., Buol, S.W.; 1984. Agronomic Taxonomy for Wetland Soils. Paper presented at the Workshop on Wetland Soils: Characterization, Classification and Utilization, IRRI, Los Baños, Laguna, Philippines. 26 March-6 April 1984.

Shawer, W.W., Philipp, P.F., Schmehl, W.R.; 1982. Farming Systems Research and Development Guidelines for Developing Countries. Westview Press, Boulder, Colorado.

Spijkers P.A.N.M.; 1982. Rice Peasants and Rice Research in Colombia. Department of Rural Sociology of the Tropics and Subtropics Agricultural University, Wageningen, Netherlands.

Spijkers, P.A.N.M., Box, L.; 1981. Cultivators and their Crops. (Chapter 7 in: Essays in Rural Sociology in Honour of R.A.J. van Lier. Department of Rural Sociology of the Tropics and Subtropics, Agricultural University, Wageningen, Netherlands.

Strobosch, P.; 1976. A Socio-Economic Study of Cassava and Cassava Starch Production in an Andean Village in Colombia. CIAT, Cali-Colombia.