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CHARACTERISTICS OF SUCCESSFUL AGRICULTURAL TECHNOLOGY
TRANSFER SYSTEMS WITH SPECIAL REFERENCE TO
CARICOM COUNTRIES

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During the early 1950's, the belief was prevalent that the technology necessary to improve agricultural productivity in the developing countries already existed. (3) The major thrust during this period was the development and improvement of extension programs in developing countries. However, the awareness was developing that the lack of technology appropriate for local conditions was a serious constraint to food production increases. The success of the green revolution technology developed by the international agricultural research centres (IRRI AND CIMMYT) in increasing production levels of certain crops in certain regions of the world served to heighten this realization. However, the technology of the green revolution was adopted more rapidly by the large farmers than by the small ones (5). It's adoption depended on institutional changes in the areas of credit and marketing.

An evaluation of extension programs carried out in Latin America was made (14) and concluded that there was little impact, mostly due to inadequate technology for local conditions. An impact study of the extension program in Central America (11) concluded that weaknesses in supervision, training, low salaries and prestige and high turnover in the extension services, contributed to their deficiencies. However, the services did have some impact on farmers mostly in fertilization and pest control.

The above experiences of research and extension as alternating bottlenecks in agricultural production serve to illustrate their interdependence in the agricultural production system which includes research, extension, credit, marketing and other services.

Here we shall concentrate on the importance and nature of the research-extension interaction on the agricultural production system.

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The very successful U.S. agricultural production system provides a basis to identify certain characteristics of a system successful in transferring technology from the researcher to the farmer. In the U.S.A., the Morrill Act of 1862 created the basis of the system of land-grant colleges which has provided the framework for teaching and research in agriculture. The U. S. Congress also created the U. S. Department of Agriculture (USDA) in the same year and its purpose and function was to acquire useful information about agricultural subjects and disseminate it. In 1897 the Hatch Act established federal funding for experiment stations at the land-grant colleges. The land-grant colleges and the USDA began to develop their own extension service among farmers, but the need for strengthening this component of the technology transfer system was met by the Smith-Lever Act of 1914. This bill provided the backing of the federal government for a U.S. Extension Service as a cooperative service among federal, state and local government; plus a cooperative service of land-grant colleges (resident teaching), experiment stations (agricultural research, and extension (rural out-of-school education)).

The Cooperative Extension Service system in the U.S.A. (Figure 1) has some of the following important characteristics:

1. There is a strong linkage between teaching, research and extension. In many states, the Dean of the College of Agriculture of the land-grant colleges may be the Director of Extension as well the Director of the Experiment Station. In other states, the Director of Extension is responsible to Dean of the College of Agriculture who is also Director of the Experiment Station. Thus at the administrative level there is a link between university training, university and experiment station research, and extension.

There is also a link between research and extension at the operational level through specialists or Subject Matter Specialists. The Subject Matter Specialists are responsible to the Director of Extension for their contacts with other extension workers and to the University Department Head for the technical matter they teach. They may be housed in the University or the Extension Service. They are supervisors of agents and work on relations, program building, selection, and training and maintenance of personnel in the counties (County Agents). Generally, subject matter is presented to farmers by the County Agents who are in turn trained by Subject Matter Specialists. The five broad groups of function of a Subject Matter Specialists are: 1) planning, 2) training, 3) direct teaching, 4) field studies to increase the effectiveness of the work in their respective subject matter lines, 5) preparation of teaching materials. (7).

2. Extension is oriented to the needs of the farm family and to solving farm production problems and as a result there is a feedback from the farm to the research and teaching components of the system. This is ensured by the philosophy that extension's function is to serve the farmer and his family. The County Agent, who deals with the farmer, participates in locally organized county associations which determine the farmers' needs and priorities. These in turn influence the work program of the County Agent and he communicates the farmers' problems and priorities to the Subject Matter Specialists who are in contact with the research and teaching components of the system.

3. The extension service is exclusively a teaching organization.

4. There is accountability of the extension service through the response of the county associations through the extension system or through individual or collective political action of the members.

TECHNOLOGY TRANSFER EFFORTS AND MODELS IN DEVELOPING COUNTRIES

The four basic characteristics of the U.S. Cooperative Extension Service which have been identified as the key to its success shall be used to evaluate models in developing countries.

In the 1970's it was recognized that research in developing countries had not adequately addressed itself to the needs of small farmers (8, 10). The link between small farmers and the research organizations has tended to be weak (13). Traditionally this interaction should have been facilitated via the extension worker, but for a number of reasons this has not often worked. Two possible reasons are 1) Institutional and administrative barriers which prevent effective interaction between researchers, extension workers and farmers. 2) Researchers often have higher academic qualifications than extension staff, and the difference is more pronounced in the developing countries, thereby reinforcing a tendency towards top-down prescriptions, from research workers to extension workers to farmers (4). Similar problems have been detected for extension systems in the Eastern Caribbean countries. (9).

The Farming Systems Research (FSR) approach starts with the farmer and his household and provides a link between the farmer and the research institution and funding agency, thus counter-balancing the more conventional "top-down" experiment

station research approach. "Upstream" and "Downstream" FSR have been identified. (4) "Upstream" FSR seeks to generate prototype solutions which will contribute to increasing productivity of farming systems. This often involves several years of research, both on and off station, and is particularly the concern of international agricultural research centers and selected regional research programs. "Downstream" or site specific FSR programs are designed to rapidly identify and subsequently test possible innovations which can be easily integrated into existing farming systems. "Downstream" FSR stresses close interaction with farmers via surveys of farming constraints and on-farm trials, and draws selectively upon results from commodity or discipline oriented research or from "Upstream" programs. "Downstream" FSR programs are commonly carried out in national research institutes or national agricultural development projects.

MODELS IN CARICOM COUNTRIES

Ministries of Agriculture:

Figure 2 gives a composite model of the ministries of agriculture of the CARICOM (Caribbean Community) countries. The smaller countries of the group would have only an extension service which depend on technology generated from extension sources. The Caribbean Agricultural Research and Development Institute (CARDI) and the Caribbean Agricultural Research and Development Training Scheme (CARDATS) and international groups function as sources of technology for these countries. The Directors of Research and Extension are responsible to a common head, but the collaboration between extension and research at the level of planning and programming and at the level of operations is often informal, variable and not institutionalized. There generally is no formal relationship between the University of the West Indies (UWI) Faculty of Agriculture and the Ministries of Agriculture. One exception is a contract between the Ministry of Agriculture, Lands and Food Production of Trinidad and Tobago and the Faculty of Agriculture of the UWI to carryout research in 1979 (12). Field Extension Agents are graduates of 2 year schools of agriculture such as the former Jamaica School of Agriculture, Guyana School of Agriculture and the East Caribbean Institute for Agriculture and Forestry. In cases where there is collaboration between extension and research Field Extension Agents are trained (once or twice a year) by the Agricultural Information and Training Unit, or by staff from the experiment stations. In the Organization of East Caribbean States (OECS), the UWI offers annual two-week

subject matter training for Extension Agents. The Agricultural Information Unit may or may not engage in training and the production of extension teaching material. In some cases the Agricultural Information Unit emphasizes disseminating information on the activities of the Ministry of Agriculture. There are very few Subject Matter Specialists, whose duties are to prepare teaching material that is understandable to farmers and extension agents, and which interprets the results of research in terms of desirable farm and home practices. Technology validation and demonstration procedures are not well developed.

The ratio of farmers to extension worker in CARICOM is very high, averaging over 1000 to 1. (6) Impact on farmers is thus low and there is little farmer feedback to the extension agent on his needs and constraints. However, since 1978, CARDI, through contracts with AID and the Caribbean Development Bank (CDB) (with UNDP) funds, have used the "Downstream" FSR approach to appraise the practices and constraints of small farmers in several Caribbean countries. The institutionalization of this effort has not yet been established. Henderson (6) has suggested a "saturation" approach to small farmers in a target area of high priority which has had impact. The ratio of farmers to Field Extension Agents were 25 to 1 to 50 to 1. Field Extension Agents should relate to small farmers and Subject Matter Specialists should relate to Field Extension Agents and large estate owners and managers who may have agricultural knowledge and skills that are superior to the Field Extension Agents.

University of the West Indies

The UWI has a Faculty of Agriculture on its St. Augustine Campus in Trinidad. The Faculty of Agriculture engages in teaching and research in agriculture thus preparing professionals and generating technology for the region. In developing countries that were former British colonies, agricultural research was conducted in ministries of agriculture and other government controlled institutes (such as agricultural research councils) rather than at universities, which followed the traditions of the British university system of not being involved in development. (12) Following this tradition, there is no formal link between the UWI and ministries of agriculture except, as mentioned earlier, by a contract with the Government of Trinidad and Tobago. As mentioned earlier, UWI offers annual subject matter training courses for Extension Officers of OECS countries. The UWI encourages its staff to publish in international journals. In addition, technical and extension bulletins are

published and UWI sponsors the journal "Tropical Agriculture". UWI staff have participated on Regional committees and have acted as consultants to various organizations in the Region. The Extension Department of the Faculty of Agriculture is however, small.

Caribbean Agricultural Research and Development Institute

CARDI was established in 1975 as an autonomous regional organization to serve the agricultural research and development needs of the 12 member countries of CARICOM. The Institute is the successor organization of the Regional Research Centre (RRC) of the Faculty of Agriculture of UWI which started in 1955 when the Imperial College of Tropical Agriculture (ICTA) was operating.

CARDI continues to be affiliated with UWI with headquarters at the UWI, St. Augustine Campus in Trinidad, but is a fully autonomous regional organization (2). Figure (3) describes the structure of CARDI. The broad objectives set out in the articles of agreement establishing CARDI include:

- (a) To provide for the research and development needs of the agriculture of the Region as identified in national plans and policies.
- (b) To provide an appropriate research and development service to the agricultural sector of member countries.
- (c) To provide and extend the application of new technologies in production, processing, storage and distribution of agricultural products of member countries.
- (d) To pursue for specified periods long term research in pertinent areas.
- (e) To provide for the coordination and integration of the research and development efforts of member countries where this is possible and desirable.
- (f) To undertake teaching functions normally at the post-graduate level, limited to the development of the relevant research by any member country.

CARDI staff collaborate with the agricultural research systems which exist in Barbados, Guyana, Jamaica and Trinidad and Tobago. However, in the other countries CARDI assumes a

leadership role in research and research validation since this aspect of the local ministry staff is weak. Since 1978, CARDI has been engaged in a USAID sponsored "Small Farm Multiple Cropping Systems Research" project where an evaluation of farmers' constraints was made thus providing a farmer feed-back into the research system for the participating countries Antigua, Montserrat, St. Kitts-Nevis, Dominica, St. Lucia, St. Vincent and Grenada. A similar study was carried out in Barbados, Belize, Guyana and Jamaica from 1978 under a UNDP financed CDB-Caribbean Regional Food Plan Project.

CARDI's Information Unit produces reports, technical bulletins and a newsletter mostly for the consumption of other scientists, and some "Fact sheets" suitable for extension agents and farmers. Assistance is provided to information units of ministries of agriculture in the preparation of extension materials. The Unit also serves as a documentation centre for CARDI professionals.

Commodity Organizations

Various export commodity organizations which were formed during the colonial period to solve their marketing problems, later extended their service to members by introducing extension and research. Such organizations include:

| | |
|--|-----------|
| Banana Board Research Department | Jamaica |
| Banana Breeding Research Scheme | Jamaica |
| Windward Islands Banana Research Department | St. Lucia |
| Coconut Industry Board Research Department | Jamaica |
| Trinidad and Tobago Coconut Research Limited | Trinidad |
| Guyana Rice Board Research Department | Guyana |
| Central Sugar Cane Breeding Station | Barbados |
| Sugar Industry Research Institute | Jamaica |
| Caroní Agricultural Research Station | Trinidad |
| Sugar Experiment Station, Guyana | |
| Sugar Corporation | Guyana |

Figure 4 describes a possible structure for a commodity research organization which may be organized to relate to an association of large plantations as shown on the right side of the diagram, or an association of a large number of farmers as shown on the left side of the diagram. One can appreciate that research and extension are strongly linked and there is feedback about constraints at the production level, and there is accountability to the members. These organizations

have been successful in transferring and generating technology in CARICOM countries. Generally the smaller and/or younger organizations start with the transfer of technology from national, regional and international sources, through the establishment of a library and the attendance of professionals to national and regional technical meetings. Extension is carried out through field demonstrations, annual reports and extension bulletins. Since the beginning of the century, various countries have Agricultural Societies, which were formed by farmers to facilitate the dissemination of information on agriculture. Publications are a major output and some engage in extension and supplies.

Agricultural input industries

Some agricultural input industries (chemicals, seeds, machinery) have developed a technical advisory services back-up, as part of their sales programs in CARICOM countries. Generally, research inputs from the parent research and product development centre, ministry of agriculture, university and commodity research centres, are used by their technical advisory (extension) and sales staff, along with standard commercial advertising methods. Field sales staff are motivated by sales commissions and they utilize commercial sales methods such as field demonstrations, free samples and technical literature. Farmer feedback would be reflected in continued sales. This system has been very successful in the CARICOM Region. However, only technology involving saleable inputs are transmitted and thus management type technology using resources existing on the farm is omitted. In addition, only farmers with available credit can use this technology.

CASES OF THE INDIAN EXTENSION SERVICE

The Extension Service in India, which was modeled after the British colonial system as seen in Figure 2, has been modified by the Training and Visit System introduced by Daniel Benor of the World Bank with good results. When this method was used in the Seyhan Irrigation Project in Turkey, farmers increased cotton yields from 1.7 tonnes/ha to over 3 tonnes/ha in three years. In Chambal, Rajasthan (India), farmers increased rice paddy yields from 2.1 tonnes/ha to over 3 tonnes/ha in two years. (1).

The Training and Visit System (see Figure 5) has been applied in areas with a large number of small farmers using low level technology and usually traditional methods. The

techniques first introduced required little or no cash inputs. As the farmer's confidence in the system grows, he is likely to use more advanced methods and more cash inputs. The system uses Village Extension Workers (VEW) with comparatively low educational standards (secondary school graduate plus one year practical training and experience) supported by Subject Matter Specialists (university trained) and provides close supervision through a management structure which establishes a clear single line of responsibility. The VEW are given regular training in the production methods which they disseminate through farmers selected by a local group, who adopt new methods and compare the results with that part of their fields cultivated by normal practices.

The Training and Visit System used followed guidelines which addressed problems that an extension worker faces in developing countries. 1) Unified extension service: A single line of command was established from the government agency responsible for agriculture to the VEW. 2) Extension exclusivity: The extension personnel dedicated their time exclusively to extension, rather than engage in regulatory and administrative functions, collection of general statistics and the supply of inputs.

3) Systematic training and visits: The number of farm families per VEW is set at a manageable level and a specific schedule of visits to farmers' fields is rigidly followed. All the farm families under a VEW's jurisdiction are divided into eight groups of about equal size, and the VEW, in consultation with village leaders selects about 10% of the farmers as contact farmers on whom he concentrates his efforts. The VEW visits one group per day 4 days per week and the fifth day is reserved for office work and training by the Subject Matter Specialist. Thus, training of the VEW is an on-going activity rather than relying only on preservice training. Each farmer group is visited once every two weeks, and each contact farmer is asked to tell 10 friends and relatives about the recommendations he has received from the VEW and to help them adopt the recommendations. A VEW may handle on the average 800 farm families by this method, but the number can vary from 300 to 1,200 depending on the local conditions.

4) Concentration of efforts: At the beginning the most important crops will be chosen, and those few practices which will bring the best economic results. The agents concentrate on the contact farmers.

5) Achievement of immediate impact: At the initial stage it is very important to achieve immediate impact which will give farmers confidence in the extension agents and the extension

agents confidence in themselves. 6) Contact farmers: The extension agent focuses his efforts on the contact farmers not to help only these farmers but to convince all farmers in the group of what everyone can achieve. 7) Best use of available resources: Initial stress is made on management practices rather than on the increased use of purchased inputs. These practices require more labour of which the small farmer generally has a surplus, whereas purchased inputs require cash which the small farmer generally does not have. When the farmer has more confidence in the VEW, then purchased inputs maybe recommended. 8) Manageable recommendations: The VEW recommends that farmers adopt better practices at first on only a small part of their land. The recommendations should be validated for the area and should increase farmers' incomes.

9. Link with research: To remain effective, extension must be linked to a vigorous research program, which reflects the needs of the farmers. Regular contact between researchers and extension personnel is established through a Research and Extension Committee, chaired by the Director of Agriculture and including representatives from research and extension. This committee has the responsibility for developing recommendations for the extension service to transmit to farmers, evaluating past experimental data, and designing a program of field trials to validate experiments. It also states the main problems faced by farmers that should be solved by research. The senior Subject Matter Specialists act as a secretariat to this Committee, analyzing alternative recommendations and presenting them to the Committee for consideration. At the district level there is a District Research and Extension Committee chaired by the District Extension Officer, and including Subject Matter Specialists of the area and staff from a regional research station. The Subject Matter Specialists also spend about one third of their time visiting the nearest research station or facilities. Their role is (a) to keep informed on the latest developments in research (b) to bring the practical field problems of the farmers to the attention of the research workers (c) together with the research workers, to design and carry out, through the Agricultural Extension Officers and the VEW, a program of field trials on farmers' fields. 10) Field trials: This involves the Subject Matter Specialists, the Agricultural Extension Officer and the VEW as explained previously. The plot size on a farmers farm is small. If a field trial is successful the VEW uses it as a demonstration. 11) Accountability: The regular and frequent visits of the VEW to farmer groups develops accountability to the groups.

PROFESSIONAL ASSOCIATIONS AND MEETINGS

There are Associations of Professional Agriculturists in Trinidad, Barbados, Guyana and Jamaica, which generally serve as a national forum on subjects of special interest. The groups are not large enough to specialize in disciplines. The regional Caribbean Agro-Economic Society has decided to sub-divide into Agronomy, Economic and Livestock groups. CARICOM countries participate in the meetings of the Caribbean Food Crops Society. The Society for Plant Protection in the Caribbean was formed in 1981. The UWI, CARDI, international organizations, technical missions and commodity organizations organize technical meetings at the national and regional level.

INTERNATIONAL ORGANIZATIONS AND TECHNICAL AID MISSIONS

There are various international organizations and technical aid missions operating in the Region in the field of agriculture. They are OAS, IICA, UN, FAO, USAID, EEC, British ODA, CIDA, IDRC and missions of various other countries.

INFORMATION SYSTEM

The UWI is a member of the Agrinter Information System which is part of the Agris world system. ECLA (Economic Commission for Latin America) will develop an information system for the English speaking Caribbean. There are various libraries in the agricultural sector of each country in addition to the ministry of agriculture libraries but communication between them is poor. National information systems receive inputs from Regional and international systems.

CONCLUSION

An examination of various models of technology transfer in agriculture shows that successful technology transfer occurs when the systems had the following characteristics: 1) Strong linkage between research and extension at the administrative and operational levels. 2) Extension is oriented to the needs of the farm family. 3) The extension service is mainly a teaching organization. 4) There are demonstrations in the area where there is production. 5) There is accountability of the extension service to the producers.

Within CARICOM, commodity organizations have been successful in transferring technology and possess the above characteristics. The same can be said of agricultural input industries, but only

technology involving saleable inputs are transmitted. CARICOM systems show weakness in all 5 points indicated, and there is almost no use of Subject Matter Specialists, who provide an important two-way link between researchers and extension workers. The modification of the Indian Extension Service by Benor achieved the same characteristics while handling a large number of small farmers and is worthy of attention for possible application in CARICOM systems.

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FIGURE 1.
Model of the US Cooperative Extension Service.

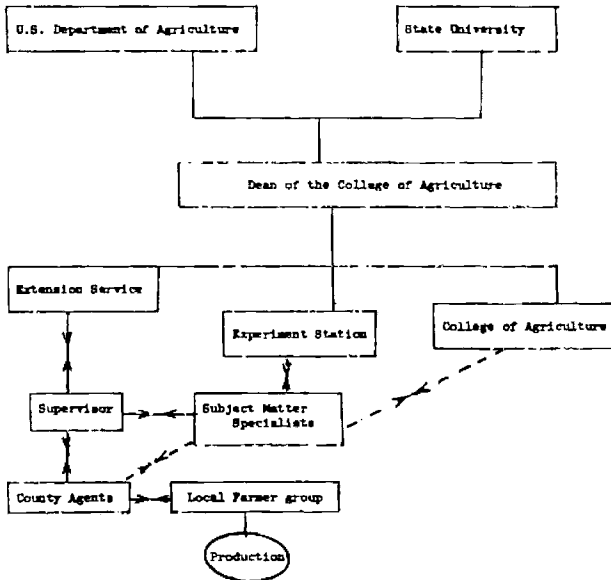


FIGURE 2.
Model of Ministries of Agriculture.

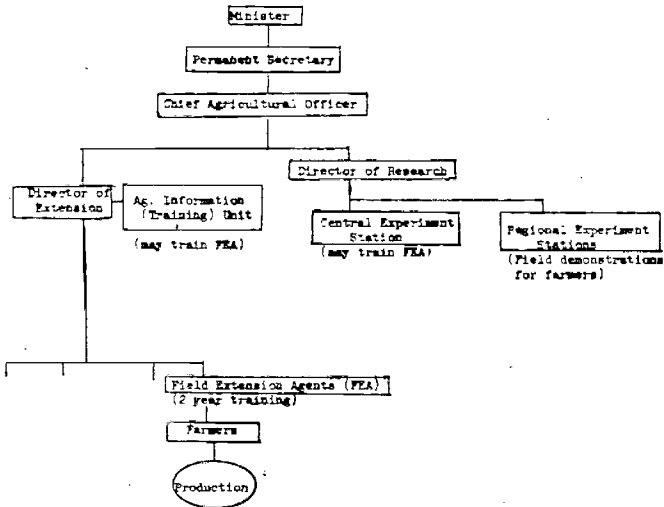


FIGURE 3.
Caribbean Agricultural Research
and Development Institute (CARDI).

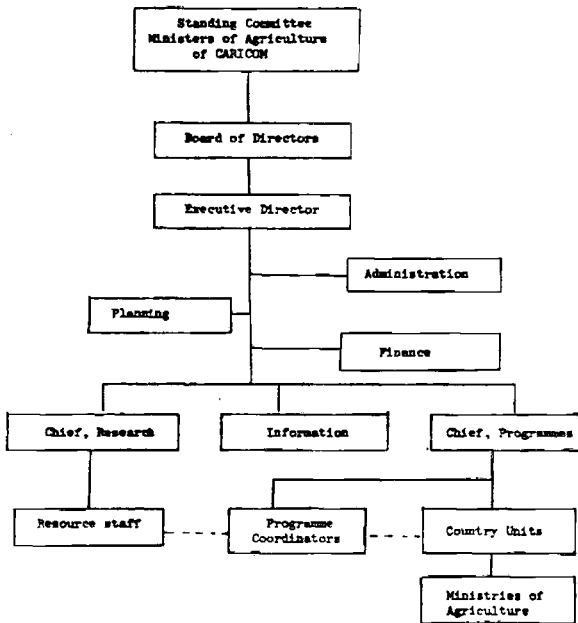


FIGURE 4.
Commodity Research Organization

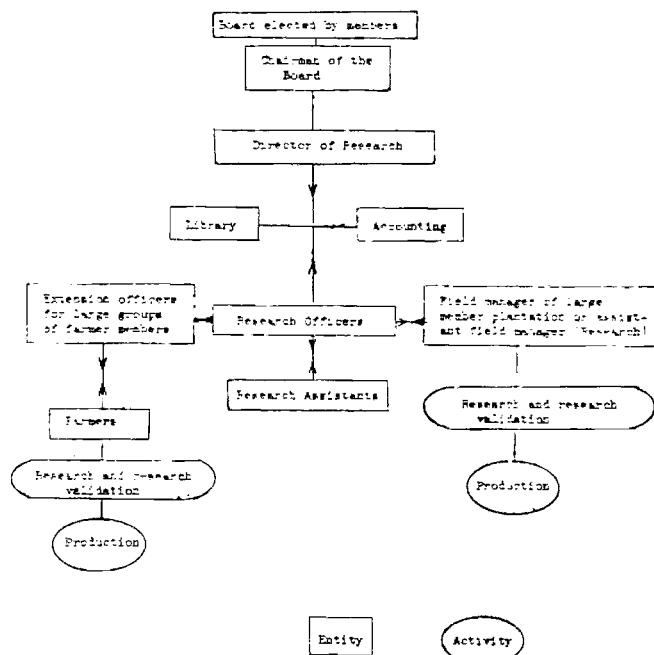


FIGURE 5.

Model of Intensive Extension Service
in One of the States in India

