PANEL ON POST GRADUATE EDUCATION AND ASSOCIATED RESEARCH FOR THE SUPPORT OF LIVESTOCK DEVELOPMENT IN LATIN AMERICA

Turrialba, Costa Rica
August 25-29, 1969

This Panel on "Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America," took place August 25-29, 1969, at the Inter American Institute of Agricultural Sciences of the OAS (IICA) in Turrialba, Costa Rica.

This Panel was made possible by the cooperative and financial support of the Training and Research Center of the IICA Graduate School and Project 80 of the United Nations Development Program through the Food and Agricultural Organization of the United Nations.

This edition contains the papers presented and the recommendations of the Panel.

Training and Research Center of the IICA
Turrialba, Costa Rica

1969

CONTENTS

ANTECEDENTS

In recent years a widespread interest has developed concerning the possibilities of fostering economic and social development in Latin America by means of post graduate education and research in the broad field of animal production. Pride, prestige, and political influences point toward a proliferation of institutions granting advanced degrees in this field. Considering the limited experience and personnel as well as the scarcity of financial resources, the quality and effectiveness of many of these programs are likely to suffer. A growing interest has also developed recently concerning the possibilities of cooperative research and training programs involving regional and international organizations as well as bilateral agreements between institutions. Constructive guidelines are needed. Immediate and long-range priorities must be determined. A sober exposure to the real difficulties as well as the potentialities and alternatives should positively influence the direction and effectiveness of these endeavours.

PURPOSES OF THE PANEL

To establish priorities for immediate and long-range policy planning to stimulate development in the broad field of animal production.

To define the requirements of institutions to build and maintain quality post graduate level educational programs.

To make recommendations to governments and other agencies concerning ways and means to better utilize human and financial resources relative to livestock development problems.

To enhance regional and international cooperation and coordination in the development and strengthning of Latin American post graduate teaching and research institutions of animal production.

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* Was not present during the Panel sessions.

PROGRAM

Monday 25

8:30 A.M.	Opening Session
	Latin American Post Graduate Institutions
9:00	Post Graduate Institutions in Latin America: Their Objectives, Problems and Potentialities.
	H. Caballero, Director of the Graduate School in Agricultural Sciences of Argentine.
10:30	Potential of the Latin American Institutions that Offer Post Graduate Studies in Agricultural Sciences for Fomenting the Development of Animal Husbandry.
	L. Robles, Technological Institute of Monterrey, México.
12:00	Barbecue
2:00 P.M.	Tour of IICA
3:30	The IICA-CEI Animal Production Department. Turrialba, Costa Rica.
	K. Vohnout, IICA-CEI, Turrialba, Costa Rica.
4:15	Considerations of Post Graduate Training and Research in Animal Science at Minas Gerais, Brazil.
	G. Carneiro, Federal University of M.G., Brazil.

Tuesday 26

8:00 A.M.	Post Graduate Program in Animal Science at La Molina: Problems and Future Plans.
	F. Sylvester, Universidad Agraria, La Molina, Perú.
	Educational and Training Programs
9:30	Undergraduate and Post Graduate Training.
	K. F. Jakobsen, FAO; National University of Colombia.
10:30	Coordinating Veterinary Science and Animal Science Training Programs.
	G. K. Underbjerg, Kansas State University.

1:00 P.M. Effective Undergraduate and Graduate Training in Animal Science. J. Váchal, Central Research Institute of Animal Production, Czechoslovakia

2:00 Increasing the Efficiency of Dissemination and Utilizing Information and Research Results.

K. L. Turk, Cornell University

3:30 Selection and Training of the Latin American Animal Husbandry Post Graduate Student.

J. de Alba, México.

4:30 Round Table Discussion on Educational and Training Programs.

Chairman, J. Glenn, University of Florida.

Institutional Policies and Programs

Wednesday 27

8:00 A.M. Institutional Policy Towards Incrementing the Number of Livestock Specialists.

O. Paladines, Ministry of Agriculture, Ecuador

9:30 Institutional Policy Development for Providing Experts to Develop Animal Industry in Latin America.

J. V. Bateman, IRI, Research Institute, Brazil.

10:30 Distributing Policy Decision, Duties and Responsibilities for Effective Administration in Animal Science Teaching and Research Units.

R. S. Temple, FAO-Technological Institute of Monterrey, Mexico.

1:00 P.M. The Development of Research Programmes to Ensure Continuity in the Face of Political Change.

M. Willis and T. R. Preston, Institute of Animal Science, Cuba.

2:00 Expanding Research and Post Graduate Training Through Cooperative and Exchange Programs.

J. C. Glenn, University of Florida.

3:30 Round Table Discussion on Institutional Policies and Programs.

Chairman, H. Muñoz, IICA-CEI, Turrialba, Costa Rica

Thrusday 28	**Research Priorities and Programs**
8:00 A.M.	Research Horizons in Animal Reproduction and Some Implications.
	D. Olds, University of Kentucky.
9:30	Establishment of Resources Priorities in Livestock Production for Tropical America.
	C. F. Chicco, Centro Investigaciones Agronómicas, Venezuela.
10:30	Establishing Research Priorities for Latin America: Livestock Aspects.
	H. H. Stonaker, University of Nebraska Mission in Colombia.
1:00 P.M.	Establishing Research Priorities for Latin America:Livestock Aspects.
	J. Blydenstein, FAO, Rome.
2:00	The Need in Latin America for Long-term Studies on Pasture Management.
	L. Snook, FAO, IICA-CEI, Turrialba, Costa Rica.
3:30	Interdisciplinary Investigation to Support Agricultural Development.
	C. V. Plath, FAO, IICA-CEI, Turrialba, Costa Rica
Friday 29	
8:00 A.M.	Establishing Research Priorities for Latin America: Pasture and Forage Aspects.
	E. M. Hutton, CSIRO, Australia.
9:30	Round Table Discussion on Research Priorities and Programs.
	Chairman, H. H. Stonaker, University of Nebraska Mission Colombia
1:30 P.M.	General Discussion Session
	Chairman, O. Paladines, Ministry of Agriculture, Ecuador
7:30 P.M.	Closing Session

FUNCTIONARIES OF THE PANEL

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INTRODUCTORY REMARKS BY Dr. H. HOWE, SENIOR ADVISOR UNDP/FAO PROJECT 80

Early in 1968, Dr. Marull, who was at that time the Director of this Center asked the staff of the Department of Animal Science and Pastures to prepare a draft for a Panel. In March of 1968, Dr. Blydenstein, who at that time was a Food and Agriculture Organization Expert here, and was serving as Acting Head of the Department of Animal Science and Pastures, brought to Dr. Marull a working paper regarding a Panel. This working paper and other supporting documents were taken to the Annual Review Meeting for UNDP Project 80 held in Rome, last October, and the idea for a Panel was received with considerable enthusiasm. Shortly thereafter, Dr. Deaton was asked to serve as the Coordinator of the Panel, and the planning began last December.

I believe a very interesting program has been prepared with the united effort, and I want to emphasize with the united finances, of IICA and of FAO. One walks into trouble when he attempts to name persons who have contributed greatly to this effort because, as is always the case, names are inadvertantly omitted. Nevertheless, while I recognize this hazard, I am going to mention: Dr. Marull, who initiated the project; Director Suárez de Castro, who has done so very much in making the Panel a reality; Dr. Deaton, who has carried the ball through the past eight months; Dr. Vohnout, Head of Animal Sciences and all the members of that Department, most of whom are here this morning, namely Dr. H. Muñoz, Ing. A. Sánchez Durón and Dr. L. Snook; Carlos Ferreiro, who is not here but who is behind the scenes in charge of Administrative Services; Arnold Erickson, the genial and general expediter of relations here at the Center; Roberto Ayala, the Administrative Officer of UNDP 80; and then all of the fine ladies who have made translation, have worked out transportation details and have performed many other essential duties Miss. Fernández, Mrs. Genis, who very efficiently will take care of your transportation problems, Mrs. Meneses, Mrs. Lopez, Mrs. Acuña and Miss. Hodgson.

It might be of interest to you to know that this is the fourth Panel in which IICA and Project 80 have cooperated in the past twelve months. From the second until the seventh of September last year, there was a Panel on the Organization and Management for Agricultural Development in Latin America - and I see one of our FAO members, Mr. Herrera setting back there. It was just a year ago that we were here with that Panel and he was the Coordinator. On the sixth to the thirteenth of July, this year, with Dr. Fassbender as Coordinator there was a Panel on Volcanic Ash Soils in Latin America. Both of these Panels were held in this room, and the two gentlemen, Mr. Diez and Mr. Lara, who will do a fine job of translating here today were with us in those two other Panels. Them early this month, the fourth to the eight of August, The Section of Project 80 which is located in Lima, Perú, cooperated with IICA and the Agrarian University at La Molina in a Panel entitled, Post Graduate Agricultural Engineering Education and Associated Research in Latin America.

One always has templations to hand out advice, particularly when you get to be my age. And as much as I try to resist this urge, something is bound to creep out. At the conclusion of this Panel, we are hopeful, in fact we desire, that there will be a helpful statement of recommendations and conclusions. And my only bit of advice is this-that you should begin giving serious thought to this statement today, and work on it every day so that the task will not become too burdensome on Friday, particularly on Friday evening.

I am sure that you have a full schedule for the week, and I know that you will be applying your talents diligently. Also, those of us here at the Center want you to enjoy every minute of the week. Director Suárez de Castro and his staff have the well deserved reputation of being wonderful hosts. Please enjoy your time at this attractive, efficiently-maintained Center, and enjoy beautiful Costa Rica. Thank you.

COMMENTARIES OF Dr. J. MARULL, REPRESENTING THE DIRECTOR GENERAL OF THE INTER AMERICAN INSTITUTE OF AGRICULTURAL SCIENCES OF THE OAS

The General Director of the Inter-American Institute of the Agricultural Sciences of the OAS, Ing. Armando Samper, has asked me to represent him at the inauguration of this Panel on "Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America." In spite of the marked interest that the General Director has on the matters which will be discussed here and his strong desire to participate in the meetings, he was unable to do so due to an unfortune conflict of obligations of his high position which required his presence elsewhere at this moment. Although he is prevented the privilege of addressing you this morning this gives me that pleasure.

It is with genuine pleasure that I represent the General Director, not only because I share his intense interest in these matters, but also because I had the fortune to participate personally in the first stages of development of this Panel. The benefit of the deliberation of this scientific meeting, as I recall which was assembled for the specific purpose of advising the IICA and other such Graduate Institutions, lies in defining the types of teaching and research in the field of Animal Production which will permit a greater fulfillment of their role in serving our countries. Such a function is oriented toward reinforcing national institutions reponsible for agricultural development through the development of competent personell. The policies used in post graduate education as an instrument to promote progress are responses to the expressed desires of the member states of IICA and represent the utilization of scarse resources with a large multipler effect.

We have the responsibility to apply these limited means to critical areas where the need is greatest, innovation is difficult, and the probable impact is more profound. Policies so formulated automatically brings animal production to the forefront to be assigned a high priority. This is justified in the first place, because animal production is the sector of the slowest growth within agriculture which, at the same time, corresponds to the most sluggish sector of the Latin American economy. In the second manner, there is a serious deficit of animal protein in the diets of our populations, a deficiency that is aggravated because the human population increases more rapidly than does animal production. In the third place, the best -and frequently the only- possible utilization of nearly one third of the total area of Latin America is through pastures. In the fourth place, the earning of foreign exchange for financing the importation of capital and manufactured goods can be realized through the exportation of animal products which not only comprise nearly half of the external commerce, but which represent a component of enormous expansion potential. It appears appropriate at this moment to note the symbolic character of this Panel by inauguration exactly on the day of the anniversary of the independence of Uruguay, essentially a livestock country, whose national income is dependant, almost exclusively, on the exportation of animal products. Finally, this Panel is justified because of the academic "no man's land" which has been neglected by the professional Agronomists and Veterinarians with the friction, has contributed to a deficient development in the technical disciplines which concern animal management.

The importance of animal production has been clearly understood by the Board of Directors of the Inter American Institute of Agricultural Sciences

which, in their Seventh Annual Meeting, solicited, through the General Director, a study of the situation and perspectives for orienting the activities of the Institution. The study was broadly satisfactory to this group when they were informed of it during their Eighth Annual Meeting at Quito during April of this year.

In the name of the General Director and in my own, I wat to express our thanks to everyone whom has contributed to make this Panel possible; to the United Nations Development Program which, through Project 80, has provided the principal financial support; to the Food and Agriculture Organization of the United Nations (FAO), for your role as an executive agency of the said Project; to you, the participants of this Panel, whom have sit aside your important duties to bring your ideas and counsel; to the personell of the IICA, especially those of this Center, for your generous collaboration. To all of you for your productive labor, and to our visitors we wish you a pleasant stay here and a happy return home.

WELCOME AND FORMAL INAUGURATION OF THE PANEL: ING. F. SUAREZ DE CASTRO DIRECTOR OF THE TRAINING AND RESEARCH CENTER OF THE INTER AMERICAN INSTITUTE OF THE AGRICULTURAL SCIENCES OF THE OAS, IN TURRIALBA, COSTA RICA

Few times have we been able to gather together at this Center such a group of distinguished specialists as the one which is sitting around this table today. The United Nations Development Program Project 80, administered by FAO together with the Inter American Institute of Agricultural Sciences have made a great effort to bring together from the four corners of the world the most distinguished and competent experts to help us on a subject that we consider to be of outstanding importance to Latin America and for the Inter American Institute of Agricultural Sciences: what should be done in research and post graduate education to develop this animal industry in Latin America?

It is easy to understand the importance of this matter for us and for the entire continent. You have just heard Dr. Marull's opening remarks. We must also take into consideration the fact that nearly one fourth of Latin American land is at present time occupied with natural pastures and perhaps most of this territory has no better use than as pasturage. There are more than five billion dollars produced annually in livestock, which is equivalent to about 40% of the GNP of the agricultural sector, and about 8% of the total GNP of Latin America. Nevertheless, there is still a tremendous lag in the industry. As was pointed out by Dr. Marull, it is the agricultural sector which is lagging farthest behind on this continent, and livestock is the part that is most primitive in its development. We have not even been able to produce the necessary meat to assure and adequate diet for our population. Except for three countries -Argentina, Paraguay and Uruguay- there is a tremendous animal protein deficit throughout Latin America. The small amount of meat exported is done so on the basis of a decrease in the availability of proteins for the population to limits below those internationally accepted as minimum to maintain the health of the population

It is no exaggeration to say that for a good part of the continent, especially in the tropical zone, animal industry is more like primitive hunting rather than an organized industry, where animals that have developed in the wild are rounded up periodically, a few are sold off and some are killed for immediate consumption. Under these conditions, naturally, mortality is extremely high, and fertility is extremely low because of a combination of poor genetics and prevailing diseases without any control whatsoever, as well as poor management. As a result of this particular situation, livestock in Latin America is just barely increasing at a rate of just over 2% per annum, which is lower than the growth of the population itself. In other words, each day the protein deficit mentioned by Dr. Marull is ever greater; the gap between the growing populations' needs and the supplies made available by this primitive industry ever wider.

I would hazard a guess that the general consensus of opinion is that to tackle this problem, we must first substantially increase the technical teams qualified to do research and teach, and capable of organizing and directing agricultural development programs. They are needed at all levels, from the non-professional through to university and post-graduate levels.

If at this time we have wanted to limit the activities of this Panel to Post Graduate Education, this is due to two main factors: first of all, this is the field that has been given as the main field of activity for the Inter American Institute of Agricultural Sciences of the OAS. Secondly, and in my way of thinking the most important, it is because we believe that by training people at the post graduate level we have a multiplier effect that is much greater than the training at any other level. These people here learn to do research and to teach. They go back to their country with a very solid foundation and will be able to expand the scope and knowledge, improve the technology of the animal industry and transmit these new ideas at all the different levels.

We are certain that from the deliberations of this Panel, as Dr. Howe pointed out, we will have excellent guidelines for the Inter American Institute of Agricultural Sciences, and for all Latin America, on post graduate education and research in animal industry. No less can be expected from the quality and level of the specialists which are gathered here at this time. I wish the greatest success to all of you in your deliberations. I extend to you the warmest welcome to this Center, and put our limited resources and facilities at your disposal not only to help you in your activities within the Panel, but also to help make your stay here as pleasant as possible.

I formally declare the Panel on "Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America" opened. Thank you.

Dr. J. Marull speaking during Opening Ceremony of the Panel.

A view of some of the Panel participants.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nationa FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. A-1 Dr. H. Caballero, IICA Graduate School in Argentina

Title: POST-GRADUATE INSTITUTIONS IN LATIN AMERICA: THEIR OBJECTIVES, PROBLEMS AND POTENTIALITIES

INTRODUCTION

This theme, which I consider of great tanscendence for the future agricultural progress of the continent, is broad, complex and involves various facets for its development, fulfillments and future.

Consequently, on this occasion, I will limit myself mainly to what happens in the southern cone of Latin America (Argentina, Brazil, Chile, Paraguay and Uruguay) and, in a special manner, to that related with the Graduate School in Agricultural Sciences of the Republic of Argentina, with which, for obvious reasons, I am more familiar.

On the other hand, considering that this meeting is broadly represented by Latin American delegates, I believe that they, better than I, can furnish information and experiences relating to their respective Institutions of Graduate Education.

Considering that livestock research, duely programmed and conducted, should constitute a fundamental element for those Post-Graduate Schools which carry on programs in the livestock field, I have considered it of interest to also stress some appraisal in this topic. This is in agreement with the Panel's ultimate purpose in the sense of studying and analyzing the principal factors that could markedly influence in livestock development in Latin America.

I. GRADUATE EDUCATION IN AGRICULTURAL SCIENCES IN LATIN AMERICA

1. A little history

In 1946 the Inter-American Institute of Agricultural Sciences of the OAS (IICA) was established at Turrialba, Costa Rica, the first Latin American Graduate School in the Agricultural Sciences. Their experience has been of utmost value and their example is worthy of imitation in other regions of our continent.

In 1957 the University of Puerto Rico was the second institution to organize graduate courses and, the same year, the Universidad Agraria of La Molina, Lima, Perú, was born which granted its first advanced degrees in 1962.

The year 1959 was really fruitful for graduate training, since three new schools were established: one in Brazil, the Escola de Pós Graduacao of the Universidad Rural do Brasil (Km. 47) and two in México, one in the Escuela Nacional de Agricultura of Chapingo and the other in the Instituto Tecnológico y de Estudios Superiores of Monterrey.

In 1960 Brazil increased its potential in this important field with a program at the Rural University of the State of Minas Gerais (Vicosa), which in 1963 was combined with the Escola Superior de Agricultura "Luis de Quéiroz" at Piracicaba, a dependency of the University of Sal Paulo.

Under IICA's direction, in September 1963, the first formal graduate course were started in Livestock and Pastures at "La Estanzuela", Colonia, Uruguay, which were repeated annually until 1967, then discontinued in January, 1968.

According to the resolution of the Board of Directors of the IICA which started in March 1963 the Regional Cooperative Program for Graduate in the southern zone, this region received a great impetus by the organization of graduate courses. This is how, in 1964, this activity was started in Argentina, the headquarters being in the Universidad de La Plata.

In 1965, the Universidad de Buenos Aires offered its first graduate courses in agriculture and Colombia formalized the program of their Graduate School in Agriculture and Zootechnia, as a dependent of the Instituto Colombiano Agropecuario and the National University.

The postgraduate educational activity in the agriculture field was finally solidified in Argentina with the creation of the "Escuela para Graduados en Ciencias Agropecuarias". It was established through an agreement, on June 28, 1967, between the University of Buenos Aires, the National University of La Plata, the "Instituto Nacional de Tecnología Agropecuaria" of the Republic of Argentina (INTA), and the Inter American Institute of Agricultural Sciences of the OAS, to provide training in the agricultural sciences to university graduates.

The action of the regional cooperative program of graduate training of the IICA also extends to Chile and, in 1967, the state university (Universidad de Chile), cooperating with other organizations, initiates activities for training graduate in agriculture. This picture is not complete without mention of the Catholic University of Chile, which started this type of education and training in 1968.

This same year (1968) the Veterinarian School of the Federal University of Minas Gerais (Belo Horizonte), Brazil, offered its first graduate course of post graduate.

Finally, on April 8, 1969, the Deans of Agriculture, Veterinaty and Forestry Schools of the Chilean universities, set up the basis for the creation of a joint Graduate School that would serve the needs and desires of all.

Thus far this is a short chronological review of the development of Graduate Training in the Agricultural Sciences in Latin America in the main institutions that have offered or do offer Post-Graduate studies in Agriculture.

It is estimated that, at present, there exist around 25 Latin American organizations or institutions that have taken a formal attitude and direction in this crusade. However, there is a great disparity among these institutions, in their processes of development, organization and stability. Diverse national and international organizations are contributing directly towards the development of these initiatives which are of so much importance for the Latin American agricultural progress. Among the international organizations, should be mentioned the Kellogg, Ford and Rockefeller Foundations, various Northamerican universities under AID contracts, the "Institute National de Recherque Scientifique", FAO, IICA and other organizations.

We hope that this contribution will continue, duely coordinated, in order to maximize the use of the physical and human resources available.

2. GRADUATE TRAINING IN AGRICULTURAL SCIENCES IN THE SOUTHERN ZONE

The IICA, through its regional cooperative program of graduate training established in 1963, has been the constituent responsible for the development of this activity in the shouthern zone of Latin America (Argentina, Brazil, Chile, Paraguay and Uruguay). For them the southern zone was divided into three regions:

SOUTH ANDEAN ZONE, with headquarters in the University of Chile, Santiago; including the region of Chile and the western part of Argentina.

REGION OF THE PLATA* with headquarters in the "Centro Nacional de Investigaciones Agropecuarias of the Instituto Nacional de Tecnología Agropecuaria", Castelar, Argentina; corresponding to the temperate climatic area of crops and livestock in Argentina, southern Brazil and Uruguay.

SUBTROPICAL REGIONS, with headquarters in the "Escola Superior de Agricultura Luiz de Queiroz", University of Sao Paulo, Piracicaba, Brazil; comprising the subtropical area of Brazil, northern Argentina and Paraguay.

The main characteristics of the courses that are developed in the different regions, under the Cooperative Program, could be summarized in the following terms:

a) The final step of each course is the awarding of the title of "Magister Scientiae", equivalent to the Master of Science, to the students that have fulfilled all the specified requisites. The awarding of this title is the responsability of one of the graduate institutions training that take part in the program.

b) The courses are basically programmed for a duration of 18 months, even though this period may undergo modifications with some frequency. The study schedule is generally trimestral and programmed in such a way for the student to not require classes at least in their last trimester in order to complete their thesis.

* The activity of the Region of the Plata, concerning graduate courses in Argentina was rendered to the Escuela para Graduados en Ciencias Agropecuarias upon its foundation on June 28, 1967.

c) Assesors committies have been established for the courses but the final orientation of each student, with respect to the minor details of his study plan is in care of an Advisory Committee, in which the Principal Advisor has a dominat influence.

d) Among the main requirements for a student to graduate are final approval in all the courses; approval of a preliminary canditure examination; a minimum residence of one year in the recognized institutions giving the courses; carrying out a research project during the study period; approval of a thesis project; presentation and assistance in seminars; and approval of a thesis and final exam.

Next is presented a complete list of the courses offering during the existance of the Cooperative Regional Program of Training for Graduates of the IICA.

REGIONAL COOPERATIVE PROGRAM OF GRADUATE TRAINING*

C O U R S E	Location	Date Initiated	Students Enrolled
1. Plant Pathology	U. La Plata	1-4-66	10
2. Experimentation and StatisticsI	Piracicaba	15-9-64	12
3. Plant Pathology I	"	"	16
4. Genetics I	"	"	16
5. Mechanics, Motors and Agr. Mach.I	"	"	12
6. Plant Nutrition I	"	"	13
7. Soils I	"	"	18
8. Plant Genetics	Univ. Bs. As.	11-10-65	10
9. Rural Social Sciences II	Piracicaba	1-3-66	30
10. Experimentation and StatisticsII	"	"	17
11. Plant Pathology II	"	"	18
12. Genetics II	"	"	15
13. Mechanics, Motors and Agr. Mach.II	"	"	9
14. Animal Nutrition and Pastures II	"	"	20
15. Plant Nutrition II	"	"	12
16. Soils II	"	"	13
17. Plant Physiology	U. La Plata	2-5-66	10
18. Animal Pathology	"	3-10-66	9
19. Genetics and Crop Improvement	U. de Chile	3-4-67	9
20. Crop Science and Technology	" Mendoza	3-1-68	12
21. Rural Social Sciences III	Piracicaba	1-3-68	15
22. Entomology III	"	"	18
23. Experimentation and StatisticsIII	"	"	14
24. Plant Pathology III	"	"	16
25. Plant Industry III	"	"	19
26. Genetics III	"	"	10
27. Mechanics,Mot. and Agr. Mach.III	"	"	12
28. Animal Nutrition and Pastures III	"	"	10
29. Plant Nutrition III	Piraeicaba	"	16
30. Soils III	"	"	10
31. Use of Agric. Machniery	Esc.Grad.Arg.	15-4-68	8
32. Agricultural Economy	U. Católica	5-8-68	9
33. Agricultural Extension	Esc.Grad.Arg.	30-9-68	10
34. Agricultural Economics	"	7-10-68	23
35. Animal Production	"	7-4-69	20
36. Animal Nutrition and Pastures IV	La Estanzuela	5-9-69	11
37. Animal Nutrition and Pastures V	"	4-9-67	(6)
38. Univ. Tech. Techniques I	U. Montevideo	7-3-66	17
39. Univ. Teach. Techniques II	U. de Chile	29-5-67	21

* This information was furnished by Dr. Carlos Schlottfeldt, Auxiliary Dean of IICA's Graduate School and Director of the Cooperative Program.

In addition to these courses, others have been announced to start soon; these are as follows:

Argentina

- Veterinary Sanitation
- Soil Science

Brazil

- IV Cycle in Piracicaba: 10 Specialization Fields.

  Starts: 1 March, 1970 (See courses 21 to 30 in the list).

Chile

- Soil Fertility and Management - Starts: 1 October, 1969.
- Agricultural Economics - Starts: August 1969 and January 1970.
- Poultry Production - Starts: January 1970.

3. THE GRADUATE SCHOOL IN AGRICULTURAL SCIENCES OF THE REPUBLIC OF ARGENTINA

a) Its purpose and development

Its foundation was due to the need of creating, training, guiding, and developing university graduates in those disciplines that are considered important for making agricultural progress in the countries of the continent.

This happens in the Latin American medium, using training techniques and methods characteristic of advanced agricultural economies, but applying, at the same time, the logical adaptations needed for our particularities and our situations.

The formation of the School was started in 1963 when the IICA undertook the Regional Cooperative Program for Graduates of the southern zone in the region of La Plata. In 1964 the first course was offered at the Masters level and, in this manner, an effective cooperation was started among the University Training institutions and those dedicated to Research.

To complete this picture, IICA's cooperation was sought, which, due to its experience as pioneer in the Post-Graduate Training in Latin America, guaranteed adequate teaching, technical and administrative experience.

This whole process culminated finally into the institutionalization of the School on the 28th of June, 1967, the date when the paternal organizations (University of Buenos Aires, National University of La Plata, INTA and IICA) established an operating agreement.

This entity constitutes a living example of integration among national and and foreign organizations; the highly beneficial results, of preventing duplication of efforts, and increasing the effectivicy of using human material and financial resources, have been obtained. All this had a beneficial overflow

effect on the institutions, the countries and the region, causing, also, stability and coninuity in the developmental progress of Graduate Education.

b) Program of the Graduate School

The "Escuela para Graduados en Ciencias Agropecuarias" of the Republic of Argentina, has undertaken the following program in order to solidify its objectives:

1) Courses at the Masters level
(minimum duration 18 months)

These courses are destined towards the formation and improvement of:

1. Researcher workers destined for faculties, specialized institutions, experimental stations schools and other agricultural services.

2. Teachers or professors at university level.

3. Specialists in technical matters, to work in Agricultural Extension fields.

2) Advanced specialized courses
(minimum duration 8 months)

These courses have the objective of training in subject matter methodology and scientific advances of special interest for researchers or high level professionals.

3) Periodic review or refresher courses
(4-8 weeks duration)

For university directors and administrators of research and extension programs (appraisal of the latest scientific advances and their practical or technical application in the agricultural field).

Conferences, symposiums, round tables, etc.

These are carried out at the highest intellect level, as a means of training for advanced teaching, research and agricultural extension.

c) School Government

The upper level administration of the "Escuela para Graduados en Ciencias Agropecuarias" corresponds to the Board of Directors which is made up of five honorary members which exercise their duties while they are fulfilling their regular functions in their respective institutions.

This Board names a president and vice-president by election among their members, whom serve one year in office with the possibility of reelection for another year.

This Board of Directors is made up of:

- The Regional Director of the Southern Zone of the Inter-American Institute of Agricultural Sciences of the OAS.
- The Dean of the Faculty of Agronomy and Veterinary Science of the University of Buenos Aires.
- The Dean of the Faculty of Agronomy of the National University of La Plata.
- The Dean of the Faculty of Veterinary Sciences of the National University of La Plata.
- The Director General of the "Instituto Nacional de Tecnología Agropecuaria".
- The Director and the Associate Director of the integrated School participates in the Board meetings but without a vote.
- The other directive body constitutes the Academic Council which is responsible for the School's organization and functioning.

This council is composed of nine honorary members who are:

- The Director of the School
- The Associate Director of the School
- The auxiliary dean of the Graduate School of the IICA in his position as the Program Head of courses for Graduates in the Southern Zone of the IICA.
- A representative of the Faculty of Agriculture of the University of Buenos Aires.
- A representative for the Faculty of Veterinary Science of the University of Buenos Aires.
- A representative for the Faculty of Agriculture of the National University of La Plata.
- A representative for the Faculty of Veterinary Sciences of the National University of La Plata.
- The Director of the "Centro Nacional de Investigaciones Agropecuarias" of INTA.
- The director of the "Departamento de Especialización" of INTA.

The direction of the Graduate School is exercised by a Director named by IICA, with the agreement of the Advisory Council and is assisted by an associate

director named by INTA, also with the agreement of the Advisory Council.

The administration of the School is charged to the head of the Administration Services, proposed by the Director of the School and approved by the Academic Council and the Advisory Council.

All internal regulations are approved and audited by the Advisory Council so as to establish and orient the work of the Administrative Services.

Both the Director and the Associate Director are assisted in their functions by a "Secretario de Enseñanza" (Academic Registrar) and by the Head of Administrative Services.

The School has its main headquarters in the "Centro Nacional de Investigaciones Agropecuarias" (National Center of Agricultural Investigations) of the INTA, in Castelar (Buenos Aires Province) and develops its activities there, in the other participating universities, in other dependencies of the INTA, as well as other places according to prevailing needs.

The School actually maintains four graduate course studies as follows: a) Agricultural Machinery, b) Agricultural Economics, c) Agricultural Extension and d) Animal Production. The total students registered number 62, accounting 46 Argentinians and 16 foreingners, distributed in the following manner:

Courses	Dates		Students Registered		Total
	Start	End	Argentina	Foreign	
a) Agric. Machinery	April 1968	Sept. 1969	5	3	8
b) Agric. Economics	Oct. 1968	Mar. 1970	19	4	23
c) Agric. Extension	Oct. 1968	Mar. 1970	9	2	11
d) Animal Production	April 1969	Sept. 1970	13	7	20
TOTALS			46	16	62

II. CATTLE PRODUCTION, RESEARCH AND TRAINING IN ANIMAL SCIENCES

1. Cattle Production, Its Importance and Efficiency

The Latin American agricultural potential reaches unsuspected levels; however, the limited development up to now constitutes the main cause of the economical backwardness of the continent.

Some progress have been recorded, nevertheless, the volume of agricultural production does not increase sufficiently with the demographic growth cycle which causes, each year, a decrease in the availability of food per-capita and a large part of the population of the continent to receive subnormal diets.

Animal husbandry can be pointed out as the principal industry responsible for this situation, since it acts as a keel for agricultural progress. Thus, in a study made by the CEPAL it was established that the cattle sector had, between the years 1964 and 1966, an annual growth rate of 2.6% which means a relative decrease when calculated on the basis growth per inhabitant. This is clearly shown in table No. 1.

TABLE 1. Latin America: Indexes of Agricultural and Cattle Production 1960 and 1964/1966

1950 = 100

			Average 1964/1966			
			Indexes		Growth rates (percentages)	
	Overall	per/inhab.	Overall	per/inhab.	Overall	per/inhab.
Total Production	141	107	165	109	3.4	0.6
Agric. Production	147	112	175	115	3.8	0.6
Cattle Production	129	98	146	96	2.6	-0.3

Source: CEPAL, based on production figures from FAO and population figures from CELADE.

All this shows us that our animal prodution is stalled. It is not appropriate, at this moment, to go into a discussion the reasons for this situation, but it is interesting to point out the following facts, which characterize the generally low efficiency of our cattle production:

1) The average calving percentage of cattle is estimated as varying between 50% and 60%.

2) Cows first calve when they are 3 or 4 years old and they produce a total of only 3 or 4 calves during their productive life.

3) Production per Ha/year has been calculated at 70 Kg of weanling calf weight.

4) Steers are slaughtered when they are 4 years old or older.

5) The situation for dairy cattle is similar, since the calving percentage time does not exceed 60% and the cows start production at 3 to 4 years of age, and yield a total of 1,500 kg of milk per cow/year.

6) The mortality rates among cattle usually rise to over 10% annually.

7) In the case of sheep, it is estimated that the lambing percentage does not exceed 70%, there also are considerable losses of lambs between birth and marking, estimated to be over 10%.

The above figures represent only very approximate averages, but they dramatically reflect the low intensity of livestock production that results from low production per animal, per/unit of land and, per person. In such manner, the returns of the cattle enterprises is considerably lower than what it should or could be.

If this situation is maintained, considering the reproductive aspects of beef cattle previously described, one can be sure that, in many regions the cow would only be able to perpetuate herself without any possibility of selection and, as a consequence, a stable or decreasing cattle population.

There is no doubt that the progress in livestock prodution constitutes the key element in the economical development of the continent and in the welfare of its population. This is due to the following principal reasons:

1) Animal foods are relatively high in nutritive value.

2) Animal husbandry constitutes an activity of great economic importance.

3) Only animal husbandry can efficiently utilize large expanses of land and certain products and by-products which would otherwise be lost.

4) Animal husbandry is an important source of foreign exchange for several countries.

2. The Situation of Livestock

a) General Situation

Cattle research, as much in the countries of the southern zone as in the rest of Latin America, is in its initial or primary stage. Their state is still incipient, since we must admit that in the past, greater efforts were directed towards agricultural research per se, notoriously neglecting that related with animal production.

Livestock research work was initiated during the last decade and has reached certain volume and significance only during the last five years. The application of the results have produced a considerable impact on cattle production, managing to increase utilization of the available resources. Under such circumstances, some countries have outlined a coordinated organization, with a more or less definite orientation, which is just beginning to take shape. Meanwhile in other cases a certain instability and disorientation has been noted regarding the organization, planning and coordination of a cattle research programs.

In this sense, I believe that a joint coordinated effort of the countries of the southern zone can be of great value, with the goal of all being able to use and profit from, not only the successes but also of the errors, made by each one of the countries throughout the organization, programming and operation of livestock research.

Sometimes it hurts to find out that you are committing the same faults and errors which were surmounted in other places through a great deal of effort and economic sacrifice. It would be logical to take advantage of this experience and not have to run the same course filled with snags, problems and disillusions.

The short life of this branch of research does not permit us to exhibit of a great volume of results or accomplishments; however, part of the information obtained could be used within the different countries, to great benefit, if the appropriate means and mechanisms existed.

Research in animal production (bovine and ovine) is being directed mainly towards works of general cattle management and, very specially, toward all that is related with animal nutrition, due to the fact that this last aspect constitutes one of the most important causes of the low efficiency which is recorded in our cattle production. Pastures, as the principal source of cattle feeds, merit special attention, as much in their direct utilization as in their management and handling when their productivity is converted into harvested forages.

b) Some important shortcomings or problems in livestock research.

The previous comments do not imply that livestock research is in a satisfactory stage of developmental; on the contrary, it is plagued with important faults and limitations which, to a greater or lesser extent, affect the different countries of the southern cone. Among these, the following can be pointed out:

1) There is a lack of national coordination among the research programs which results in unnecessary duplications, and consequentially inefficient use of physical and human resources.

2) Inadequate orientation and programming of some research.

3) A shortage of technically capable personal. Also many of the existing researchers obtain insufficient salaries, communication little with other national or foreign research centers, are supported by insufficient libraries and there are difficulties in obtaining adequate funds or resources for the development and expansion of their work in quality and quantity.

4) Considerable confusion is produced by the foreign technical assistance, which has been abundant but with extremely variable ideas. Also, these programs do not always have stability or continuity and normally there is no inter-coordination among them.

5) Problems derived by the developmental infrastructure tend to favor plant research.

6) Facilities or means for contact among researchers through assistance to congresses, seminars, courses, etc. are limited.

7) Currently there are no government programs available which; a) adequately consider incentives toward the development of livestock production; b) have established a good extension system to make efficient use of the research results or; c) have provided the necessary credit in a simple and quick manner.

8) Ignorance, on the part of the farmer, of the importance of his own economic problems, which at times may have an unfavorable influence on the orientation of research.

9) The major part of livestock research does not consider the economical and productive aspects as an overall, or integrated concept, but generally provides incomplete information which involves only a part of the problem under study.

10) There exists a considerable anarchy in the employment and use of experimental techniques and designs, which makes the interpretation and comparison of the results very difficult.

11) By and large, livestock research has not been approached in relation with rural administration problems, that is in reference to the selection and integration of different types and classes of agricultural enterprises that produce optimum yields without sacrificing future productivity.

12) Economics information relative to the costs of labor, energy and machinery is scarce or nonexistant. Likewise, there is a lack of studies on comercial agricultural products, use of credit, and data or information relating to variations in prices of the products as well as their corresponding overhead expenses.

13) Usually, research on animal production is neither planned nor carried out by with the participation of a team of specialists from different disciplines (soils, crops, forages, livestock, socio-economics, etc). In this manner no joint and integrated action is achieved in the solution of the cattle production problems.

3. Training in Animal Sciences

The situation mentioned above of limited cattle production and research, also has important implications on related educational programs. That is, this aspect of education has been neglected and has been passed as "the poor cousin" the agricultural training activities, as much is the schools as in the universities and post-graduate institutions.

As a logical consequence of this situation we find ourselves with a great scarcity of adequately trained personnel which could produce an important impact on the progress of livestock activities via production, research and training.

On this particular theme, it is of interest to recall the statement of Professor K. L. Turk, from one of his publications on education: "There exists a unanimous agreement that in the underdeveloped countries of the world the most underdeveloped science is animal science".

As long as this situation persists, I believe it will be difficult to obtain a considerable increases in livestock production.

The causes that have been responsible for this relegation or impartiality toward the animal sciences in agricultural training, are numerous; they have been widely analyzed and discussed in different international meetings, symposiums and congresses and therefore I consider it unnecessary to go into them.

Considering now the graduate training in animal sciences and which correspond to the specific theme of this Panel, I believe that its programming and development are difficult mainly due to the faults and problems which affect pre-graduate training. This does not mean that it is not necessary at this time, on the contrary, I believe that this type of training is extremely important and vital, since on one hand it would furnish competant professionals whom would decisively influence and stimulate livestock production and, on the other hand, would produce teachers and investigators duely trained towards improvement of education at the professional level.

Graduate Education in Animal Sciences has been forced to fill in the deficiencies of the university trainee, as much in the basic sciences as in the applied ones. Also, in many cases, it must face the problems of insufficient practical experience by the students and ingnorance of the realities of agricultural business. This always results in difficulties and complications, but it is absolutely necessary that one be conscious of the problem and try to correct it by all means.

Some specialists, for reasons noted above, have questioned the value of investing efforts into graduate education before resolving the problems of education at the lower level.

For many reasons, principally problems of structure, finance, and operation of our university faculties, I believe that efforts, properly channeled into well organized post-graduate schools, will render good dividends, of which, as previously mentioned, would directly enrich the faculties. Also, if, at the same time, we work towards improving and modernizing professional education, we will all benefit.

Progress in education at all levels constitute the master key which will open the doors toward progress and prosperity of the populations.

III. OBJECTIVES: PROBLEMS AND POTENTIALITIES OF THE POST-GRADUATE SCHOOLS IN LATIN AMERICA

1. Objectives

I believe that the objectives of graduate education in agricultural sciences in Latin America are similar and coincide with those of the various existing institutions.

For example, allow me to point out the stipulated regulations of the "Escuela para Graduados en Ciencias Agropecuarias de la República de Argentina".

ART. 1 - The activities of the Graduate School of Agricultural Sciences will be directed towards perfecting the professional graduated in the Faculties of Agronomy, Veterinary Science and other similar specialties.

ART. 2 - Its objective will be the formation of specialized university teachers, investigators and professionals, such that, as innovators, they will accelerate the scientific technical, economical, and social evolution of the institutes related to the rural environment, contributing in such a way as to stimulate national development.

ART. 3 - It will proportion high level courses to graduates that will give them, in addition to the basic scientific knowledge, the specific knowledge appropriate to their field contributing to develop or perfect:

a) creative aptitude through original research work, an independence of reasoning, particularily in the planning and execution of research and field and laboratory experiments, the habit of impartial investigation, a judgement based on ample information and an own interest in their own fields of specialization;

b) Scientific methodology, the theoretical approach towards problems solving in professional activities not only related to rural enterprises, but also with respect to national development plans;

c) an adequate mentality about the importance that the specialization has in research, training and agricultural extension and the influence of these on modern life.

ART. 4 - The Graduate School pursues, through the means indicated, the following ends:

a) to satisfy, in quantity and quality the necessities for specialized technicians in training, research, rural extension and development by reintegration of the graduates into their original institutions or professional activities;

b) increase the usefulness of the institutions by improving and strengthening of their scientific and academic levels and of their services;

c) increase the knowledge related to agricultural problems and their solutions, through research carried out by the graduates;

d) influence the less developed scientific or technological sectors by the spreading of their activities and those of their graduates, thereby giving impetus, to economical development of the countries.

Graduate education within the Latin American institutions have distinct advantages which cannot be obtained outside of the region. Among these we can point out:

a) A greater number of professionals has access to it, since certain problems are already eliminated, such as, difficulties of language, and the student studying and working in familiar surroundings.

b) Normally, it is much more economical.

c) The student has the opportunity of being involved in local problems and conditions, among which he will later work.

d) Local research is stimulated, developed and improved.

We are aware that the advantages described are coupled to some important problems but we believe that the final balance favors regional post-graduate training.

2. Principal Problems Confronting the Graduate School

Without trying to cover this theme in its totality, as it will also be discussed by other participants, I wish to point out below some of the main problems which are faced by the training institutions today:

1) Inadequate or insufficient administrative, financial, and academic basis. In the latter case, the scarce number of fulltime professors in remarkable and often times the part time professors do not possess the background or experience desired.

2) There is a lack of sufficient communications among the graduate schools in Latin America, aimed at exchanging ideas and experiences, in view of resolving some of the difficulties and complementing or coordinating this work in the continent. A system for registering the institutions and the programs should be established and maintaining up to date and be made available to interested parties. It is necessary to maintain unity within the group.

3) Libraries are not up to date, and do not have flexibility nor continuity with their publications.

4) Planning is often inadequate in reference to time sequence, definition and type of courses to be offered, etc. Technology always changes, creating problems in the concoction of curriculi and its revision and updating.

5) For each country the actual professional needs are not always known, and as such it is difficult to make decisions with respect to courses preparation and offerings.

6) The curriculi of the different schools are usually not uniform in intensity or value. Minimum rules should be established in order that the grading system will be standardized and have international recognition. In this aspect, the establishment of a central organization or nucleus that is in charge of formalizing, summarizing and controlling procedures and programs would be of great utility (Latin American Council of Graduate Studies).

7) Rules and procedures are not always adequate in the selection and admission of students. Among others, the age factor and professional experience do not usually receive due consideration. In this respect, it seems advisable to fix limits between a minimum of two and a maximum of twelve years of professional experience.

8) The exaggerated profusion of graduate courses charged to different institutions does not seem advisable. The tendency should be towards institutionalizing these into stable and permanent university organizations.

9) Deficient and heterogeneous preparation of the students at the professional level creates serious problems in the organization and development of graduate education. Many times, a training period of 18 months for obtaining a

Masters degree is insufffficient. In some cases it would seem advisable to extend that period to two years, alloting the additional six months towards pre-requisite materials or courses and to complete the work on the thesis..

10) Considering the precarious situation of the agricultural research, many times it is difficult or unadvisable to offer some courses and especially to complete the corresponding theses. This occurs in spite of the necessity of being able to rely on capable professionals in a specific area. This situation may result from: a) Lack of good local research; b) Lack of physical facilities (laboratories, experimental fields, libraries, etc.) and c) Lack of competent personnel to guide the students in their studies and experimental works.

11) Fellowships are always in short supply. The policy used by some international organization of granting fellowships only to students from outside the country of study causes a bothersome discrimination.

12) Foreign aid is valuable, necessary and useful but inconsistant and many times conditional. In this manner, it is necessary to interest the local institutions and organizations and the national community in our graduate schools if we want to gain stability, contiuity and permanent progress in this training activity.

3. Potentiality of the Graduate School

If we first consider the "demand potential" for graduate instruction, I believe this is considerable and steadily increasing. It is also repeated at the professional level, since different studies on the matter have established in Latin America the necessity to greatly increasing the number of Bachelor-level and similar professionals.

The preceding notions can be demonstrated with a report by Armando Samper of the Board of Directors of the IICA, in which he mentions "In 1963 Latin America had some 16,000 agricultural graduates available and needed no less than 43,000 in order to fulfill the needs of agricultural research, teaching, extension and development. The sixty or more Faculties of Agriculture graduate only some two thousand professionals annually".

Other studies have indicated an immediate necessity for quadrupling the number of university agricultural graduates and other related technicians.

One should consider, however, that the deficiency of technicians or professionals is not only resolved with quantity but also with quality. Where will the high-level professionals needed by Latin America to increase and improve agricultural teaching, research, extension and finance be obtained? We believe that a good possibilities reside in the Latin American Graduate Schools.

Summarizing we can then say that the "demand potential" is considerable and will continue to increase as the Latin American countries establish the adequate conditions, structures and systems for the full development of the agricultural activities.

Another question we should ask ourselves is the following: Do we have in Latin America graduate schools sufficiently capable of absorbing this demand for instruction and to furnishing a high level training to the numerous students that come to their doors? I belive that in almost all the cases the answer is negative and that was clearly established in the preceding discussion when we considered the problems, limitations and difficulties which face these institutions or organizations.

In this manner, all that we might do to resolve or minimize these annoyances will directly benefit graduate education which would considerably widen their potential towards producing more and better professionals. They will be the ones directly in charge of resolving the problem of the economical backwardness of our region through dynamic and effective action; the ones which will put agriculture, and especially animal husbandry, in its correct place within the whole of the productive activities of the continent.

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Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. A-2 Ing. L. Robles, Tecnological Institution of Monterrey, Mexico

Title: POTENTIAL OF THE LATIN AMERICAN INSTITUTIONS THAT OFFER POST GRADUATE STUDIES IN AGRICULTURAL SCIENCES FOR FOMENTING THE DEVELOPING OF ANIMAL HUSBANDRY

INTRODUCTION

Latin America is made up of nations which offer great contrasts with respect to availability of natural resources, socio-economical development, political situation, ideology, public and private administration and also in agricultural training for graduates.

There are certain favorable ecological zones in some countries of Latin Anerica wherein small investments will produce good harvests. Nevertheless, in a large portion of the area in these same countries there are diverse and complex problems in obtaining an optimum utilization of their agricultural and forest resources.

If we agree that the obstacles which impede progress in our countries are different, then the measures applied by the governments and the institutions to defeat them must also be different. Among these measures the outstanding one by its importance is the fomentation of superior education in the agricultural sciences, the acceptance of which is an irreversible process that has a fundamental reason the demand for scientific work exacted by livestock development.

In order to satisfy this demand for technicians and scientists, it is necessary to consider that the Latin American Institutions which offer post graduate studies can contribute directly to their preparation. For this purpose a short comparative study is presented of the purposes, problems and potentialities of those that have supplied the pertinent information.

I. INSTITUTIONS WHICH OFFER POST GRADUATE STUDIES IN AGRICULTURAL SCIENCES.

Training at the graduate level in Latin America was started in the year 1946, ten countries actually count with institutions which offer post graduate training in agricultural sciences, divided as follows:

Argentine (two)	1967	Escuela de Graduados en Ciencias Agropecuarias of the Instituto Nacional de Tecnología Agropecuaria in Castelar, of the Universidad de Buenos Aires in Buenos Aires. Universidad de la Plata in La Plata.

Brazil (five)	1959	Post Graduate School of the Universidad Rural (Kilometer 47) in Itaguai, Rio de Janeiro.
	1960	Graduate School of the Universidad Rural of the State of Minas Gerais in Viçosa, Minas Gerais.
	1966	Superior School of Agriculture "Luis de Queiroz" of the University of Sao Paulo in Piracicaba, Sao Paulo. Post Graduate Studies of the Faculty of Agronomy and Veterinary of the University of Rio Grande do Sul in Porto Alegre, Rio Grande do Sul.
	1968	Post Graduate Studies in the Veterinary School of the Federal University of Minas Gerais in Belo Horizonte in collaboration with the Inter American Institute of Agricultural Sciences.
Chile (two)	1967	Post Graduate Studies of the Universidad de Chile and of the Universidad Católica in collaboration with the Inter American Institute of Agricultural Sciences in Santiago.
Colombia (one)	1967	Program of Graduate Studies in Agricultural Sciences of the Instituto Colombiano Agropecuario and the Universidad Nacional of Colombia.
Costa Rica (one)	1946	Graduate School of the Training and Research Center of the Inter American Institute of Agricultural Sciences of the OAS in Turrialba.
Cuba (one)	1965	University of Havana and the Institute of Animal Science
Mexico (two)	1959	Colegio de Post-Graduados of the Escuela Nacional de Agricultural in Chapingo, Mexico
	1959	Graduate School-Agricultural Division of the Escuela de Agricultura y Ganadería of the Instituto Tecnológico y de Estudios Superiores de Monterrey in Monterrey, N. L.
Peru (two)	1957	Graduate School of the Agrarian University in La Molina, Lima. Graduate School of the Faculty of Veterinary Medicine of the University of San Marcos, Lima.
Puerto Rico (one)	1963	Faculty of Agriculture of the University of Puerto Rico in Mayaguez.
Venezuela (one)		Faculty of Forestry Sciences of the Universidad de Los Andes in Merida.

II. GENERAL PURPOSES OF THE POST GRADUATE PROGRAMS.

According to the published information, the purposes of the institutions which offer post graduate training in agricultural sciences are:

1. To form specialists of the highest moral and intellectual qualities in order to fulfill the demand for professors at all training levels of agriculture of agricultural scientists including the fields of livestock, forestry and socio-economics, and of extension workers in the entities dedicated to the publication and promotion of the results of research and training.

2. To prevent the knowledge of the training institutions from becoming obsolete.

3. To realize original basic research in the fields chosen for their importance, to obtain significative contributions in agricultural sciences of practical application.

4. To coordinate agricultural education, research and extension.

5. To spread new knowledge and research advances into the professional agronomic, animal husbandry and forestry medium.

For the students the foremost purpose of the post graduate training is the acquisition of academic competence and intellectual independence and maturity.

The compliance of the previously pointed out purposes accelerates the agricultural and institutional development and contributes to raise the human living standard.

III. ACADEMIC DEGREES AND ANIMAL HUSBANDRY COURSES OFFERED.

Of the seventeen institutions that offer postgraduate courses in agricultural sciences, fourteen are located in universities and institutes of higher learning and three in training and research centers related to universities.

The majority of the institutions academically project the professional area departments to higher levels. Some possess their own departamental organization, academically and even physically separated from the professional cycle, others depend on decentralized programs of graduate training and research with Latin American projection and, lastly, the governmental entities which coordinate their programs with the universities.

The academic Degree on the average is completed within a year and a half, mainly due to the fact that the students have the obligation to do a thesis based on original research.

Since 1965, eight institutions award the Degree of Master of Science or Magister Scientiae while the other offer special post graduate or post professional courses. For this it is common to provide documentary evidence or certificates which signify a greater depth or breadth of knowledge.

From Table 1 it can be seen that thirteen institutions award the Degree of Master of Science or Magister Scientiae and one more, in agreement with other entities, extend study certificates in 26

disciplines, which in the current order of frequency correspond to plant genetics, rural economics, entomology, plant pathology, soil chemistry, animal nutrition, pastures, animal husbandry and others. Actually two schools plan to offer the Degree of Doctor in Agricultural Sciences or Doctor Scientiae.

TABLE 1. Disciplines which award the Degree of Master in Sciences, Magister Scientiae or a study certificate in fourteen institutions in Latin America.

Discipline	Turrialba	La Molina	Chapingo	Monterrey	Viçosa	Mayagüez	Piracicaba	Buenos Aires	Castelar	Bogotá	Santiago (U. de Chile)	Santiago (U. Católica)	Belo Horizonte	Mérida, Venezuela
Agronomy	X				X	X								
Biology					X									
Rural Administration														
Botany			X			X		?						
Water Conservation and Use				X						X				
Forestry	X													X
Rural Econ. & Social Sci.	X	X	X		X		X		X (1)	X		X		
Soil Chemistry	X	X	X				X			X				
Agricultural Education						X								
Entomology			X			X	X							
Statistics			X				X							
Agricultural Extension	X	X	X		X				X					
Plant Physiology										X				
Plant Genetics			X	X		X	X	?		X	X			
Plant Pathology			X			X	X			X				
Horticulture						X				?				
Irrigation			X							X				
Animal Husbandry or Animal Industry	X				X	X			X	X		X		
Agricultural Mechanics														
Engineering and Machinery							X		X	X				
Animal Nutrition		?			?		X							
Plant Nutrition							X							
Parasitology				X										
Pastures					?		X							
Resources for Development	X													
Zoology						X								
Animal Pathology or Veterinary Medicine										X		X		

X Disciplines which award the Degree
? Special postgraduate courses in which a certificate of studies is awarded.
1 Auspices of the Faculty of Agronomy of La Plata.

The only institutions which in 1965 were offering disciplines on a graduate level, which were within animal husbandry and related fields were the following:

IICA, Turrialba: Animal Husbandry, Animal Nutrition and Pastures.

Agrarian University La Molina: Animal Nutrition

Rural University of the State of Minas Gerais: Animal Husbandry, Animal Nutrition and pastures.

University of Puerto Rico: Animal Industry.

Based on the above it can be said that only five countries in Latin America offer post graduate courses in animal husbandry or animal sicience, for which are granted the Degrees that are enumerated below:

Country	Institution's Location	Degree	Courses in Animal Husbandry
Argentine	Castelar Buenos Aires La Plata	Magister Scientiae	Animal Production (Nutrition, Genetic and Pastures)
Brasil	Kilometer 47	Magister Scientiae	
	Rio de Janeiro	Doctoris Scientiae(1)	
	Viçosa	Magister Scientiae	Animal Production
	Piracicaba Porto Alegre	Magister Scientiae	
	Belo Horizonte	Mestre	Animal Production (Genetics, Nutrition, Reproduction and Production) Veterinary Medicine(Pathology,Physio-Pathology of Reproduction, Clinical Phathology, and Surgery and Medicine)
Chile	Santiago (U.Chile)	Magister Scientiae	
	Santiago (U. Católica)	Magister Scientiae	
Colombia	Bogotá	Master of Sciences	Animal Production, Animal Nutrition, Animal Pathology
Costa Rica	Turrialba	Magister Scientiae	Animal Husbandry
Cuba	Habana	Magister Scientiae	Animal Genetics, Ruminant Nutrition, Non-Ruminant Nutrition, biochemestry

(1) Institutions which plan to offer the Doctor's Degree.

(cont.)

Country	Institution's Location	Degree	Courses in Animal Husbandry
México	Chapingo	Master in Sciences Doctorate (1)	
	Monterrey	Master in Sciences	
Perú	La Molina	Magister Scientiae	Animal Nutrition
Puerto Rico	Mayagüez	Master in Sciences	Animal Industry
Venezuela	Mérida	Magister Scientiae	

(1) Institutions which plan to offer the Doctor's Degree.

IV. REQUISITES FOR OBTAINING A POSTPROFESSIONAL DEGREE

The requisites for obtaining an academic Degree of Master in Sciences or Magister Scientiae are as follows:

a) To have completed all the admission requisites, which are generally reduced to: Possessing a professional title of "Ingeniero Agrónomo" or its equivalent at a university level. Presenting a certificate of the courses taken in the professional cycle, with a general average of 8 if the classification scale ranges from 0 to 10, or its equivalent in other systems.

b) Approval of the assignments of the major and minor with a minimum average of 8 if based on a classification scale from 0 to 10 or the equivalent "B" when the granding system is expressed in the ascending scale "F", "D", "C", "B", "A".

c) To complete a minimum of credits or valued unities which vary from one institution to the other but that in general represents a year and half of intense work in the classrooms, laboratories, experimental fields, and research centers.

d) To prove capability of translating a foreign language, preferably English.

e) To complete a thesis of original research, to the satisfaction of an advisor and several assesors (generally two), who preside at the same time as a final examination committee.

f) To fulfill a minimum residence of one year in the institution.

g) To pass the final examination.

V. PROBLEMS OF THE INSTITUTIONS

Due to the fact that the majority of the institutions which offer post graduate courses initiated their activities in very precarious conditions and up to date have not realized any detailed study of the situation that prevails in them, next there are exposed some problems known to the author, or well ennunciated in some publications:

1. Insufficient economic, human and phisical resources for training and research, especially in reference to full-time professors, laboratory and field equipment and fellowships for the students. The growth of the graduate schools should not be at the expense of professional schools.

2. Nonfulfillment or failure or orientating of goals pursued by the graduate schools according to the advances of science, the present and future necessities of each country, the priority with which the agricultural problems should be resolved in terms of economical development and the resources available in the institution.

3. Deficient research activities in the graduate schools, and because of this, a low capacity for improving knowledge, preventing obsoletion, and obtaining results which benefit the rural society.

4. Lack of coordination in the specialized fields within the graduate schools or training and research Centers, and among the various universities offering post graduate programs or the research institutions.

5. Lack of a defined market for the graduates.

6. High percentage of students not completing all their requirements; mainly because the students abandon the thesis due to a lack of methodology in research as they prefer to study courses of interest to them and because the "job-market" doesn't make obtentioning a superior Degree compulsory.

7. Lack, on the part of the students, a study methodology at a superior level, chiefly manifested in limited use or misuse of the library and lack of self determination and self sufficiency in the laboratory. These deficiencies are, undoubtly, due to faults in the professional formation at the pre graduate level.

8. Inadequate organization of libraries and a shortage of books, scientific journals, and facilities for interchange of publications.

9. A deficiency of interchange of information between Latin American institutions with respect to common problems and developmental activities.

10. Proliferation and deficiencies of schools of the professional type.

11. Heterogeneity in the level of preparation of the Degree candidates whom enter the postgraduate institutions.

12. Lack of stimulus on the part of some institutions by not duely recognizing the post graduate academic Degrees.

13. Maladaptation of those graduates whom have studied for long periods of time in countries economically more developed and who, upon returning to their institution, apply norms, methods and systems that oftentimes do not correspond to the regional reality, who long for the equipment and facilities and who dictate assignments at an excesively high professional level.

VI. POTENTIAL OF THE INSTITUTIONS FOR FOMENTING LIVESTOCK DEVELOPMENT

The directory of the Latin American Association of Superior Agricultural Education indicates that of the 175 agricultural animal husbandry and similar sciences' schools or faculties, 33% offer studies in veterinary science and animal husbandry. If to this percentage we add the schools that dedicate part of their time to trining in disciplines that are within the field of animal husbandry, it can be concluded that the influence of these in the foment of the Latin American livestock development could be more significant than on institutions which grants the Degree of Mágister Scientiae in animal industry, animal husbandry, animal nutrition, and pastures (which according to Table 1, is but a few institutions).

In spite of the above, we can proceed to make some general considerations and then point out some recommendations which could be put into practice to stimulate agricultural development in Latin America:

1. Post graduate education is an investment in knowledge that should promote economic growth.

2. The graduate schools improve and develop professors, research workers, extensionists, and working professionals, in whom have been entrusted the work of carrying out, within their area of influence, labors inherent to their specialization in order to solve the problems which hold back Latin American livestock development.

3. The increment and efficiency of cattle production should come from the application of new techniques and from the ability to improve the administration of the agricultural enterprises-be they farms or businesses.

4. Graduate schools dedicated to animal husbandry and related fields are scarce in number and therefore do not fulfill the purpose of Latin American livestock development since their radius of action is very limited.

5. Nutrition of the Latin American population is very deficient especially in animal proteins; due to the low purchasing power of the rural population, high cost of meat production, lack of a dietetic education, and to the fact that the oceans, from which thousands of tons of marine food could be obtained, have not been exploited.

6. Livestock development has been held back, among other things, by the following causes:

   a) Ill use of natural resources.

   b) Backwardness of the technology.

   c) Insufficient volume and inadequate structure of investments.

   d) Lack of financial resources and erroneous channeling of these.

   e) Faulty combination of the whole of productive resources.

   f) Scarce diversification of production.

   g) Faulty organization of interior markets.

   h) Equally faulty organization of producers.

   i) Excessive dependency on foreign markets.

   j) Lack of organization in exportation management.

   k) Insufficient domestic consumption.

   l) Insufficient transportation.

   m) Insufficient storage facilities.

   n) Lack of coordination among and within agronomic and cattle activities.

   o) Lack of security in property rights.

   p) Unstable prices.

   q) Lack of quality standards.

   r) Lack of livestock policies.

Of the above mentioned considerations it is entailed that the post graduate institutions could potentially participate more efficiently in the stimulate of Latin American livestock development, putting into practice, as a test, the following recommendations:

1) To accelerate the study of the prevalent situation in the institutions which offer post graduate courses in agricultural sciences, making special reference to animal husbandry and similar sciences.

2) To influence the existing institutions, and those that will be established in the future, toward a reliance on the scientific rigor, human and physical resources and philosophy required at post graduate level.

3) To find out if the graduates of the institutions of the graduate schools are effectively participating in the solution of the problems which hold back animal husbandry in its area of influence.

4) To determine if the countries or the institutions have the economical means to institutionalize graduate level education.

5) To stimulate the preparation of professors, research workers, extensionists and professionals working in the training and research centers of renown prestige in two well defined stages (Masters and Doctorate), separated by an interval of one or two years in order to prevent maladaption and unstability problems.

6) Coordinate education, research and livestock extension with the purpose of having the first form the service personnel, the second improve the first and the third publish and promote the results of the first and second toward benefiting the cattleman, and at the same time scrutinize the true agricultural problems in order to be able to evaluate and periodically modify the study and research programs.

7) To plan the graduate training on a regional level, in such a way that the countries can combine their resources under the basis of multinational interest agreements.

8) To encourage the institutions which offer post graduate training, especially concentrating on those where prerequisites can be corrected.

9) To foment in the institutions graduate training and research in the field of cattle breeding, management, improvement, nutrition and health, management of pastures and harvested forages, oriented towards the maximum use of domestic animals as much in the extensive as in the intensive type of commercial operations.

10) To form a new type of graduate capable of facing the technical economical and administrative complexity of the agricultural problems so much in the farm level as in marketing, processing, credit, finances, extension, regional programming and sumministration of intakes so that the cattle enterprises will be economically productive and supply products according to market demands.

11) To promote meetings of the graduates, supported by the post graduate institutions for the purpose of maintaining continuity with their "alma mater" making propitious and exchange of professional interest and whenever possible establish basic lines of common action within livestock policies.

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Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working Paper No. A-3 Dr. G. Carneiro, Federal University of Minas Gerais, Brazil

Title: CONSIDERATIONS ON POST GRADUATE TRAINING AND RESEARCH IN ANIMAL SCIENCE AT MINAS GERAIS, BRAZIL

INTRODUCTION

It is generally recognized that almost all of Brazil lies in the tropical and subtropical zones. Still, these terms do not tell us much because, in addition to latitude, there are other factors linked to climatic conditions, to soil and water and to socio-economic factors within these, more or less defined, grographical regions. The sum, or total of these factors constitute the tropical or subtropical environment which affects animals as well as the human population. Such a concept has a special significance in a country such as Brazil with near 8.5 million square kilometers of area. Thus it appears more appropriate to speak in terms of the components of the environment. In reference to Animal Production, Central Brazil should be considered as an adverse environment. Whatever plans which can be made to increase animal production must be based on this fundamental reality.

Nevertheless, under these limitations, we have built, in our tropics, a civilization "*sui generis*". At any rate, there is a general interest in education and training, sometimes indefinite, but nevertheless a persistant interest in attaining a better health, culture and life for our population. Within this general objective, the establishment of a *Masters* training program to develop high level technicians has focused special attention on the Universities and other groups, including international organizations. Foreign post graduate studies will be given preference at the doctorate level in specialized centers.

I. MASTERS IN ANIMAL SCIENCE

Within the sectors chosen for post graduate training, programs for a Masters Degree in Animal Science have already been initiated in a few institutions in Central Brazil. These include the University of Sao Paulo, the Rural University of Minas Gerais in Viçosa, and the Federal University of Minas Gerais in Belo Horizonte which has emphasized the lines of genetic improvement, feeding (includes pastures), animal production, and reproduction.

The characteristics of the courses, along general lines, are similar to the courses given in other countries. Depending on the special interests of the student, certain courses are required and others may be taken as electives. To obtain the MS degree the student must complete at least one year in residence and complete a thesis based on investigation. All the professors directly or indirectly involved in the teaching programs in Animal Science at the post graduate level in the above mentioned Universities have either a MS or Ph.D from a national or foreign institution. (The appendix contains a list and description of the courses offered at Belo Horizonte).

Together with the classroom training there is a more objective orientation or characteristic in the post graduate course. It is such that the student must be prepared to solve the agricultural or livestock problems of the country within his area of action as a professional. Thus, the peculiarities are most important in such courses involving Animal Production, Applied Animal Improvement, Feeding, Pastures and Seminars.

2. RESEARCH

2.1 Objectives

The immediate application of many known or established methods and technology could increase productivity in the existing herds. Yet, other practices should be introduced and/or other methods should be applied and/or other types of animals should be studied in order to fulfill the real needs of the country. This task involves a researcher whose objectives is, in the first place, to discover and identify some of the environmental factors judged to be important in animal production, and secondly, to identify the kinds of animal populations needed for specific purposes and the most advisable systems to increase the productive capacity of the animals and herds.

In short, as in the case of animal production or post graduate teaching programs, research must take into account: (1) The ecological conditions, in the sense of including the human technician, breeder and manager elements; (2) The size and quality of the existing animal populations; (3) Actual and potential markets; (4) The general feeding and management practices considering the economic and practical possibilities; (5) Diseases and their possible eradication or control; and (6) Methods of genetic improvement (if existant). Without doubt these factors must guide any programming of research.

2.2 Orientation of Research

To obtain a better insight into the conditions of husbandry, principally in the state of Minas Gerais, we should emphasize the following topics as a list of priorities in animal research.

2.2.1 <u>Census</u>

The existing data acumulated in government and private establishments is a good source of information for initial studies. In the following stage more precise experimental projects can be designed to furnish answers to specific problems.

2.2.2 <u>Animal Ecology</u>

Under this title we can combine the general aspects of physical, human, and economic geography relative to the various regions of the country. There are published studies relating directly or indirectly to the animal ecology of Brazil. Nevertheless, the first phase would include a revision of such studies, followed by other works carried out by various specialists. These should be careful studies which should not only consider ecological and geo-economic aspects, but also animal behavior under these conditions in terms of reproduction, growth, and production as well as seeking economic solutions for the cattlemen of the region.

South Central Brazil is currently in a developing stage. The state of Minas Gerais lies in the transitional zone between the underdeveloped North and the progressive South. Consequently, the state has examples of the various stages of development which roughly correspond to the geographical location.

In Minas Gerais, the environmental conditions, such as climate, soils, water, flora, and fauna, particularly in respect to parasites, accompany, to a certain extent, the transition in terms of progress. Such characteristics impose, in certain areas, practical standards which are adequate for this kind of agriculture. Adaptations are necessary and critical in the raising of cattle, especially in beef cattle which are maintained year around in enclosed fields or the likes. This type of pasture system can be found in more than 70% of the state. The existance of a dry and a wet season has a special importance in the planification to increase animal productivity.

Efforts have been made to improve these environmental conditions, but these are too slow and expensive to be applied on small farms, at the existing level in this extensive area which is poor in capital and general agricultural technology.

2.2.2.1 <u>Special Topics of the Environment</u>

Within the environmental factors, it is worthwhile to emphasize: Feeding, Animal Pathology and Animal Management.

Feeding. One of the basic problems of our animal production is feeding. Two special points should be the object of investigation: Pastures and feeding during the dry period. In spite of the well recognized seriousness of these problems, the methods used have been based on trial and error. It would be desirable to have a better knowledge of pasture management, use of concentrates and their substitutes, proteins, energy, minerals, etc., in order to increase the productivity of farm animals.

Animal Pathology. To the animal husbandryman it is important to use good measures for prevention and control of diseases. Initially, perhaps, it is more advisable to improve the description and characterization of the geo-economic regions (with respect to diseases etc.) before proceeding with other studies. Without doubt, it is advisable for Veterinarians to play a larger role in extension according to the environmental conditions and suggest practical and efficient husbandry practices.

General Animal Management. There are a number of factors which could be grouped in this category. Such factors, especially those linked to general herd supervision, should be identified and evaluated as to their importance, above all in the case of new innovations.

2.2.2.2. Other Factors

Another group of factors of special value should be mentioned: The adjustment of production data for useful comparisons. Here should be mentioned circumstances of general order (year, season of the year, locality, etc.) and those inheritant to each animal (age, weight, health and internal conditions of the animal). In Brazil there is much variation in the magnitude of the effects of these factors on the performance of animals, and sometimes, these effects are very different than those encountered in temperate zones.

2.2.3. Markets and Commercialization

As previously mentioned, this category should include: Expensive and difficult transportation, outmoded standards or commerce, and price determination policies of the government especially those relating to the basic food items such as meat, milk and other agricultural products.

2.2.4. Physiology

There are few studies from Brazil in Applied Animal Physiology either as such or in combination with other branches of Biology and Animal Science. Of particular interest are

those that refer to reproductive efficiency and the response of European breeds to the Brazilian climate and conditions. Apparently we cannot say that the climate, per se, is a limiting factor in rearing cattle of the European breeds. Nevertheless, there is sufficient evidence to indicate that some climatic factors, in combination with management practices and diseases, which constitute an important obstacle (still not overcome) to acclimatization of European breeds in Brazil. On the other hand, there are regions in the Northeastern part of the country with high temperatures and low humidity (and free or certain parasites including Dermatobia hominis) in which European cattle fair quite well under rather common conditions. Perhaps we should expand more careful research studies on animal production in these regions.

2.2.5. Hereditary Factors

Once the environmental factors have been established and described for a given region, it is the task of the Animal Breeder to raise the kind of animal which is economically appropriate for these conditions, or produce this animal in the case that is does not already exist.

In Central Brazil, the commercial beef cattle are largely Zebu and Zebu crosses with "Criollo" cattle derived from old Iberian breeds. Commercial dairy herds are mainly mixtures of European dairy breeds with the Zebu strains. The pigs produced for the market are of local unimproved breeds and their crosses with imported breeds. Whereas in the case of poultry, modern and specialized operations are supplied from large supply centers. But in the interior of the country poultry production is based on the growing of farmyard hens. In the country in general, as in the State itself, or the geo-economic region, herd productivity is generally very low as a result of an adverse environment and, in most cases, poor genetic material from the viewpoint of animal improvement.

There is, nevertheless, a nucleus of purebred European cattle (called pure by origen or P.O.) and purebreds by crossing (P.C.). The principal objective of these cattle has been to produce breeding stock, but these herds generally produced milk for the commercial market. There are still significant importations of foreign cattle with the objectives of numerically increasing the P.O. herds and for genetic improvement. Still, there are difficulties in raising these cattle and their productivity has been low. In this manner, it appears to me that there are sufficient objectives to justify studies such as, a more firm knowledge of the destiny of the imported cattle as well as their descendants, and their performance under the various management and micro-climatic conditions of Brazil. The investigations should include mixed and P.C. herds which have been kept closed to outside breeding for various generations.

A great controversy exists, especially among foreign technicians working in Brazil, over the advisability of such studies. Many of these recommend outright importation of pure specialized breeds and feel that it is necessary only to change the environmental conditions. This orientation has been valid for poultry production which is located in large centers and also in some cases for swine, as in certain regions of Brazil there are intensive and semi-intensive commercial operations in both these species. This orientation has been less valid in the case of dairy cattle maintained year around on pasture with supplementation during the dry season. In truth, it has been demonstrated that those herds (even specialized breeds) with better management produce milk more expensively. The producer then, for such reasons, tries to obtain the type of cow that he thinks most appropriate for producing milk cheaply under the conditions which he can maintain on his farm.

There should also be research not only of the effects of the general mating systems, but special attention should be given to mating of crossbreds and the utilization of hybrid vigor within these systems.

From my point of view, another interesting angle would be a more thorough emphasis of the preliminary, general estimates of heritability coefficients for the various economic characteristics specifically applicable to the Brazilian conditions and also to compare these estimates with estimates of the same characteristics obtained under the better management conditions from temperate zones. The similarity or disparity, as well as the magnitude of such coefficients have a special significance in the practical application of selection of animals in Brazil. In this respect, although limited in number, several heritability values published here (Brazil) relating to different breeds are surprisingly similar to those obtained in temperate regions.

2.3. Extensionists and Researchers

There are relatively small numbers of professionals trained in Animal Production to satisfactorily attend to the short or medium range economic conditions of our breeders. Possibly one of the biggest problems is that our professors and research workers are not always able to give adequate training to extension workers. This situation results from the lack of basic research on existing animal production and also a shortage of data on new or recommended practices. An objective of post graduate programs is to help find solutions to such problems.

As the numbers of national technicians are very few, we have resorted to the importation of foreigners and many of these have associated with our nationals in a manner comprehensive and real. Some have failed but often the lack of adaptation of foreign technicians is a result of the fact that they are located in the

large urban areas, absorbed in meetings and excessive planning, or evaluating projects to be carried out in the distant and little known interior. In other cases the change from the developed to the undeveloped environment is too drastic for technicians to easily adapt. In general the foreigner that goes into the interior becomes more objective: Study and analyze before doctrines or changes.

2.4 Programming

Programming is an important item in the establishment of animal production research in certain areas of Brazil and certain organizations of the public domain. There have been some difficulties in research, owing to the fact that administrators prefer work in extension and development, which gives more immediate results, and consequently more political promotion. Foreign organizations working in Brazil are also subject to such political considerations. In such cases it is easier to write reports which include photographs and graphs.

Other difficulties arise from the frequent changes of directors or heads of our technical services. Consequently there often is a lack of continuity or a complete change in orientation based on the criteria of the personalities concerned. As a result of a centralized administration within the usual beaurocratic network, there are problems of allocation of research resources as well as their distribution, which may be guided by political opportunity. This explains, at least in part, the abundance of isolated agricultural projects instead of overall programming with various coordinated projects supporting a common objective.

The combination of research and teaching at the post graduate level, perhaps, helps correct part of these difficulties thorough the possibility of long-term programming and the use of student projects for seminars and these works. Mention should also be made of the importance of organization and developing specialized libraries in the training institutions.

An interesting aspect to be brought into focus here is the greater utilization of private operations in research studies in such a manner that the official institutions can concentrate on real, field problems and, at the same time, the private operations can more rapidly utilize the results. The use of private farms for carrying out some studies, experiments or demonstrations has been an effective method to improve rural education and to introduce improved practices into a region. An example of this is a project in progress concerning genetic improvement of Zebu beef cattle. This project involves the cooperation of eight breeders of the zone Alto Soa Francisco in Minas Gerais. It is evident that all experiments cannot be made on private farms. The general line of programming in Animal Science research and post graduate teaching in our Institution may be sketched as follows:

1. Review the studies of animal research already completed in Brazil or from other countries with similar conditions, in the sense of a critique of the results in relation to those obtained in more advanced countries. These points have special value for subjects of student seminars.

2. Animal Production: Principally on the basis of the revision of the literature, the selection of priorities for study, taking into account those which may be appropriate for a Masters thesis. Such subjects comprise, mainly, problems of the general environment, including disease control and evaluation of production.

   a) Census surveys relative to animal production with different methods of pasturing in the various regions.

   b) Statistical studies of intensive production systems.

   c) Costs of production, supplies and commercialization of animals and/or their products.

3. Animal Feeding:

   a) Energy and protein during dry and wet seasons.

   b) Minerals in general

   c) Pastures

4. Genetic improvement of the animals:

   a) Under a pasture regime, especially in the case of beef cattle.

   b) In intensive regimes.

3. APPLICATION

One general line of work can be outlined, perhaps not representative but as a typical example of the orientation of a post graduate teaching and research institution. Possibly the most useful information in this session should be taken from what has been established in our Institution.

For a long time, the Escuela de Veterinaria has had a program of research in the field of pathology as well as animal production. This year we have began a post graduate program in Animal Science in combination with the research program. For some years prior to 1968 some professors of our Escuela in association with colleagues of other institutions have carried out several experiments in feeding, breeding and management in eleven different zones of the State of Minas Gerais. Also studies were made from census data.

An example that illustrate how the general orientation and programming can be applied to beef cattle was in the organization of a breeding herd into a cronogram of improvement practices (principally selection), combined with supplemental feeding during the dry season and the use of native and improved pastures during the wet season. Mutatis mutandis, the cronogram can be applied in a commercial herd of beef yearlings to produce slaughter animals at a live weight of 400 to 450 kg. and at an age not over two years, instead of the actual 4 to 4.5 average.

For the majority of calvings which occur from July to October, with weaning in the first part of the dry season, the following scheme has been adopted: Calving-from July to October; weaning- the first third of the dry period; post-weaning period (with supplementation during the dry period)-from May to the middle of November; extension of rearing period (in a pasture regime during the rainy season)-mid-November until late April or early May; incorporation of replacements for herd reproducers, under a regime of limited supplementation, and fattening of those animals destined for slaughter-mid-May of the following dry season.

Thus, the season advisable for selecting the animals for herd reproducers (based on conformation, liveweight, and/or weight gain) would be: (1) At weaning during the start of the dry season (males and females), (2) At the end of the rainy season around the first of May (predominately females of breeding age), and (3) at the end of lactation (first calf cows on the basis of the weight of their first calf at weaning). An analogous scheme could be made for a second calving season (if one exists) with weaning early in the rainy season.

Such cronogram brings to light the seasons of the year and/or the ages of the animals. Such genetic and environmental factors should be studied in relation to the performance of animals for the various characteristics of interest in beef cattle. The scheme could be adapted to standards of selection for other characteristics of other species of farm animals.

These considerations are presented to demonstrate the value of a useful combination of profundity and objectivity in the orientation of Masters'level courses, as we should not overlook the advantage of including high level and objective training toward attending the real needs of Brazil, which depends so much on the well trained technicians for its development.

SUMMARY

These work relates to the establishment of the post graduate training program in Animal Science at the Escuela de Veterinaria of Federal University of Minas Gerais, Brazil and the connection with the research program involving various aspects of animal production in the state of Minas Gerais.

Naturally, the post graduate program at the Masters'level is organized according to the standards common for such purposes. In teaching as in the elaboration of research projects, special attention has been given to the livestock situation of the state with a major objectivity in these works linked to the post graduate program.

There is sufficient evidence to indicate that the general programming of such works should take into account not only the existing ecological conditions, but also the economic possibilities within these conditions. There are good herds of all farm animals bred in the region, but for the state as a whole, the productivity is still very low. Conseuqntly, in the majority of the cases, the situation is serious owing to the joint effects of the adverse environment, animals of low production capacity, and a low level of education and training of the population.

Although measures for immediate effects can be employed advantageously there is a dire need to amplyfy post graduate teaching at the Masters'level, and to combine the programming with animal production research. In such a manner, we can hope, through such basic orientation, to develop professionals which not only have a profound knowledge of animal production but also know the methods which should be applied in this environment.

The teaching of post graduate courses and the carrying out of animal production studies should take into account the utilization of private farms whose owners take an active participation in the planning and development of the state of Minas Gerais and of Brazil.

APPENDIX

The Masters'program of this Escuela started to function in 1968, in the Department of Pathology and Clinics, and in 1969 in the Department of Animal Science. The following areas of study are offered:

In Veterinary Medicine (12 vacancies): Pathology, Physio-pathology of Reproduction, Clinical Pathology, and Surgery and Medicine.

In Animal Science (12 vacancies): Animal Improvement, Nutrition and Production and Reproduction.

Requirements for obtaining the degree of Magister Scientiae: 12 months full time residence; 30 credits as a minimum; a knowledge of English, passing a final examination; presentation and defense of a thesis.

An academic year consists of 38 complete weeks. The courses are chosen from those existing in the catalog, 12 credits respresents the minimum required for each area of study. Each credit corresponds to 16 hours of classwork or its equivalent.

The catalog lists the courses required in Animal Science. In addition to these, others can be chosen in the Departments of Morphology, Physiological Sciences, Pathology and Clinics, or Microbiology and Public Health. In special cases, other courses can be offered, such as, this year, "Review of Mathematics" (without credit). In certain cases the students have access to studies in other Units of the University, such as the Faculty of Medicine, Institute of Exact Sciences, etc.

The Escuela de Veterinaria has various facilities available for post graduate teaching such as their own Library and access to the Libraries of the other Escuelas; experimental farms and private farms, packing houses, etc. For the post graduate Masters'program the Escuela has its own resources plus some from other sources, such as: The Technical and Scientific Development Fund of the National Bank of Economic Development, the Research Counsel of the Federal University of Minas Gerais, the National Research Council, and the Inter American Institute of Agricultural Sciences of the OAS.

A brief description of the courses offered for the Masters Degree in Animal Science is as follows:

ZOO. 601 - Statistics I (3:2) - 2 credits
Description statistics. Linear regression and correlation. Statistical inference.

ZOO. 602 - Statistics II (3:2) - 2 credits
Analysis of variance and covariance. Multiple regression.

ZOO. 603 - Design and Analysis of Experiments (3:2) - 2 credits
Discussion of experimental projects. Survey of analysis experimental data.

ZOO. 610 - Population Genetics (4:0) - 2 credits
Introduction. Genetic structure of breeds and other populations. Effects of number of genes, degree of dominance, and gene interactions. Linkage. Methods of selection. Systems of mating. Heritability.

ZOO. 610a - Population Genetics (4:0) - 2 credits
Continuation of ZOO. 610.

ZOO. 610b - Population Genetics (4:0) - 2 credits
Continuation of ZOO. 610a.

ZOO. 612 - Animal Improvement (2:2) - 2 credits
Application of genetic principles to animal improvement.

ZOO. 612a - Animal Improvement (2:2) - 2 credits
Continuation of ZOO. 612.

ZOO. 616 - Hereditary Pathology (2:0) - 1 credit
Hereditary defects and abnormalities. Disease resistence and susceptibility.

ZOO. 621 - Analysis of Feedstuffs (0:2) - 1 credit
Determination of the chemical composition of the most important animal feedstuffs.

ZOO. 622 - Feeds and Feeding (4:2) - 3 credits
Study of feeds and formulation of rations.

ZOO. 623 - Pastures and Forages (1:3) - 2 credits
Cultivation and management of pastures and cut forages.

ZOO. 623a - Pastures and Forages (1:3) - 2 credits
Continuation of ZOO. 623.

ZOO. 624 - Techniques of Experimentation in Animal Feeding (2:2) - 2 credits
Techniques especially applicable to feeding, including pastures.

ZOO. 626 - Ruminant Nutrition (4:0) - 2 credits
Peculiarities of ruminant nutrition; digestion, absorption and metabolism of nutrients relative to maintainance, growth, lactation, production and reproduction, review literature of research problems of ruminant nutrition.

ZOO. 626a - Ruminant Nutrition (4:0) - 2 credits
Continuation of ZOO. 626.

ZOO. 628 - Non-Ruminant Nutrition (4:0) - 2 credits
Peculiarities of nutrition in non-ruminants; digestion absorption, metabolism of nutrients relative to maintainance, growth, production, and reproduction. Review literature of research problems in non-ruminants.

ZOO. 628a - Non-Ruminant Nutrition (4:0) - 2 credits
Continuation of ZOO. 628.

ZOO. 630 - Nutrition and Reproduction (2:0) - 1 credit
The role of nutrition in the various phases of reproduction.

ZOO. 632 - Beef Cattle Production (2:2) - 2 credits
Breeds, crosses, selection, feeding and management. Systems of rearing. Markets. Discussion of economic aspects of production. Carcass studies.

ZOO. 632a - Beef Cattle Production (2:2) - 2 credits
Continuation of ZOO. 632.

ZOO. 634 - Dairy Cattle Production (2:2) - 2 credits
Breeds, crosses, selection, feeding, systems of rearing and management. Markets. Discussion of economic aspects of production.

ZOO. 634a - Dairy Cattle Production (2:2) - 2 credits
Continuation of ZOO. 634.

ZOO. 636 - Swine Production (2:2) - 2 credits
Breeds, crosses, selection, feeding, systems of rearing and management. Economic aspects. Carcass studies.

ZOO. 636a - Swine Production (2:2) - 2 credits
Continuation of ZOO. 636.

ZOO. 638 - Poultry Production (2:2) - 2 credits
Breeds, crosses, selection, feeding, systems of rearing and management. Markets. Economic aspects. Carcass studies.

ZOO. 638a - Poultry Production (2:2) - 2 credits
Continuation of ZOO. 638.

ZOO. 642 - Bio-climatology of Domestic Animals (4:0) - 2 credits
Environmental factors and their influence on domestic animals in relation to growth, reproduction, production and adaptation.

ZOO. 649 - Animal Science Seminar (1:0) - 1 credit per unit
Discussion of Animal Science problems in general. Active participation of the students under the supervision of their professor.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. A-4 Dr. K. Vohnout, IICA-CEI, Tuurrialba, Costa Rica

Title: THE IICA-CEI ANIMAL PRODUCTION DEPARTMENT*

Since 1944, the Animal Production Department has been a part of the IICA-CEI graduate school. It was started using the USA graduate school model and, at present time, the students can specialize in Animal Production, with emphasis in Nutrition, Pastures, Breeding or Management of cattle.

The main attraction of the Animal Production Department has been a graduate program which is offered in the tropical environment and facing actual problems of the Tropics. Such problems could not be found at other places. As a result or this unique characteristic, the graduates of the Animal Production Department hold, at present time, special leadership positions in Latin-American Animal Science field (Table 1).

TABLE 1. Present positions held by the Animal Production graduates.

Position	Number
Teaching, university and graduate level[a]	25
Technical Assistance to banks	10
Research	9
Administration	4
Technical Assistance to Governments	3
Ranch Management	3
Extension	1
No news from new graduates	5

(a) Some working in research.

* Inter-American Institute of Agricultural Sciences - Training and Research Center.

The objectives of the Animal Production Department are: a) Provide the students with the proper instruction and background for the identification and solution of animal husbandry problems, and b) Provide a model for the new graduate schools which are in the formation process in Latin America.

The Graduate Program

The graduate program consists of course work in the fields of Nutrition, Management, Pastures and Breeding. It includes lectures and field and laboratory practices. In order to obtain adequate professional orientation students are required to complete a Thesis and special problem assignments, and are also required to participate in seminars and study trips. They are also allowed to take coursework in other IICA-CEI Departments or recognized Institutions.

Although research is dependant upon the graduate program, solid research programs are being carried out. This research is covered basically through the Thesis work and is divided as follows:

Animal Nutrition. This program was designed to study how to obtain from tropical pastures and tropical by-products full cattle production requirements in the most efficient way.

Pastures. This program has been concerned with improving tropical grasslands through management and through the use of new exotic pasture species.

Breeding. This program has been concerned with the identification and evaluation of practices dealing with the genetic improvement of the production traits of cattle in the Tropics.

At the present time, a fourth program has also been included:

Cattle Management. This program has been designed to identify and evaluate the management practices which would be best fitted for Tropical environments.

Fig. 1 summarizes the several research projects within each of the listed disciplines. These projects have been designed for training the students in research and also for collecting valuable results for improving cattle production in Tropical areas. Research has been limited to cattle because this species is not competing for food with men, as non-ruminants do. This is a very important factor in underdeveloped countries. In addition, research results obtained with non-ruminants at other than tropical areas, are more easily extrapolated to the Tropics than are research results with cattle. In Appendix 1 are listed experiments which have been completed.

For carrying out the outlined programs, the Animal Production Department has the following facilities: a) The Research Station has 450 hectares of pastures and more than 900 head of cattle. The dairy herd has Jerseys and Criollo cattle, as well as their crosses. The beef herd has Brahman, Santa Gertrudis, Criollo, and all the reciprocal crosses for these breeds. Adequate barns, corrals and a milk processing plant are also vailable. b) Nutrition and Physiology laboratories, including a climatic chamber. c) An introduction garden for foreign species of grasses and legumes.

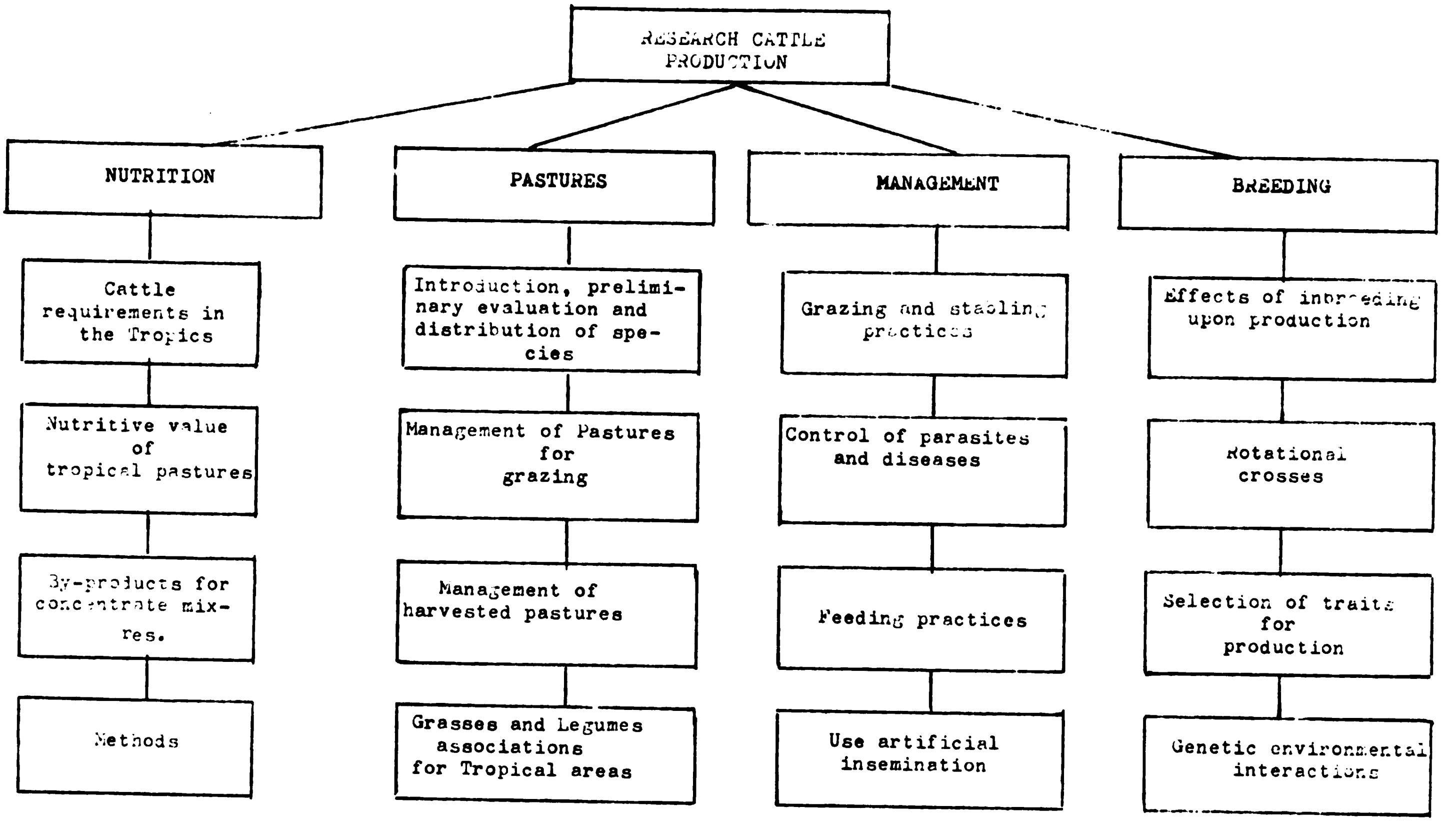

FIGURE 1. Research projects by Disciplines.

The future

The Animal Production Department has been orienting the students towards research of biological problems dealing with cattle. However, the market for technicians includes development programmers. Therefore, starting the 1969-1970 period, activities will be expanded to include development programming in cattle production. This expansion will be possible through the cooperative work with other IICA-CEI Departments, especially the Department of Rural Development. The Program of study for each student will be worked out early after the student arrival to the Center. Figure 2 outlines the different 4 x 2 choices and in Appendix 2 are listed the courses offered at IICA-CEI.

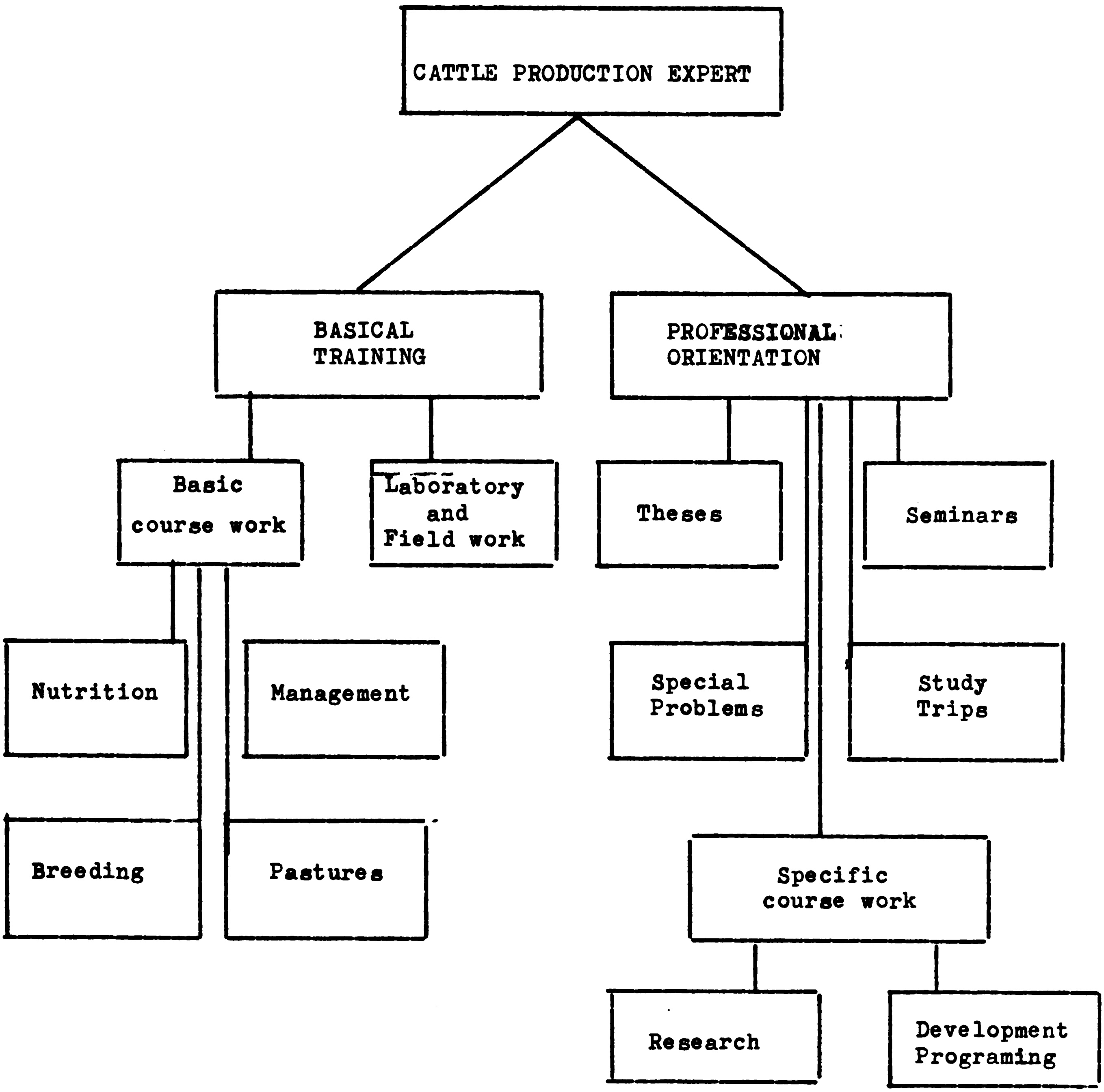

FIGURE 2. The Graduate Program

APPENDIX I

THESES OF THE ANIMAL PRODUCTION DEPARTMENT

The influence of environmental temperature on the spermatogenesis of young bulls.

The effects on Guinea grass (Panicum maximum) of 2 fertilizer levels, 3 cutting frequencies and time of year, measured through production, digestibility, morphologic characteristics and palatability.

Comparison of weight gains between purebred and hybrid beef calves.

The effect of food fiber on growing and thyroid function of cattle in hot environment.

Evaluation of milk replacer mix with and without Aurofac.

The influence of season, fertilization and age of grass on the digestibility by cattle.

Digestibility and digestable energy in some by-products of the tropics.

The effect of season, cutting age and fertilization on the growth and palatability of Elephant grass.

Determination of calcium phsophorus and protein of forage of four cattle producing areas in Costa Rica.

Beef sire evaluation by progeny performance in two environments.

The effect of and cutting and fertilization on seasonal growth of Napier grass.

The effect of high levels of molasses in fattening steers.

Bull tests based on performance in pasture and feedlot.

Comparison between palm oil meal, quinua and dried skimmilk in growing of weanling pigs.

Estrous cycle, period of estrous and time of ovulation of cattle in the tropics.

Performance testing studies with bull calves on pasture and corral to prove their sires.

A comparison of cassaba meal and corn meal in calf-starters.

Estimating Pangola (Digitaria decumbens) and Guinea (Panicum maximum) grass consumption with grazing cattle of different ages and bodyweights.

Control of Gramalote (Paspalum fasciculatum Willd) in pastures with herbicides.

Permanent stabling, semi-stabling on the growth rate of dairy heifers.

Effects of molasses on milk production in the tropics.

Yield of pastures of Pangola and Guinea measured in milk production.

Estimating consumption and digestibility of tropical forages under direct grazing.

Influence of leguminous and non-leguminous trees on their herbaceous undergrowth.

Weight gains of heifers from three breeds and their reciprocal crosses, from weaning to twenty-four months.

Marbling and ether extractables in the carcasses in the Santa Gertrudis, Brahamans, Criollos and their reciprocal crosses.

Comparison between several methods of establishment for Pangola grass (Digistaria decumbens Stent.).

Determination of calcium and phosphorus content of Elephant grass (Pennisetum purpureum) and Guinea grass (Panicum maximum)

Study on the growth of Elephant grass (Pennisetum purpureum Schumach.)

Carcass characteristics of Criollo, Brahman and Santa Gertrudis cattle and their reciprocal crosses.

Evaluation of different system of estimating digestibility and consumption under grazing conditions.

Estimation of genetic improvement in milk production, length of lactation and fat percentage of the Criollo herd at Turrialba.

A study of hybrid vigor in reciprocal crosses of the Brahman, Santa Gertrudis and Criollo breeds.

Some factors involved in the establishment, nodulation and growth of the forage legume Leucaena glauca.

Effect of phosphorus supplementation on reproductive efficiency of range beef cattle in Uruguay.

A comparison of barn and pasture ration for maintenance of dry cows under tropical conditions.

Heat tolerance on bull's progeny and the influence of crude fiber on rectal temperature and respiratory rhythm under heat stress.

Rumen motility in dairy cowas.

Determination of protein production and palatability by cattle, of various varieties of Elephant grass (Pennisetum purpureum Schum.).

Protein content of the milk of the Jersey, Criollo and cross breeds.

Proving bulls for heat tolerance by measuring the influence of different levels of fiber in the ration on rectal temperatures and respiratory rates of their progeny.

Effects of molasses on pasture consumption of cattle.

A study of some agronomic methods for evaluating Imperial grass.

Sugar cane molasses for feeding dairy and beef cattle.

Mastitis incidence as determined by the California, Hotis and Catalasa tests.

Value of banana leaves, sugar cane leaves and Elephant grass for milk production.

Effects of molasses upon consumption and digestibility of balanced rations of cattle.

Costs of establishing Pangola grass.

Cacao pod meal in steer fattening rations.

Production of Jersey and Holstein cattle under barn management in a tropical environment.

The use of Stilbestrol for fattening cattle under grazing conditions at three levels of concentrate supplementation.

Methods for studying tropical pasture.

Estrous cycle and resistance to skin parasites in Criollo cattle.

Effects of torsalo grubs (Dermatobia hominis, Linn, Jr.) on productivity of beef cattle, and factors affecting the intensity of infection.

The effects of high temperatures and humidity on different breeds of cattle.

Effects of inbreeding on some economic characteristics of Criollo dairy cattle.

The use of two oral progesterones to control the estrus cycle in beef cattle.

Agronomic evaluation of some legume-grass association in the humid tropics.

APPENDIX II

COURSES OFFERED AT IICA-CEI

Agricultural Credit
Agricultural Policy
Anatomy and Morphology of Plants
Animal Nutrition
Animal Physiology
Applied Entomology
Applied Forest Economics (for Latin America)
Area Planning
Basic Ecology
Basic Forest Economics
Basic Genetics
Breeding and Improvement of Cattle
Cartography
Cattle Feeding
Cattle Management
Clasification of Forest
Cultivated Tropical Anuuals
Cultivated Tropical Perennials
Cytogenetics
Demography
Dendrology
Design and Analysis of Experiments
Developmental Planning
Ecology of Cultivated Plants
Economic Development
Economics of Agricultural Enterprises
English
Environmental Biology of Insects
Evaluation of Natural Resources
Forest Conservation
Forest Economic Problems
Forest Economic and Management
Forest Ecology
Forest Management
Forest Planning and Protection
Forest Regeneration
Forest Technology
Farm Accounting
Farm Management
General Entomology
Geology
Hydrology
Inventory Techniques for Human Resources
Inventory Techniques for Physical Resources
Laboratory Methods
Land Economics
Macro Economics
Management of Wildlife Areas
Marketing, Distribution and Commerce of Forest Products
Mathematics
Meteorology and Climatology
Methodology of Social Research
Microtechniques of Photometry
Organic Chemistry and Biochemestry
Pasture Evaluation
Pasture Management
Photointerpretation and Photometry
Physiology of Adaptation
Plant Breeding Principles
Plant Breeding and Improvement
Plant Physiology I.
Plant Physiology II.
Plant Pathology
Quantitative Genetics
Rural Public Administration
Sampling Techniques
Silviculture
Sociology
Soils
Soil Chemistry
Soil Classification
Soil Conservation and Management
Soil Fertility and Fertilizers
Soil Physics
Special-Study Trips
Special Problems in Animal Science
Statistics
Survey of Natural Resources
Technical Writing
Use of Radioisotopes
Use of the Library
Wood Anatomy
Wood Technology
Wood Utilization

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. A-5 Dr. Francisco Sylvester, Agrarian University "La Molina"

THE POST GRADUATE PROGRAM IN ANIMAL SCIENCE AT LA MOLINA: PROBLEMS AND FUTURE PLANS

Among the fundamental problems which face the country, one of the most intense is the problem of food. The nutrition of the Peruvian population is deficient and this fact is known to all. Underfeeding is a peril for the future citizens which results in a serious threat toward developing the potential of the country. The deficient nutrition is due, largely, to the scarcity of animal products. The improvement of such a situation should be closely linked to the development of the nation's animal production for it is essential to use capable, well trained specialists to work toward a more efficient animal production, technology and combat animal diseases as well as solve nutritional problems, etc. This is possible only with a complete knowledge of the problems, and their possible solutions, which confront our Animal Industry.

The study of animal husbandry problems is deeply involved with graduate training and consequently with research.

OBJECTIVES

In our concept of a graduate program in Animal Production, Agronomy or whatever other field we have various objectives. For example we may speak about:

a. Accomplishing improved teaching
b. Doing research for:
   (i) Contributing to improved teaching
   (ii) Increasing scientific and technical knowledge in general and especially for solving national problems.
c. Prepare leaders in those fields of Animal Production and highly trained scientists who are able to advance the industry of the country. The orientation of a graduate program should favor the formation of integrated personnel, leaders capable of excelling in extension, teaching, and research at all levels of activity within the country. We should not forget that graduate students are multiplying factors in the work of the professors'research as well as the most rapid medium for putting the results into action. Also, it is well to emphasize the fact that as the student enters into research work he becomes by this, an active explorer and gains experience that later on could be advantageous to him.

REQUIREMENTS FOR DEVELOPING A GRADUATE PROGRAM IN ANIMAL PRODUCTION

I would like to refer to two aspects closely related, but for the purpose of obtaining a clearer picture, which will be considered separately these are:

1. The minimum requirements necessary for soliciting graduate training.
2. The requirements of a student for admission into a graduate speciality.

In reference to the first point, we can say that University research without graduate training, or graduate training without research are doomed to oblivion. Nevertheless, it is no exaggeration to state that productive research requires a combination of several factors within the University. The first and most important of these is the existence of a group of professors specially trained to do research.

The Faculty of Animal Production at the Agrarian University, La Molina, includes nearly 40 professors with Masters or Ph.D degree and the others have received educational training in different advanced countries.

It is suitable, here, to make some comments on the experiences obtained with scholarship programs, as perhaps it may be useful for other universities.

1. Academic scholarships are included in the program for obtaining advanced Degrees. Sending information and results to the students is obligatory.

2. The Universities and Institutions are selected for their high academic standards and for having prominent scientists in the specialities concerned.

3. There is a coordinating office and the extension of a scholarship is dependent upon the productivity of the student.

4. The students, upon returning, are obligated to work for the University for twice the time they were supported with a scholarship.

The establishment of this scholarship policy has resulted in the nucleus of researchers mentioned above. The second need of research, especially when there are capable personnel involved, is such facilities as laboratories, equipment and economic means sufficient to complete these functions. The National Agrarian University has available laboratories for the production of beef cattle, dairy cattle, pigs, sheep, and poultry as well as facilities for handling and processing all the products of these species. However, the economic resources that the country allots to research is still insufficient. Without continuity and with much uncertainty this insufficiency has been solved many times, by the creation in the University of certain services and establishments which have the purpose of distributing research funds. This solution, if made correctly, gives excellent results, leads to a broad familiarization with practical priorities, and creates questions that should be resolved by the most advanced researchers.

The third need of research is to be able to depend upon academic units that permit differentiating the areas which should be studied and the organization that provides the necessary coordination for obtaining good results, avoiding duplications and losses of time and money.

The fourth need that we consider very important is that there exists in the University, an atmosphere of mutual confidence and tranquility such that research work can be done.

In reference to the admission requirements for students into the Graduate School, the following should be considered fundamental:

1. As an undergraduate student he should have a good record.

2. That he should truly be inclined towards research.

The main training in Animal Production graduate programs, is centered around the following points:

a. A broadening of the general scientific base by means of the following courses; Advanced Biochemistry, Biology, Animal Physiology, Statistics, Experimental Design, etc.

b. Avanced courses in the major fields of Animal Production, Nutrition, Genetics, Reproduction, Animal Health, Technology, etc.

c. Courses in minor fields such as Pastures, Animal Physiology, Animal Industry, etc.

d. Special Problems

e. Seminars

f. A knowledge of foreign and national languages, English, French, Quechua, etc.

Presently the Masters Degree in Nutrition and also in Animal Production is offered.

GRADUATE PROGRAM ORIENTED TOWARDS OBTAINING A MASTER'S DEGREE IN NUTRITION AND ANIMAL PRODUCTION.

JUSTIFICATION

Influence of Nutrition

It is the duty of the Animal Production specialist to improve the nutritional level, seeking varied and economical foodstuffs rich in proteins and calories and increase the production of meat, milk, etc., as well as being concerned about other products of animal origin, such as wool etc.

His contribution toward solving the problem of undernutrition in the country, is being advanced indirectly, thanks to better and more economical animal foods, as well as directly and by means of better balanced and economic human foods.

The official institutions and also private entities dedicated to Animal Production and Food Technology, frequently requests highly trained personnel in the fields of Nutrition, Animal Production, Animal Food Technology, etc.

This demand has become more prominent with the creation of national animal production and feeding programs and with the creation of new universities that contemplate Agriculture and Animal Production programs in the country requiring specialists in the fields of Nutrition and Animal Production at a high academic level. More or less 20 years ago the former Faculty of Animal Production of the Agrarian University (now the Animal Production Academic Program) has been doing research and extension in the fields of basic Nutrition and related Human and Animal Nutrition, as well as in many aspects related to Animal Production. These have given quidelines and solutions in the field of poultry feeding, whose development has grown notibly in recent years in the country; have developed an increased yields of beef and mutton by means of fattening practices; have shown the most efficient use of feeds by means of scientifically prepared rations. The sum total of these research efforts in the field of food technology for producing protein concentrates of high quality and of high acceptability such as cottonseed meal, fishmeal, carbohidrate feeds such as molasses, various grains, roots and tubers, etc., have been able to improve the standards in feed production for animals and also those destined directly for human feeding. However, there are still many problems to be studied such as defining zones within the country where the major nutritional problems occur and looking for means of solving them.

THE NATIONAL AGRARIAN UNIVERSITY FACING THE NEEDS OF THE COUNTRY FOR SPECIALISTS IN ANIMAL PRODUCTION AND NUTRITION.

The Departments of Animal Production and Nutrition has been progressively confronting the problem of training specialists, above all in the last few years: By means of graduate courses given at the graduate level, as well as supporting undergraduate courses which are shown in Table 1 and 2.

Simultaneously research, both basic and applied, has been intensified; there are numerous laboratory and field facilities used for research among which we can mention a stable for 100 dairy cows, pigpens for 20 sows, a center for fattening 1000 animals, a small animal laboratory comprising a colony of 500 rats, a colony of 30 guinea pigs, 2000 chickens, five laboratories for analyzing all the nutrients, storage facilities, a pilot milk plant, a pilot plant for preparing cottonseed and fish meal, a plant for processing feedstuffs, and a slaughter house. These and other facilities assure the students who wish to dedicate themselves to increasing their knowledge, can develop efficiently research work, thereby giving them a realistic preparation that permits them to obtain well-formed objectives; a sound feeding program for man and animals contributing to good health, development and productivity.

SOME PROBLEMS OF LATIN AMERICAN GRADUATE SCHOOLS

It has been said that within Latin America the future is somewhat uncertain for postgraduate professionals and that our country is still unprepared to utilize this type of specialist. Nevertheless, on this particular subject, it may be pointed out that, perhaps in reality there is a very distinct role which conforms to the further development of our country by executing agricultural programs and industrial planning, such as agrarian reform, governmental research, planning and promotion, and above all by demonstrating the high productivity of these enterprises. It is very possible that there is a growing need for more professionals trained with greater specialization and depth of knowledge.

Another objection that has been made in Latin America is the idea that the postgraduate school is still not accepted by the public and, mainly on the part of our government officials, it is difficult to obtain funds to support them. Effectively, there still is some certainty but, in reality, each day that passes our countries are becoming more clearly aware that there is no progress without education nor without research.

From the viewpoint of technical cooperation that is offered by the United States of America, there have been some difficulties, above all due to the difficulties that have resulted from recruiting high level professors that want to go to Latin America and develop technical programs for periods of 2 or 3 years duration. These not only jeopardize the progress of their research and advancement within their own universities with long time foreign assignments, but many times in their new occupation in Latin America they become affronted with the necessity to make hard decisions which are viewed as urgent but for which they do not have sufficient general or specific information. From there they believe that one of the solutions to the problem is to emphasize contracts with highly qualified professors for short periods when assured of a local counterpart of some experience. This system capitalizes on both phases, preparation and experience, and develops an effective action program.

Likewise, an additional point should be made which refers to the sporadic nature of cooperative efforts. In certain cases the Latin American Institutions loose the effective contact between their researchers and those of the North American Universities that have come to collaborate with them. Owing to the lack of adequate communications, neither the North America nor the local researcher find an effective form to resolve some of the problems that develop after the visiting researchers have returned to his country. For this reason we have the opinion that there is a need to maintain continuous contacts for which it is indispensable to use modern technology such as the radio, magnetic tapes, etc., which permit elaboration over the initial works.

But these problems are no more than incidental details which cloud the great benefits which can be derived from these programs of international cooperation of which I am convinced are going to be progressively more beneficial for all those which participate in them.

TABLE 1. Courses required for the Master of Science Degree in Nutrition

1. Undergraduate courses required for admission

These are the basic courses that a student should have to apply for admission. To be considered for a regular student he should have not less than 4 credits for each type:

		Credits
CM-103	Calculus I (Differential and Integral)	4
CM-104	Calculus II (Differential and Integral)	4
CF-201	Physics I (Mechanics, Heat, Sound)	4
CF-202	Physics II (Electricity, Magnetism)	4
CQ-101	General and Inorganic Chemistry	4
CQ-102	Organic Chemistry	4
CQ-207	Biochemistry I	4
CQ-308	Biochemistry I (Laboratory)	1
CB-102	General Botany	4
CB-103	General Zoology	4
CB-101	Biology (this course can replace General Botany and General Zoology)	4
ZN-301	Nutrition I	4

2. Undergraduate courses needed but not required for admission

These are required basic courses for all students specializing in Nutrition and must be taken if not already completed.

CQ-301	Analytical Chemistry	4
CB-302	General Genetics	4
CE-301	General Introduction to Statistics	4
ZN-401	Animal Feeding	3

Also considered in this category are those undergraduate courses which the Advisory Comittee considers necessary for each student for completing his chosen orientation within the Specialty as well as other required courses which be included in his program.

(Continued)

TABLE 1 continued

3. Required Graduate Courses

Graduate level courses indispensable for all graduate students specializing in Nutrition:

	Course	T	L	C	Prerequisites	Semester
ZN-707	Human Nutrition	2	2	3	ZN-301 ZN-401	I (o)
ZN-701	Carbohydrate Nutrition	2	2	3	ZN-301	I (e)
ZN-702	Protein Nutrition	2	0	2	ZN-301	I (o)
ZN-703	Mineral Nutrition	2	2	3	ZN-301	I (e)
ZN-704	Intermediate Metabolism	2	0	2	ZN-301 ZN-701 ZN-702	II(e)
CE-501	Statistics I	3	2	4	CE-301	I (t)
ZN-799	Research			1-6		I;II;S (t)
ZN-791	Seminar I			1		I;II;S (t)
ZN-792	Seminar II			1		I;II;S (t)

4. Graduate Level Electives

The graduate level electives are included by the Advisory Committee into each students program of study according to his particular orientation within the specialty. In this category are included complimentary courses in Statistics and Physiology. Once the program of study has been established for the graduate student they are considered obligatory, although the Advisory Committee can make modifications if necessary.

	Course	T	L	C	Semester
ZN-710	Nutrition II	2	2	3	I (o)
ZN-601	Poultry Feeding	2	2	3	II(e)
ZN-711	Lipid Nutrition	2	2	3	II(o)
ZN-712	Vitamins and Hormones in Nutrition	2	0	2	I (e)
CQ-601	Enzymology	3	3	4	II(t)
ZN-785	Special Problems in Nutrition			1-4	I;II;S (t)
ZN-709	Special Topics in Nutrition	2	0	2	I(e);II(o)
ZP-604	Advanced Animal Production	2	2	3	I (o)
CD-601	Cytology and Microtechniques	2	2	3	I (t)
	Human Physiology	4	6	5	I (t)

Abreviations:

T = Hours of theory per week
L = Hours of laboratory per week
C = Credits

(o) = Offered in odd years
(e) = Offered in even years
(t) = Offered every year
S = Summer session

TABLE 2. Courses offered in the specialty of Animal Production by the Graduate School.

		Credits	T	P	I	II	S
1. Required Graduate Courses							
ZN-601	Nutrition II	3	2	2	x		
AP-601	Pasture Management	3	2	2	x		
ZP-701	Basic Physiology of Animal Production I	4	3	2	x		
ZP-702	Basic Physiology of Animal Production II	3	2	2		x	
ZP-703	Population Genetics and Animal Improvement	3	2	2		x	
CE-704	Statistics Applied to Animal Production	3	2	2		x	
ZP-705	Special Problems in Animal Production	4			x	x	x
ZP-791	Seminar I	1			x	x	x
ZP-792	Seminar II	1			x	x	x
ZP-799	Research	6xx			x	x	x
2. Graduate Level Electives							
Complimentary Fields							
a. In Nutrition							
ZN-701	Carbohydrate Nutrition	3	2	3	x		
ZN-702	Protein Nutrition	2	2		x		
ZN-703	Mineral Nutrition	2	2			x	
ZN-704	Lipid Nutrition	2	2			x	
b. In Genetics							
CB-703	Advanced Genetics	3	3			x	
CB-706	Quantitative Genetics	3	3			x	
CB-707	Physiological	3	3				
c. In Statistics							
CE-601	Statistics I	4	3	2	x		
CE-602	Statistics II	4	3	2		x	
d. In Agricultural Economics							
SE-601	Economic Decisions	3	3				x
SE-616	Linear Programming in Economics	3	3		x		
SE-721	Agricultural Marketing	3	3		x		
SE-732	Agricultural Planning and Administration	3	3		x		

x Maximum of 4 credits
xx From 4 to 6 credits

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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. B-1 Dr. K. F. Jakobsen, FAO; National University of Colombia

Title: UNDERGRADUATE AND POSTGRADUATE TRAINING

INTRODUCTION

Three professions are involved in the major part of a country's agricultural development: Agronomy, Animal Husbandry and Veterinary Medicine. In some countries all three professions have equal status, but in others Animal Husbandry is not yet recognized as a separate profession. Where this is the case the responsibility for Animal Husbandry lies with the Agronomist or the Veterinarian or both.

This paper is the result of experience gained in Project COL 181 with the National University of Colombia in Bogotá. The purpose of the project is to strengthen veterinary training and develop a separate comprehensive programme of studies leading to a degree in Animal Husbandry.

Agronomy and Veterinary Medicine/Animal Husbandry have long been established professions in Colombia, while the acceptance of Animal Husbandry as an independant, but allied profession to Agronomy and Veterinary Medicine is new. In order to establish the courses at Bogotá, it was necessary to set out, in broad terms, the functions of the three professions.

1. <u>Definitions</u>

<u>Agronomist</u>: A specialist trained in soil/plant relations, with a reasonable knowledge of Animal Husbandry;

<u>Animal Husbandryman</u>: A specialist trained in plant/animal relations, farm management and the processing and marketing of animal products;

<u>Veterinarian</u>: A specialist trained in Veterinary Medicine and having some knowledge of animal production.

These descriptions may appear to be over simplified and it is easy to find examples from all over the world of the difficulties encountered in trying to establish the degree and nature of specialization for each profession. The difficulties arise partly from an inevitable overlap in training and sometimes because of the unwillingness of one

profession to recognize the specialist qualities of another. Competition in this latter respect however is not always a handicap and will tend to produce the best trained man for the job.

2. Needs of the country

Agricultural development in Latin America is in urgent need of well trained men from all these disciplines. The first approach to facilitating technical assistance should be made by men from the three professions who have broad training and a knowledge of the difficulties to be overcome.

3. Responsibilities of the three professions

In a meeting on superior agricultural education, recently celebrated in Bogotá, the agronomists considered the following professional opportunities:

Ingeniero Agrónomo Administrador;
Ingeniero Agrónomo Industrial;
Ingeniero Agrónomo Extensionista;
Ingeniero Agrónomo Fitomejorador;
Ingeniero Agrónomo Asistente Técnico;
Ingeniero Agrónomo (Enciclopédico, actual);
Ingeniero Agrícola.

As Animal Husbandry as an independant, but allied profession, is comparatively new, its function has yet to be clearly defined. Only a few students have graduated up to the present time, so it is still premature to draw conclusions about their opportunities, but as training develops and experience is gained, it may be expected that the part played by Animal Husbandry will become clearer.

The classical concept of a Veterinarian is that of a clinician. There is an ever increasing demand for them in Latin America, particularly for those specializing in bovine reproduction. The characteristic features of animal production in Latin America seems however to indicate that preventive medicine has a wider application than curative medicine, and Veterinary Public Health will also become more important as the standard of living increases.

4. Undergraduate education

Accepting that Agronomist, Animal Husbandry specialists and Veterinarians must work together to increase food production makes it easier to establish the relationship between the principal components of the Agronomy, Animal Husbandry and Veterinary curricula and to accept that Animal Husbandry lies midway between Agronomy and Veterinary Medicine. Consideration must also be given to the fact that the degree of intensive training required by the Animal Husbandry specialist, makes it virtually impossible to provide sufficiently advanced courses in this discipline in

the routine four year training for Agronomists and Veterinarians, though it is important that they should receive some training in Animal Husbandry.

(Refer to Appendix 1)

Many countries in Latin America are experimenting with undergraduate curricula to try and ensure that graduates are adequately qualified to assist with agricultural programmes. It must be realized that the wide range of environmental and social conditions under which agriculture is conducted, means that there is no single or uniform type of agricultural practices. As a result, some variation of curricula between regions must be regarded as normal.

Veterinary Medicine curricula are under revision in many countries at the present time and discussions are mainly concerned with the animal husbandry component. There are quite pronounced variations in the results of these discussions. Most countries favour a curriculum with more emphasis on Animal Husbandry, while others are facing the difficulty of combining sufficiently advanced courses in Animal Production with the traditional veterinary courses.

5. <u>Problems related to undergraduate education</u>

Whatever may be the final result of these discussions, it is important that education, research and extension programmes be determined by the agricultural needs of the country and contacts between universities and the field are important. Experience in practical agriculture among the students is indispensable, but universities seldom have facilities to provide this training. The importance of strengthening the practical aspects of education cannot be overemphasized.

Training at the secondary education level should be based on creative thinking rather than by rote learning and student selection should be carefully supervised.

Teaching ability is a highly important factor, and staff shortages can severely retard education. The necessity to combine teaching and research is recognized and is fundamental to any good university. The necessity of good library facilities need hardly be stressed.

One of the major problems facing Latin America Universities is lack of funds, and university education will progress very slowly unless more funds are forthcoming.

6. <u>Specialization</u>

Undergraduate education should produce graduates with a broad, practical training, but there is also an urgent need for specialization within each profession to assist in the solution of regional or local problems. This should take place at postgraduate level and many universities in Latin America have already established facilities for this

training. There is the question however as to whether present undergraduate training facilities are sufficiently well advanced in most universities to be able to cope with the requirements of postgraduate programmes.

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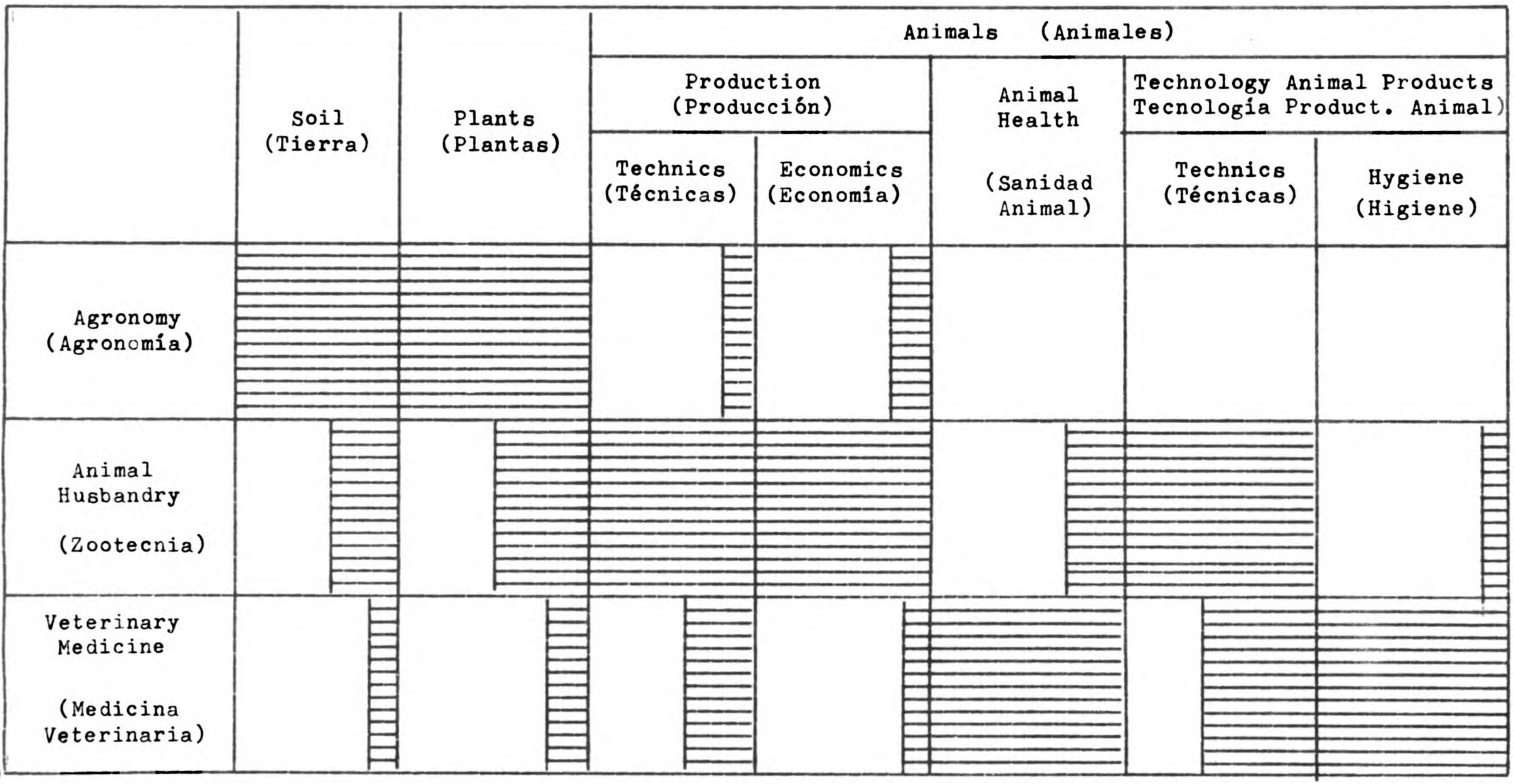
Appendix I
(Apendice I)

The Principal Components of the Undergraduate Curricula of Agronomy, Animal Husbandry and Veterinary Medicine
(Principales Componentes de los Planes de Estudio del Pregraduado en Agronomía, Zootecnia y Medicina Veterinaria)



Note: Shaded boxes: Intensive study of the subject
(Nota) (Casillas llenas: Estudio intensivo de la materia)
Partially shaded boxes: Less intensive study of the subject
(Casillas parcialmente rayadas: Estudio menos intensivo de la materia)
Unshaded boxes: Subjects not included in the curriculum
(Casillas vacías: Materias no incluidas en el plan de estudio)

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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. B-2 Dr. G. K. L. Underbjerg, Kansas State University

Title: COORDINATING VETERINARY SCIENCE AND ANIMAL SCIENCE TRAINING PROGRAMS

Most Latin American countries have self sustaining veterinary schools affiliated or associated with universities. Likewise, Animal Science Departments are probably located or work in close liaison with the veterinary establishments. It is obvious or natural, then, to assert that postgraduate education and associated research should be established in Latin America. Further, graduate students are valuable technical assistants in research. Also, students sent abroad for training find it difficult to readjust to conditions at home on their return. On the other hand, there is no substitute for postgraduate or postdoctoral study on foreign soil by promising young scientists, to expose them to and to train them in techniques of current research. Yet growth of research depends on sufficient human resources. Nothing less than first rate scholars and research workers do qualified investigational work. Yielding to mediocrity in personnel and research is as expensive in money and materials as investing in superior quality. The greatest injustice which can be meted out to any developing country is to yield to substandard educational policies. Organizing a postgraduate training program does not necessarily create good research. It can only be as good as the growth of the basic sciences or the core courses in a given field of study. It is a culmination of that growth and not a subsidiary. Postgraduate study and accomplishment may be expressed as the striving for knowing everything about a given subject, an attainment which is never reached but results of such research contribute to knowledge. Apprentices, then, for postgraduate training in research must be recruited from the best in the undergraduate fields.

There are some 30 veterinary schools in Latin America. Are they equipped for creating a research group with the requisite balanced composition of personnel with range of ages and experience and mechanisms for acquiring new members as older ones retire or are otherwise lost to the profession? Probably not, as judged by experiences of other veterinary colleges in the world. Without establishing the exact causes of this state of affairs, a brief look at the history of the veterinary medical sciences seems appropriate.

Most governments where livestock production is possible have established redoubts in one form or another to combat animal diseases. History is replete with accounts of epizootics affecting herds and flocks intermittently. Thus zoonoses (infectious diseases) represent a great adversary to the production of an adequate and wholesome supply of animal protein for human consumption. They

are a constant threat to the livestock or poultry producer. Out of control, this peril multiplies as the prevalence and severity of a disease increases. The wasted resources in animals affect the economy and health of peoples everywhere.

The socio-economic conditions of one-half the world depend to a large extent on livestock production, cash-crop agriculture, animal herdsmen and soil tiller -- one of the oldest forms of organized labor in the world. Other industries await such development. A population must be fed and clothed with not more than half its labor force so the other half is available for industrial, social, political, and other such endeavors. Many societies foresaw (envisioned) the need for a realistic animal health program. With development of the scientific method and the advancement of the basic sciences, early veterinary medical schools were fostered and developed with the science of medicine and the healing arts. Application of genetic principles in animal breeding and nutrition has increased animal production many fold. This together with applications of veterinary medical technology through veterinary colleges and redoubts throughout the world have been of immeasuable value in protecting and improving the health of the animal population. Conquering and measurably controlling major animal diseases made an increase in the animal population possible in parts of the world where veterinary medical and basic animal science techniques were applied. However, the animal health scientist must continue to be vigilant. It is said that Napoleon never slept - and conquered the world - but at one instance he failed to be vigilant and was sent to forced retirement on an island. The challenge to the animal health professions in any society is vigilance on the part of intensively trained veterinary medical scientists and their closely related colleagues in animal production.

Faculties of veterinary medicine and veterinary services throughout the world, must, like most organizations, maintain a staff alert to and responsive to new challenges and changing conditions. That is not a new situation; it is rather one most faculty members have experienced. Few veterinary faculties remain fixed for long periods. Fixation of anyone can be interpreted to mean the realization of the ultimate or, conversely, stagnation at a certain level. However, most faculties are affected intermittently with tremors in development. The signs of difficulties are varied and many. Generally it can be stated that the economy of the country markedly influences most colleges as it has in the United States and other countries where technological and basic sciences are at high levels. Tremendous advances in the basic sciences during the recent decades has stimulated new developments in technology, the applied sciences and the healing arts. The impetuous wind from the basic sciences opened new vistas in biological research undreamed of before. The result is that veterinary faculties have increased with rigorous selectivity their capacities many fold (in teaching, research and physical facilities) to carry the impetus forward.

Self-perpetuating academic systems of low quality following fashions of styles a few years back simply cannot survive among abmitious scientists where competition is fierce. Any faculty that tends to flabbiness eventually suffers from brain drain, that is, the best, rather than suffer from scholarly decay, seek opportunity elsewhere where the academic climate is favorable for productive research. Ideals, ideas for the art of teaching and experimentation travel

inside people and are transferred from one to another through prolonged contact. A feeling of associateship perhaps is more precious than instrumentation or tomes of books.

It is generally proposed in the development of the livestock industry that existing schools (Veterinary Medical, Animal Science) should first be built up satisfactory standard and operated to full capacity before new schools are established. This entails assessing what exists and planning for long term renewability of existing institutions. It may be far more difficult and expensive than establishing a new school would be. Experience seems to indicate that anomaly.

Veterinary schools originally were established to provide veterinary services for the livestock industry. Following the control of the major diseases, research stagnated for various reasons and governments in general seemed content with that state of affairs. Practicing veterinarians and government agencies often have expressed concern about over-production of veterinarians and many expert panel sessions have expressed similar attitudes, despite veterinary establishments never having been able to furnish enough graduates for world demands. However, the same faculties definitely saw the need for expanded research on animal diseases and allied subjects. Conversely, agencies representing political forces do not necessarily agree with the obvious and natural needs in education and research, since the demand for education to them is neither obvious nor natural, but purely ethical. Certain governments for years in the past have spent hundreds of millions of dollars to control Foot and Mouth disease, but often those in charge did not see fit to allocate funds for research on the malady. Control through vaccination and other methods may induce a sense of false security. Then little research is done on the disease in question, nor on other less obvious diseases, which are more incipient in development. Thus opinions, strong will and feelings defend traditions established years ago become powerful instruments in arguments against possible developments or new ideas. Establishments engulfed or enveloped in such fortresses unwittingly have created their own prisons. Apparently jarring events are needed to induce authorities to become interested in investigating conditions that affect the health, nutrition and well being of animals and man. The population explosion, malnutrition, rank starvation and the prospects of limited food supplies finally seem to have aroused governments and people everywhere to seek alleviations. The vast areas of investigation of nutrition in relation to infection of animals and man have hardly been explored. The incipiency of nutritional deficiencies in the newborn and the very young remain unexplained in animals and man. (Kwashiokor, marasmus, sprue in man and similar conditions in offspring of nomadic cattle when subjected to inadequate diets).

Nutrition as a science deals with the study of providing an organism with adequate food so that it in turn can grow, reproduce and function properly. Practically this means that animal and health sciences should direct their efforts to develop animal and agricultural resources. For that purpose energy is the ultimate raw material needed.

Some 2000 years ago Hiprocrates, the father of medicine, thought of the stomach as being a stewing pot in which food was cooked by body heat and believed that the amount of heat the body produced determined the needs for food.

In our atomic age Weinberg(3) has elaborated on energy as the ultimate raw material. He visualizes that energy can be exchanged for almost all the essential raw materials on which industrial society depends.

A similar relation between energy and agriculture appears to exist, and Weinberg cites Prof. Perry R. Stout, University of California, Davis, who states that the essential input to mass production of grain is energy; for pumping, for producing fertilizers, for transporting the product to market and so on. As he points out, availability of energy limits the agricultural output in many cases.

With cheap power, Winberg, based on results of research, envisioned a nuclear-powered agro-industrial complex: An integrated collection of heavy chemical industries clustered around nuclear reactors and desalting plants, and associated with a highly mechnized, scientific farm or food factory, but made no provisions for animals in the program to utilize by-products from farms.

Tomes of books with titles: Land, Soil; Seeds; Food and Life; A Place to Live; followed by titles of Insects; Animal Diseases; Keeping Livestock Healthy and After a Hundred Years are on the bookshelves. There are many lessons in these titles. They represent man striving for ultimate in agricultural progress during more than one hundred years. They give some of the methods of controlling adversaries. Results of the investigations of such topics have meant happiness to millions of people, but also frustation to some who could not find the answer to many problems. New developments in many countries bring additional problems such as imbalancing ecology in regions of the world with dams, reservoirs, and irrigation, large scale spraying of chemicals, strip-mining of land, and mining forests, including rain forests. Horror stories range between laterizing soil with deforestation and increasing schistosomiasis and attracting the tsetse fly to lake regions to misusing pesticides that induce upheavals of the ecology. Thus developments bring on their own problems and can foul the nest of those they were to have helped. Likewise developments in educational processes create problems since education in itself induces revolutionary ideas which do not always agree with traditional processes. Ignorance as well as enlightenment has its agitators. Unfortunately a reductionist attitude or bias can thrive in a camp of either ignorance or enlightenment.

In understanding a complex system the tendency today is to study properties of its isolated parts. This has led the physiologists to become biochemists, the biochemists to become enzymoligists or cellular biologists or molecular biologists and they in turn to chemists and chemists into physicists and physicists into mathematicians. Every one is looking for the answer in a more basic or pure science. On the other hand, the education of technical experts cannot be left entirely in the hands of their own practical technologists. Modern veterinary medical, animal science, and medical experts require the exercise and skills and the application of knowledge acquired from the basic disciplines of physics, chemistry, mathematics, microbiology, genetics, pathology, anatomy, pharmacology, physiology and nutrition. The applied scientist or technical expert is a good as his ability to exploit or apply the latest techniques in research in those fields, developed in close contact with the latest theoretical principles.

Governments or societies within governments create missions that presumably meet the needs of people. However, when missions are organized, they tend to be separated into fragments or interphases such as agronomy from water resources and animal production; agriculture from veterinary medicine and medicine from the latter. Likewise, there is separateness between industrial and academic areas. Such interphases weaken complex missions. Therefore, the accomplishments of any mission or integrated attack depend on a broad spectrum, capabilities not usually present in a single enterprise.

To attack the problem a versatile, integrated institution with interphases and disciplines coordinated is needed.

A cure for isolation is to travel to active centers of learning in one's particular field to gain in experiences related to new knowledge. The establishment of such a center of teaching and research on the postgraduate level at a university may well be the key to progress. When capital funding is limited, resources spread out too thinly fail in their objectives. An integrated center on a relevant subject like veterinary science and animal science would seem highly fitting to the economic, geographical, metereological and social background of Latin America. Cross linked with the scientific community of others, it could be the area from which ideas and new findings would flow outward.

Previous experience supports such an idea. Recently a veterinary college was established at a university in Africa (2). Following its establishment, a relevant research unit soon became attached. In the fifth year of its existence, undergraduate students are enrolled from other countries on that continent. Other agencies are helping the college establish a major research unit aimed at meat animal medicine and production. In other words, the multidisciplinary approach in personnel as well as in laboratories is necessary in new missions. This involves a great many experts in the field of animal nutrition, production, genetics or animal breeding, in veterinary science and medical subjects.

Since the mission would contact various cultures, experts in anthropology, sociology and communications should be included also. Desired changes cause painful adjustments that sometimes are opposed so strongly that the desired changes are delayed or stopped. The latter three disciplines ease the pain and accelerate the desired changes.

The virtues of a multidisciplinary, research post-graduate training site for studying problems related to animal production and veterinary science transcend the usual disciplinary bounds in undergraduate teaching. The very applied and practical nature of veterinary science and animal science programs demand highly specialized training to the changing occupational programs associated with large scale developments or missions in developing countries. A veterinarian stationed in a remote redoubt supervising a vaccination program against Rinderpest of nomadic cattle is not necessarily a competent oriented virologist nor is the contrary self evident.

However, in the proper environment transfer orientation and training is possible, and brought together opens new vistas and forms the bases for improvement in occupational programs or missions. To expect a veterinarian or animal production science professional to be an occupational specialist, or and occupational specialist to always be a competent veterinarian or animal scientist in the broadest sense suggests strongly institutional expediency and interferes with quality.

It would seem imperative then that the veterinary schools and animal science departments critically examine their staffs in functional overlaps and specialty training. Staffing the specialty components of a post-graduate training program would require careful study. The solutions may in part lie in answering questions:

1. Are the specialty programs adequately staffed?

2. Are there recruitment problems? If so, what measures can be employed to enhance recruitment?

3. What kinds of programs are needed to prepare technology specialties for teaching and research in a postgraduate training program in veterinary, or animal science field and animal production?

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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. B-3 Dr. J. Váchal, Central Research Institute of Animal Production, Czechoslovakia

Title: EFFECTIVE UNDERGRADUATE AND GRADUATE TRAINING IN ANIMAL SCIENCE

Many thanks for the opportunity to express my opinions on some problems connected with the effective training of technicians in the field of animal science. I am also going to try to apply my ideas to the countries of Latin America with quite special conditions. I am also going to use some examples from the Czechoslovakian education system.

A lot has already been said about the education of young people, much very valuable, and representing experiences of teaching success covering many years. All this was said with the intention of looking for and revealing new and more effective ways of teaching. Therefore, undoubtedly, it will be impossible for me to look for or directly discover some universal solvent for so complicated a problem as the programs of teaching of technicians in animal sciences at all grades including university grades. That is why I only want to express some of my opinions in this regard.

There is no doubt that the perfect preparation of professional intelligence is the most effective investment which insures not only the utilization of investments but also in its consequences presents the source of its own further improvement. We are surely of the same opinion that the stay and work of experts in the so-called developing countries is the first necessary step not only for the introduction of modern methods and new techniques, but also a necessary basic foundation for providing for the preparation of scientific technology in these countries. This must be directed in such a way to insure the continuity of further development without repeated help of these foreign experts. The education of a certain part of the population in a given technical direction will also undoubtedly contribute toward the development of the cultural level of the country. It is also certain that this contribution would be more effective if we would select whom already have a good basic education. Technical education, also in the case of assistance of foreign experts, should always go hand-in-hand with the rational planning within the structure of the general educational system. On the contrary, if the general educational system especially with respect to basic education, is not insured, this will limit the results of any, however good organized teaching, in a certain part of technical knowledge only.

These basic aspects can be considered as limiting factors which apply to further consideration in the development and preparation of technicians.

Objectives of Animal Science Education

The forms of education in animal science must be such as to cover the demands which society has on the preparation, extent, and quality of the graduates of these schools. The general requirements for assuring the development of a modern animal industry can be considered as follows:

- We must have technicians, experts in animal production, to be able to insure the desired level of growth in the production of farm animals in given conditions.

- We also want to have such professionals in animal production to be able to insure the growth of the animal products.

- And finally, it is necessary to prepare students, as future scientists, in the various scientific fields which can contribute toward solving the problems in different aspects of animal science.

Forms of Animal Science Teaching

It is logical that the realization of the goals mentioned above are connected with general rules of teaching which has to be fullfilled. But it is also natural that their realization will be, in a certain measure, limited by the general conditions of that country involved.

For example, the American style of training in animal science can be evaluated quite objectively from the historical viewpoint different periods in the level and extent of education in the professional schools of animal science. The characteristics of these periods were determined by the development of social and productive forces and they corresponded also with the general development of scientific knowledge including the possibilities of application in the livestock industry (Bentley, 1968).

Another example, we have in Czechoslovakia, a country with a high cultural level, and already for many years with a good level of agricultural education. In this example I would like to show the economic influence on teaching including teaching at the graduate level. It was necessary in this country to build over the whole system of agricultural and animal science training as a consequence of a tremendous change in the structure of agriculture from the small private farms to large scale state farms. In connection with these economic conditions very clearly the necessity appeared for narrow specialization of professionals in all categories and all grades in animal science.

The formation of large scale units and the new system of animal husbandry in these units brought quite different demands on the technique of animal production beginning by identification of animals and finishing by the management. It was necessary to submit not only the training program

but also the system and structure of the whole education to these new production conditions.

I suppose that I now can give a brief explanation of the education and above all the university agricultural education in Czechoslovakia.

The education in Czechoslovakia is organized similar to that of other European countries. In the branch of agricultural education there are substantially three main categories of schools as follows:

- Apprentice schools
- Technological schools of pre-university level
- Universities and Postgraduate studies

For the last 15 years, we have had a special form of scientific preparation, the so-called candidates of science. That is to say that there is a certain differentiation between the systems that we are using here in the American continent and, for example, what is being used in our country or in Europe. On this basis, or form these people are intensively prepared for the fortification of all branches of animal research. In recent years also, special postgraduate courses are arranged especially for older university graduates which can complete their education with regard to new knowledge in special fields principally in genetics and animal nutrition.

The universities are all organized in a similar manner. For example in Prague, we have a School of Agriculture at the University of Prague with the following Disciplines: Agriculture, Economics, and Mechanization. The Agriculture group assures the teaching of plant and animal sciences and soil conservation. This Discipline for example, prepares three different sub-university technicians. The Discipline of Economics prepares the Agricultural Economists and the Discipline of Mechanization trains the Agricultural Experts in Mechanics. Besides that, the Prague University has a farm of about 3400 hectares for the students to carry out their basic practices and where they carry out different research programs directed by their senior professors.

Contents of the Educational Training Programs in Animal Science

What has been said thus far can be considered as formal and general part with regard to the preparation in animal science. It is true that there are some small deviations in the organization of teaching in the various European countries, but they all have in common a high level of agricultural education including in animal science.

Although the forms of teaching in the different countries may not be exactly the same, the content and depth of the teaching should always be maintained in the schools of equal level.

A tremendous development in the basic scientific fields in the past also has influenced the application of their discoveries in practical life. Animal production may obtain a lot of the information from Genetics, Physiology, Chemistry, Microbiology and also Physics and Mathematics. This penetration of science meant the successive changes in animal science

teaching programs. Today we feel a greater need for a stronger and more expressive proportion of the basic biological sciences in the extent of teaching of animal technicians at all levels including pre-university as well as university level. The practical realization brings, within time, a demand for teaching these disciplines. We can observe at the University of Prague.

Concerning the Animal Production career that requires 5 years, we can distinguish five different groups of subject matter; Social Science, Basic, Applied, Specialized and Complimentary subjects. If we express the percentage of courses that are of basic subjects and basic applied we would find 27.8, 13.9, and if we also include the Social Sciences we would have more than 50% that belong to the basic theoretical or basic applied subjects.

The deep preparation of basic matters for the preparation of a good specialist is a necessary supposition. In practice today we not need universal workers so much as specialists. In the field of animal science these include specialists in several species of domestic animals, the Nutritionist and the Genetiticists. That is to say, not only the general Animal Scientists. Also in our country we have faced this question. Today for example, we are introducing at the Prague school in the Animal Science branch a partial specialization during the study period.

In order to be a little clearer, I am going to give a complete revision of the subjects and the curriculum with an indication of the five specializations. Besides the Mathematics, Chemistry, Physics, Agricultural Chemistry, Botany, Zoology, Microbiology, Genetics I and II, and Basic Cytology there are Apply Agrometerology, Anatomy, History, Animal Physiology, Biophysics and Statistics. In the group of special subjects we have included the following: General Animal Science, Animal Nutrition, Mechanization of Animal Production, Cattle Production, Poultry Production, Swine Production, Sheep Production, Horse Production, Artificial Insemination, Disease Prevention, Gynecology, and Dairy Industry. And besides that the student, during the last three semesters beginning at the eight semester, has the possibility of choosing one of the five selected groups. The first group includes Swine, Mechanization, and Organization within those units. The second group consists of Special Genetics, Animal Breeding Methods and Basic Biometry. Group three constitutes Cattle, Pastures and Reproduction; group four deals with Aviculture, Economics and Organization in the Production of milk and eggs. The fifth group comprises subjects that have a close relationship such as Forage utilization, Biotechnology, Technology of Production and Organization and Economics of the forage mixtures. Each student has the possibility of choosing one of these groups, but also they need to go to some of the other courses.

It is interesting that the early specialization of these courses has also been discussed in Federal Germany according to the reports that I received a short time before I came here (Glodke, 1969). It is expected that by 1970 they will decide whether the specialization should begin at the fourth semester. In Holland they are thinking of shortening the studies by better organization of the teaching, specialization of the graduates into two different directions - for practice and for research (Glodke, 1968).

In this connection it is necessary to remember the not so good fact that some universities especially in Latin America that it is usual to combine the animal and veterinary science teaching mostly in disadvantage to animal science. The desintegration of such combined faculties or schools at the planned specialization and necessary division of teaching could be objectively considered as fruitful and directly suitable with respect to the future reciprocal collaboration between both. The same opinion expresses Raun (1968).

Let me tell you at this time about the preparation of the Veterinary Doctors in Czechoslovakia. The main task of the Veterinarian is to guarantee the health of the animals and their protection grown in a good environment. They have hygienic control and biological control of the foods of animal origin as they also protect the health of man. Also, in the University Teaching of Veterinarians, we have pointed out the importance of the basic subjects and basic applied subjects. In percentages of the type of study, which is 11 semesters, and the figure is 46.1 percent for the basic and basic applied subjects and when we include the social sciences these total more than 53 percent of the entire teaching effort. The field of work of graduates of Veterinary medicine, in our country, is very broad. They can work as Veterinarians, they can be inspectors of quality control work in clinics, in experimental stations and in many other places.

Apart from the professionals whom are able to assure production directly on the farms (and here we consider predomenantly but not exclusively the graduates of the agricultural high schools and technical schools) every modern society would be interested in professionals who could be able to handle different animal products. Specialized schools of a pre-university nature, for example, produce graduates for industry, that is, for the cheese industry in France, for the milk industry in the case of the Netherlands and Switzerland or for the meat industry in our country, etc. (Trnka, 1959).

There is another particular aspect that is being discussed at this time in our country - the cooperatives which have oftentimes merged into very large units. In these large agricultural practices very good managers are necessary and the manager must have the talent and training of a postgraduate nature for that type of work. The selection and mostly the preparation of these specialists are extremely specific and cannot be guaranted by the normal university teaching. In several countries, more correct forms of preparation for such specialists are being sought, generally through postgraduate courses. In our country, at the Institute of Postgraduate Teaching in Agriculture we are preparing the educational system of an individual nature. This system, with regard to the problematics of teaching, represents an open system capable of utilizing the new knowledge, of answering practical needs, and likewise of guaranteeing the development and qualification of the individual workers. The most serious problem that we have in this regard in developing this Postgraduate system is getting high level professors. Our best source is the Universities and the Research Stations. A similar system for the preparation of managers has been established by Rumania in their center for the education of leaders founded in 1967.

The postgraduate studies, according to the present standards in Czechoslovakia, are solely the responsibility of the universities. In the case of agriculture the Institute of Postgraduate Studies in Agriculture that belongs to the Ministry of Agriculture is the organization entrusted with organizing the postgraduate courses for the different Universities. This Institute also was established in 1967. In animal science, we are beginning this year with postgraduate studies in the following branches or areas: Genetics, Technology of Animal Production in Large Units, Production of Fur Animals.

In my own unit we are preparing the post-graduate course specifically for Genetics. The revision of the assignments for the first course will be briefly as follows: Genetics, Biochemistry, Artificial Insemination, Genetics I, Quantitative Genetics, Theory of Selection, Performance Tests, and Methods of Reproduction, Mating Methods, New Aspects of Animal Production, completed by two additional subjects and reports on the new knowledge of animal science which try to indicate other possibilities in the investigation and research of animal breeding. This is a four semester course with most of the study is done individually and is finished with regular consultation according to the program of several subjects.

Postgraduate education of the Veterinary Doctors in Czechoslovakia, differently from the Animal Scientist, has a long tradition and is very well organized. In order for a Medical Veterinarian to occupy a higher position in the district or the region he must have Postgraduate studies of the specialized type. The work in such a function is subject to a previous examination in the given specialization. Therefore this type of postgraduate specialization is related to the most frequent problems of practice such as animal hygiene, food hygiene, reproduction, nutrition, surgery, etc.

The postgraduate studies of the Veterinarians is organized by the Institute of Postgraduate Teaching for Veterinarians. This teaching is done by the University professors and also the scientific workers of the Research Institutions. Recently we started a cyclic form of education at the postgraduate level which is determined mostly for the Veterinarians that are going to work directly in the districts. Supposedly all of them participate every five years, in an informative refresher course of short duration where they are informed of recent scientific developments. Another type of postgraduate courses which we have are short courses which are offered according to the needs.

Science represents today the most progressive force part of modern society. In the so-called developing countries the number of university and scientific workers is growing very fast, even more so than the other forces of production. But at this time it is necessary to see, and to underline the following aspects; a worker, although he may be qualified, if his knowledge does not correspond to the contemporary level that is existant is sometime like a factory with old machinery. Therefore, the results produced are correspondingly similar; they both produce products of an undesirable quality. But the contrary can also happen; if a qualified technician is not going to have adequate space to implement his talents, his capability will not be used to advantage. Then we also face the problem of the most objective studies of the need and utilization of university technicians in all the branches including animal science. We believe those aspects to be extremely important in the preparation of those studies at the pre-university level as well as at the university level.

Preparation of Scientists and Teachers in Animal Science

Lastly, I would like to mention the preparation of the future professors in animal science. In general we can say that the specialization or development of science carries with it a greater demand of this type of worker. I want to show this in the field of genetics. The development of this scientific field can be measured by tens of years if we begin at the turn of the century with the rediscovery of Mendel's Laws. Today we must distinguish, within genetics, a whole set of quite specialized branches only with regard to animal genetics. We can speak about the necessity of specialization of scientists and teachers in Population Genetics, Quantitative Genetics, Immunogenetics, Behavioral Genetics, Ecological Genetics, Pathological Genetics, etc. That is to say, the development of the preparation of teachers for their future tasks has followed along those lines of the development of the different sciences.

Because I am personally very close to the problems of animal genetics, allow me another small note which I should like to use as a modest argument for my opinion on the quality of teaching. It is connected with Prof. Lush or population genetics. He was outstandingly able to apply the general population genetic aspects to the needs of animal breeding and he explained them in a simple manner to his pupils. Therefore this field of animal science achieved in the last twenty - thirty years outstanding successes not only in the teaching but also in practical application (Willham, 1968).

Animal genetics and breeding is becoming a frequent object of postgraduate courses and it offers still better results directly in practice. Therefore I believe, apart from Animal Nutrition, Animal Population Genetics should be taught in animal science mainly in the Latin American countries with regard to the improvement of domestic animals, especially cattle. The relationship between science and teaching can be represented by a pyramid which represents the decreasing number, but increasing depth, of technicians from the ground level to university graduates respectively. The pyramid also can serve to illustrate the effective selection of specialists and research workers.

The basis of this selection is a logical one since not all students posses the same capacity for knowledge or the same inclination for research work. Also these aspects need adequate attention in the formation of conditions for their fulfillment which represent a high level, profound preparation in this speciality of animal science and in the related basic sciences. It is very important to consider some aspects of the succession of generations: The high level specialists educated today will tomorrow prepare the teaching programmes in the Universities of animal science and will prepare the teachers for the colleges and undergraduate basic schools. The quality of their preparation today will influence in a certain measure also the quality of technicians at all levels of education in the future. If we admit that there is a lot of truth in this statement, then we should also admit the necessity of a maximum emphasis of this level of teaching animal science.

From this particular point of view, I believe that we should observe that there must be cooperation among the universities of animal sciences and the experimental institutions in research and their common development always expanding the cooperation between them.

CONCLUSION

There are indeed many open aspects for solving all the needs connected with well organized teaching in the field of animal science. My ideas which I tried to indicate are briefly as follows:

1. Basic and undergraduate courses represent the fundamental link in the preparation of qualified workers in animal production. These regard especially the farm workers. The form of teaching at these levels must be as simple as possible with a broad scope. I believe that the students in these schools and courses should receive basic biological information and a complete survey in livestock husbandry with regard to the kind of animals involved .

2. Specialized technical schools and pre-university level schools should be so specialized as to prepare technicians fully trained for then given professions. In these schools a stream of common information should dominate over narrow or deep specialization. But it is also necessary at this level to introduce new scientific discoveries into the teaching programmes.

3. Universities should ensure in their teaching programmes a deep and stimulated preparation of students especially in pure biological sciences which are becoming an increasingly fundamental source of development in animal production. At this level, attention must be directed toward genetics, physiology, microbiology, biochemistry, biophysics, and mathematics.

4. Postgraduate courses and the special preparation of future scientists are at the top of animal science education and thus deserve the greatest attention. They represent the most important key to the growth and future of animal science teaching. Direct collaboration and cooperation between University Departments and Research Stations and Institutes should be considered useful for both groups. In countries with limited material and human resources it is recommendable to plan such a form of collaboration as a basic one.

   For a given country, the possibility of assistance and direct collaboration in solving a problem will be given to students, future professors and research workers. The present research workers will have an excellent opportunity to participate directly in the training of their own successors.

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Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. B-4 Dr. K. L. Turk, Cornell University

Title: INCREASING THE EFFICIENCY OF DISSEMINATION AND UTILIZING INFORMATION AND RESEARCH RESULTS

New knowledge in the animal sciences, as in other fields, derives from research. But research results and new knowledge are of little value unless they find a way to the people on farms and ranches who can utilize the results for increased efficiency of livestock production.

One of the problems in agriculture the world over is how to get the proven findings of the scientist put into practice on the land. Scientists are mainly interested in <u>why</u>; farmers are mainly interested in <u>how</u>. There is a tremendous gap between these two interests; one that is fatal to a progressive agriculture unless it is bridged. In many countries of the world, extension workers are doing what they can with such facilities and personnel as may have been provided. But they cannot bridge the gap alone. The scientists ought to help.* The job of the research worker in animal science is not finished until the results of his labors are made available through all channels of communication and in such form so they can be utilized effectively by the livestock farmer in the improvement of his herds and flocks of animals.

According to reports of the U.S. Department of Agriculture, the numbers of livestock on farms in the United States have not changed appreciably during the past 50 years; yet the production of meat, milk, poultry, and eggs has more than doubled in this same period of time. The per capita supplies of animal products in the diet have been more then maintained. These gains have come from research advances in animal genetics, animal nutrition, animal physiology, livestock management, pastures and forages, meats and milk technology, and animal health and the application of this expanded knowledge on farms. ranches, and feed lots and in the food industries throughout the United States. These advances in productivity of livestock are not accidental. They are the product of research and education and utilization of research by farmers, resulting from the extension educational services. New knowledge translated into action by livestock farmers and those concerned with agricultural industries and business all have contributed to the breakthroughs in milk, meat, and egg production.

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* H. W. Hannah, Resource Book for Rural Universities in the Developing Countries, University of Illinois Press, 1966.

Livestock Programs Profit from Crop Advances

World-wide attention has been focused in recent years on the agricultural revolution that has been taking place in several developing countries, espacially Mexico, Pakistan, India, Philippines, Taiwan and Kenya. Dramatic breakthroughs have been obtained in crop production, mainly with the cereals wheat, rice and corn. The real success story has been with wheat and can be attributed to research on rust resistant varieties, new and higher yielding, short-strawed varieties, improved soils and cultural practices, and getting the results of research put into practice. Increased crop production is resulting from the whole package of practices.

One of the significant observations that has emerged from this "green revolution" is that farmers, even though they may be poorly educated, will adopt new practices rather rapidly if (a) the new sets of practices are clearly more productive and more profitable to him, (b) an experienced agriculturist will show him how to use them, (c) governments will make available to him, on credit when needed, fertilizers, pesticides, and other essentials, and (d) there is an available market and a satisfactory price.*

Similar dramatic breakthroughs in livestock production in developing countries have not been taking place. Is this because of a lack of knowledge in nutrition, genetics, artificial insemination, management, etc., on how to increase milk production or rate of gain, or how to produce finished animals for market at younger ages? Is it a failure of extension and other agencies to provide the information that will result in the necessary changes from traditional methods? Is there lack of a suitable market for livestock and livestock products? If adequate price and other incentives are provided, is there any reason why livestock farmers in Latin America will not adopt new and desirable practices that will result in more efficient and profitable production? Is research in progress on local problems that will provide the knowledge for livestock improvement in Latin America?

Livestock Farmers Will Respond to Incentives

Recently, the writer had an opportunity to spend a few weeks reviewing the livestock situation in India. A good example of farmer response to price incentives was observed in the city of Bangalore. Milk deliveries to the city milk plant amounted to about 30,000 liters per day. Additional milk was needed and a marked increase in the price to producers was established about two years ago. Milk deliveries jumped very quickly up to more than 65,000 liters daily. A retail milk marketing problem was created, but it illustrated that producers will respond if adequate economic incentives are provided.

In the same area, the writer saw crossbred cows producing from 4 to 10 times more milk than their dams and other cows in the community. The practice

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* J. George Harrar and Sterling Wortman, Expanding Food Production in Hungry Nations, paper in Overcoming World Hunger, Edited by Clifford M. Hardin, Prentice-Hall, Inc., 1969.

is spreading rapidly because the higher yielding animals offer opportunities for greater income to the dairy farmer.

These and other examples I have seen lead me to believe that livestock farmers will respond to incentives and make desirable changes if they are convinced they will be profitable and if the new practices will more than offset the risks involved in making changes. Packages of practices are doing the job in crop production in many developing countries and can do the same with livestock production. A combination of practices based on research and experience, including improved feeding and management, higher quality forage production and utilization, better breeding through the use of high quality sires and artificial insemination, careful selection of breeding animals, higher breeding efficiency and shorter calving intervals, and control of diseases can interact to obtain major breakthroughs in livestock production. It takes longer and it costs more money to breed and develop new and higher producing breeds and strains of animals than it does a new variety of wheat, but the job can be done.

Key Factors in Adoption of Artificial Insemination

One of the most effective tools in the genetic improvement of dairy cattle and other livestock over the past 30 years is artificial insemination. Of many new practices that have been developed in animal husbandry, none has been welcomed with so much approval throughout most of the world as artificial insemination. It has grown rapidly in many areas, especially in North America, Western Europe, Australia, and New Zealand, and more than a dozen countries are breeding artificially from 50 to 98 percent of their cows.* In my State of New York, for example, approximately 72 percent of the dairy cattle are now being bred artificially compared with none just 32 years ago. What has been responsible for the rapid adoption of this system of breeding? Why has the technique been more widely adopted and more effective in some countries than in others?

Let us examine briefly the key factors and methods of dissemination of research results that have been responsible for the acceptance of this practice and for the effective role of artificial insemination in mass genetic improvement of livestock populations.

First of all, in those countries where artificial insemination has been effective, it was preceded by 25 to 30 years or more of milk recording systems. For example, cow testing associations (now Dairy Herd Improvement Association) were first organized in 1905 in the United States. One of the uses of these records was for progeny testing of bulls. Progressive dairy farmers during the 1930's recognized the value of proven sires. And with the technique of artificial insemination on the horizon, it was relatively easy for these dairy farmers to appreciate the value of greatly extending the usefulness of the outstanding sires - those of known transmitting ability for high milk yields and

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* Enos J. Perry, The Artificial Insemination of Farm Animals, 4th Revised Edition, Rutgers University Press, 1968.

desirable body conformation. They could readily see the economic advantages for all dairymen, but especially those who could not afford to purchase and maintain a proven sire of high quality.

Throughout all of this development, the key factors have been (a)research, (b) extension education, and (c) leadership among the farmers. Knowledge provided through systematic and successful research programs made the growth and development of artificial insemination possible. The vital links are provided by the extension services through the local extension agents and the state extension specialists using all known means of communications - field days, demonstrations, printed bulletins, news items in newspapers and magazines, radio and television, and educational and promotional programs of business firms. Important roles in the education of farmers to the potentials of artificial insemination are the field staff members of the A.I. cooperatives and private organizations. Furthermore, these organizations provide the means of quickly putting into application the findings of the research laboratories. And much of the field research involves animals owned by cooperating dairymen who therefore have a personal interest and are quick to put the results into action.

Someone has said, "There is nothing like success to breed success!" From 1926 to 1946, before artificial insemination had been adopted to any great extent, the average annual milk production per cow for the United States increased by approximately 12 percent. In the following 20 year period, 1946 to 1966, the average yield per cow jumped by 65 percent.* This increase was due to many factors, of which artificial insemination was a signal factor. For example, I know a dairyman in New York State who has used artificial insemination exclusively for the past 20 yeas, and last year his herd of more than 40 cows averaged over 20,000 pounds of milk per cow! Over 3,500 DHIA herds in New York State averaged 13,020 pounds of milk per cow in 1968. Demonstrations like these are invaluable in extension educational programs.

It should be clear, therfore, that the major point I have been driving at is the need for a system to provide a vital link between research centers and livestock farmers. In the United States and some other countries, it is the Extension Service. But whatever it is called, the essential that is needed is a mechanism that will constantly get new information into the hands of the farmers. Publication in a scientific journal will not reach very many farmers. Other means of communication must be used.

Coming back for just a moment to artificial insemination, in every case in the United States where the practice has been most successful, there have been well-trained dairy extension specialists responsible for the educational programs with farmers. They have the same kind of training as the research scientist and often they are a part of the research team. They interpret research findings so they can be applied by the dairy and livestock farmer. They cooperate closely with communications specialists. In recent years they have also become specialists in computers and in the interpretation of computer

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* Enos J. Perry, The Artificial Insemination of Farm Animals, 4th Revised Edition, Rutgers University Press, 1968.

data on dairy records that pays big dividends.

For reemphasis, let me summarize the key points that have been responsible for adoption and effectiveness of artificial insemination, a new practice that was started in the United States in 1938:

1. Dairy farmers had a background of milk recording systems and appreciated the value of milk production, and other records in herd improvement.

2. The proven sire concept was developing rapidly. Progressive farmers were learning to recognize the value of bulls with demonstrated ability to transmit to their offspring high levels of milk production and desirable type or body conformation.

3. Leading farmers quickly recognized that artificial insemination offered the best tool that had ever become available to greatly extend the usefulness of outstanding sires - those of high transmitting ability. Higher producing cows result in greater incomes and a better standard of living.

4. Research on techniques of artificial insemination, sperm preservation, semen extension or dilution, frequency of collection, handling of semen, etc., and later frozen semen, provided the knowledge for artificial insemination to be practical anywhere in the world. Analysis of records and young sire evaluation and many other areas of research have played vital roles.

5. Farmer-owned cooperatives and private organizations (and government programs in some countries) grew rapidly and provided mechanism for large scale adoption of this new technique for livestock improvement. In the United States and other countries where artificial insemination has been most effective, farmers have paid for the service since the beginning.

6. An essential ingredient is farmer education through organized and well supported programs. Every known means of communication has been used in acquainting livestock farmers with the value and potentials of this practice. Subject matter specialists, highly trained in animal breeding, genetics, physiology of reproduction, etc., have quickly interpreted the results of research and made the information available to farmers for application. Teamwork exists between the extension specialist, the research scientist and the communications specialist. Extension agents in the local areas and counties have been essential members of the educational team.

7. Environmental influences on production, such as feeding and management, better quality forage programs, improved breeding efficiency, and maintenance of healthy herds have been important parts of the educational programs.

If you examine those countries and areas where artificial insemination is successful and effective, you will find that all of the factors just enumerated have played significant roles. In those countries where the practice has failed in the basic objective of wide adoption and herd improvement, one or more of these links is missing.

Artificial insemination is only one of dozens of practices that go together in bringing about livestock development. The same principles that have been effective in dissemination and utilizing results and information with artificial insemination, however, can be applied to each of the other practices that are essential to livestock improvement.

<u>Teamwork Necessary Between Specialists in Research, Extension and Communications</u>

In a recent report, Comunication and the Agricultural Universities in India,* Professor W. B. Ward describes a study made in 108 villages that show "every avenue of mass communication was positively related to agricultural innovation. Mass communications have both a specific and global beneficial effect. First, litening to radio , reading papers, and seeing block films provide scientific information about modern agricultural practices and help to persuade farmers to adopt them. Second, the mass media help to bring the outside world nearer to the farmer and this general knowledge is also functional for agricultural innovation. We found a strong association between adoption and this linkage with the outside world."

Professor Ward comments further, "In regard to the extension information service function from the university, the concept and operating policy should be that the research scientist, the subject matter extension specialist, and the communication specialist of the Center should work together in a team approach. The communication specialist can often be the link between the scientist and the extension subject matter specialist and bring the two together so the research can be interpreted into practical, localized information and provided to people through the existing channels of communication."

"Just as the experiment stations field test new and improved crop varieties to determine their application under specific conditions, there is need also to analyze audiences to determine who they are, where they are, and what the level of their understanding is relative to the specific messages agricultural universities want to deliver to them. Communication is a two-way process and for these universities the effective use of the new sciences will help determine what messages are needed, wasted, and will be used by the people."

The significance of communications in agriculture was fully recognized and explores in Latin America in the First Interamerican Research Symposium on the Role of communications in Agricultural Development, which was held in Mexico City in October, 1964. Many of the difficulties of communications, even between scientists, were recognized. Further, the lack of good research in the field of communications, compared with technologies, was explored in some depth.

It is relatively simple to convince well-educated livestock farmers of the value of new research findings and to adopt new methods and techniques. These men are sufficiently competent that many of them go to the experiment stations seeking out new information and for discussion of their problems. Often they are innovators and get out ahead of the research workers. They are readily reached through bulletins, field days, radio, television, newspapers and magazinez.

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* William B. Ward, Communication and the Agricultural Universities in India, Rationale and Guidelines for Establishing a Center of Strength in the Field of Agricultural Communication, The Ford Foundation, New Delhi, India, 1969 (also, Cornell IAD Reprint 29, Ithaca, New York, 1969).

But the real problem is how to convince the great majority of poorly educated farmers, who have only a small landholding or a tenancy arrangement and seldom travel any distance from home*. With this group of livestock farmers, the message of new technology must be brought to them directly and in a way they can understand. The extension agent and livestock specialist must be sufficiently experienced and knowledgeable to convince the farmer that a change in practice will be profitable. Not only must they know the livestock business throughly, i.e., nutrition, breeding, and management, but they must also be able to advise the farmer on closely related problems in soils and crops, especially pastures and forage crops, and farm management.

SUMMARY

Research results and new knowledge in animal science are of little value unless they are utilized by people on farms and ranches for increased efficiency of livestock production.

Experiences and observations throughout the world show that farmers today will change and adopt new practices if there are adequate incentives, and if the new sets of practices are clearly more productive and more profitable than traditional methods. Experienced and knowledgeagle agriculturists and animal scientists have the responsibility to teach and demonstrate desirable practices. Governments need to provide the political commitment or climate at the top level to insure adequate credit and other essentials, such as available markets and fair prices.

Universities, colleges, and experiment stations and research centers that desire to serve agriculture (livestock production is an integral part) must relate themselves to the groups and individuals who are at the heart of agriculture. These institutions need to be exposed to the public in order to bring better practices to bear more rapidly and among more farmers.

Efficiency of dissemination of research results will be improved through teamwork and constant interaction of the research scientist, the extension subject matter specialists, and the communication specialist. Extension subject matter specialists need to be as well trained as the investigator for interpretation of data for practical application. Extension agents must be kept abreast of new knowledge becoming available from research stations and universities. Short courses, training schools, field days and demonstrations, in addition to radio, television, printed bulletins, circulars, newletters, newspaper and magazine articles are essential, both for field extension agents and progressive farmers. Oftentimes, experiences of innovative and progressive farmers provide the most effective demonstrations of desirable and effective practices.

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* J. George Harrar and Sterling Wortman, Expanding Food Production in Hungry Nations, paper in Overcoming World Hunger, Edited by Clifford M. Harding, Prentice-Hall, Inc., 1969.

The fundamental function of livestock in the agriculture of a country must be in the forefront of educational programs. The basic function of farm animals is to convert into foods and other products for human use the forages and crop products and by-products that are not suitable for direct human consumption. Ruminants utilize vast pasture and grazing lands that are not suitable for crop production. It is important to recognize that any livestock enterprise must be profitable and competitive with other agricultural enterprises if it is to have a place in the economy of a country. Dairy cattle and other livestock must be sufficiently productive and efficient so their products can be sold at prices that are satisfactory to the producer, but at the same time can be sold at prices which larger numbers of consumers can afford. Educational programs emphasizing a combination or package of practices based on sound research and experience, including improved feeding and management, higher quality forage production and utilization, better breeding through the use of high quality sires through artificial insemination and selection, improved breeding efficiency, and control of diseases, will provide the knowledge to farmers so major break-throughs in livestock production can be obtained.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. B-5 Dr. Jorge de Alba, Mexico

Title: SELECTION AND TRAINING OF THE LATIN AMERICAN ANIMAL HUSBANDRY POST GRADUATE STUDENT

1. The objective should be to produce a useful man to society in its struggle for improvement and economic advancement.

2. He must be specifically capable of up-grading his profession in his own country in the following approximate order of priorities:

   ... As a teacher
   ... As a researcher
   ... As an advisor to farm business, through extension, banking and government policy making.

3. To fulfill this task a very special man is required, yet, all attempts to reshape his training has to be tempered by the fact that he is already half-schooled by his own college. Success will depend largely on his background. His selection should take these facts into consideration. Then, some criteria should be developed by paying attention to the actual process of selection before acceptance; and, allowance for mistakes in selection with rejection if he fails, upon attempting the real post-graduate work.

4. Selection for admittance should be based on answering these questions:

   a) Is he really interested in Animal Husbandry? This question, which is the most important of all, cannot be solved by asking the subject point blank. The solution is through his own description of his own background and experiences. Very much can be advanced by an interview, if not personal, at least by a person in his country who can be trusted by the selector. Some advance can be made by listening to the opinions of his teachers, especially if known or respected by the selector. The slightest doubt about his sincerity or indecision about his real interests should discard the candidate.

   b) Can the man organize his thoughts and express his ambitions in a coherent manner? This question is easily solved by an exchange in correspondence with the applicant. If command of his native language is very much at fault or the order of his ideas in writing or talking

is disorganized, the man should be considered a risky candidate. Specialized graduate training has no time to go back to these bare essentials.

c) What has been his academic record up to the time of application?

By short interviews or by correspondence at a distance those are really the only points that can be considered prior to admittance. Up to this point, it must be very strongly emphasized, the only person concerned, from the training institution point of view, should be the researcher who is going to act as potential mentor to the student. A head of a department or program may be synonymous with the mentor or selector, but in a complicated larger institution this certainly would not be the case; then the chairman might act only in the final mechanics of putting the candidate in contact with the administration. The latter up to that point has absolutely no role to play in selection, though requirements of health or other paper work may enter eventually in the process.

5. The Latin American circumstances for post-graduate training are very different from those existing in the U.S., Europe and Australia.

Some outstanding facts that support the latter statement are:

a) The Latin American candidate for Animal Husbandry comes from a school where very little research is done.

b) Most of his teachers have had very little experience in the recent advances of the industry, or have had no post-graduate training.

c) The industry our candidate is trying to serve is very distant from the advances in technology that should be the subjects of research.

Taking these points into consideration it seems obvious that no graduate training program can expect to be succesful if it is not prepared to undergo a high death rate within those already chosen as candidates for a degree.

6. In Latin America a heavy selection must still take place in those admitted for training but not yet candidates for a degree. This second stage selection should be based on:

a) Ability and willingness of the candidate to work directly with animals. This should be strongly emphasized in view of the fact that though research problems offer an excellent tool for training, the chances of the candidate finding work or support for serious research back home are practically nil. He must be prepared to be useful to the industry in any technological level. Modern technology cannot possibly advance in our midst if the technician clings to the belief that he can direct practical matters from a distance, without mastering or understanding how to do things differently with animals, machines, laboratory equipment.

b) Ability to think independently instead of following books or notes by wrote. This qualities can be discovered best by giving the candidate a chance to work on a small problem with original data. Also, much can be done by personal contact within the farm operation. There, field problems can be taken as they are encountered and the mentor can pose questionsto the candidate to induce him to use his technical knowledge (some of the details of which might be supplied on the spot by the teacher) and watching if the candidate can make use of the information to solve or understand the problem at hand.

If the pospective candidate shows no promise in mastering his own prejudices or mastering his own mind in handling scientific data for solving practical problems, he should be sent back home. Thus a qualifying examination should not be strictly theoretical but take into account his behaviour in the field and the questions asked should be more in the mental handling of the data than its memorization, or even the abstract understanding of the scientific facts. The latter may be very essential in more advanced environments, but not in ours.

7. A graduate program in Latin America should not waste time with mediocre minds or unwilling bodies incapable of assuming the leadership required of them in the future. Our profession must take into account that if it is going to make future progress to be able to change production patterns and levels it must require that every new member have not only talent but deep convictions. His convictions should nobody a visualization of his own role as a technician. His personal qualities to assume leadership are per-force very different than these required by our colleges in more advanced areas. He must be capable of holding his own technical convictions in an environment in which by tradition politicians have taken the most venturesome decisions that affect society without regard for the technical facts. Our ideal man, it must be remembered, is likely to fall into a field of incomprehension when he goes back home, where the machinery to utilize his training is not already in operation. Necessarily he must be prepared differently than the way it is done in more advanced countries where a nich (more or less adequate) has already been built by predecessors to place the young well trained man upon completion of graduate training.

8. The other side of the coin. The careful choosing and training of selected men is aimed at lessening the probabilities of failure. But on the other hand the young man with ambitious and desires for self-improvement has a very legitimate right to make choices in the institutions he wishes to enter.

A prospective well informed graduate student certainly would not consider applying for entrance in an institution in which most of the teachers had not received a higher degree of training than the one he has. Where the prospective mentor was not outstanding in his ability to perform work in quantity and of the highest quality would be no place for a bright young candidate to apply.

This poses the serious question of the true right of old non-evolving institutions to enter the field of post-graduate training, simply because it has been talked about much and seems to be a modern necessity.

A vicious circle is established in that the young candidate is attracted to apply in institutions where the most outstanding researchers are employed. Nobody should deny their right to do so. But outstanding researchers are largely so because they work where their administrations protect their work with adequate budgets and salaries. Yet we know that, those institutions are specialized in preparing men to be useful to their own societies, not to Latin America.

Under these circumstances the best young men are likely to seek training outside of Latin America. Certainly no young man should be advised to seek entrance into a graduate training center that has no outstanding researchers, no sound long term research programs underway and no adequate budget to provide him with animals, transportation, laboratories and a critical mind to place his inquiry into a logical position in the struggle for new knowledge. In addition, and her lies the most accesible advantage of the Latin American institution, we would advice our young man to seek training where his time and effort would lead to solving local important problems.

Very few institutions within Latin America are really prepared to offer first rate post-graduate training in Animal Husbandry. Where traditions and lack of experienced personnel to inspire them are critical features it seems logical that countries, or at the very least groups of institutions within countries, should work cooperatively to break the ground and initiate higher type training. The lone institution that has had no experience in reaching the frontiers of knowledge with new research or has failed to stablish a steady job for it's better trained teachers, should not attempt under any circumstances to jump into a post-graduate program.

Inter-American Institute of Agricultural Sciences of the OAS
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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. C-1 Dr. O. Paladines, Ministry of Agriculture, Ecuador

Title: INSTITUTIONAL POLICY TOWARDS INCREMENTING THE NUMBER OF LIVESTOCK SPECIALISTS

The relatively general theme that has been assigned to me allows me to explore the establishment of institutional politics which estimulate an increase in the number of livestock specialists from various angles. I believe that, in order to simplify things, I shall analyze the Institutes of Post Graduate Training on one side, and those of Research and Services, together, on the other. Of course I realize that many other types of institutions have a hand in stimulating livestock specialization.

The University or Post Graduate School is fundamentally the contributing scientific element towards the specialization process. For this reason, its training system, or better still the validity of its systems of training in animal husbandry, are the most important stimulus for the specialty to either take impulse or fail as a technical-scientific activity. It should be added that ill trained specialist can only produce more ill-trained specialists and the only logical consequence, is a decrease of interest in that branch of agriculture by the new graduates. It is common to note in the training institutions the development of strong groups of specialities which grow in a disproportionate manner as compared with the other specialties. Generally this is not caused by the institutions not wanting to furnish sufficient backing to all equally but by their wanting naturally to back, at any level, that will be successful. The success of a group will be based on the individuals which form if and generally is derived from the existence of men capable of leadership who generate the fundamental energy to move the group.

I wish to stress the fact that the development of a group is attained only when there is a technical-scientific leadership and that this leadership is the source of energy of the group. This concept can be applied to the entity which trains as the receiving entity of the trained man.

Observing technical programs we note that leaders of good programs were at a time students of leaders of good programs. This condition, not conditional nor passing, is the most important part of the post graduate training. And it should be noted that only the graduate student can absorb the leadership spirit as only he has direct almost intimate contact with the professor.

The foremost policy towards establishing a post-graduate entity is to attain professors of greater capacity and to award the leadership to those that are capable of maintaining it.

Animal husbandry, at any level, is a combination of the science and daily practice of living with the animals. Someone said that one couldn't call a person a cattleman (at this term also includes the specialized technician in livestock) if he hadn't slept in the stable, more than once, taking care of his cattle. Very true. But, a cattleman is not one who has slept many times in the stable and did not take into consideration the scientific complications of the complex problem of production. That is the complete specialist is the practician that can employ scientific knowledge in order to attain an increased animal production. This individual is then capable of planning and undertaking technical programs that are economically successful. The most important problem for the cattleman in all the regions of the world continues to be the management of the animals in their mean surroundings; the only things that change are the grade of control that the individual uses in that surrounding and the scientific level which should be explored in order to find means of control or adaptation to the surroundings.

I don't think I am wrong in ascertaining that the true leader of a livestock training program is he who with scientific knowledge manages to focus the practical problem of production and feels the multiple contact points of one with the other.

If not more important than the part of the trainer (Institution or Individual) the part of the institutions potential work source for the specialists, is more complex and diffuse. The experience in many of the developing countries indicates that the process which is carried out well up to the moment that the individual leaves the post-graduate school, is disastrously interrupted upon reaching his country or institution of origin.

Almost in fairness and certainly by necessity, the specialist hopes that the following conditions will be fulfilled upon his return:

1. Recognition of the work accomplished with success in the Post-Graduate School;

2. Provision of means which will permit him to conceive and carry out the programs within his specialty or to strengthen those that are existant.

3. Gaining a better salary as part of his recognition; and

4. To be backed in his work by the Directives of the Institution.

Analyzing the four points proposed makes us realize that at least 50% of the requirements of the specialist are in the mental attitude of his directives. Undoubtedly the mental attitude of the leaders redounds in the economical backing (the other 50%) necessary for working.

Only the intellectual and technical "maturity" of the institutions would make it possible for points one to 4 be fulfilled. Maturity, however, is a difficult term to define in the case of the institutions. As with men, some grow old without becoming mature. I believe that in Latin America could be made a long list of this type of institutions.

Even at the risk of not having sufficient knowledge, I will try to describe the "maturing" process of an institution.

Birth occurs with an idea pronounced by some individual, in the sense that an institution should be created in order to realize certain purposes. In the majority of the cases, the objectives are enumerated and the interpretation of details are left to the organizers.

Here is where the participation of men capable of maintaining leadership starts (in my sense it is technical leadership, a leadership of capability and action, not a leadership of speeches or figures). The leadership is closely related to the irradiation of strength which leads the others to follow the ideas and accompany the attitudes.

If a newborn institution is lucky to be able to count with real leaders, this is a good way to reach successfully and within a short time its maturity. On the contrary its infancy will be prolonged sometimes until its happy death.

I believe that maturity has been reached in an institution when this one acts directed towards definite objectives and determined goals; when an institution knows the magnitude of the labor that must be accomplished and which is accepted with the surety of having sufficient intellect and material when the institution counts with the sufficient number of technicians capable of making decisions and willing to assume responsibilities no matter what.

The part of the institution in the development of capable individuals is most important. Somebody once told me that in the development of all the outstanding men of science of the modern epoch, were found one or two institutions which had known and had sheltered their genius and had stimulated it in order to further their knowledge. I believe that in the case of the countries of little development of Latin America there is a great subdevelopment of the institutions and of course being the institutions a generation of men, there is a great mental subdevelopment.

There are two concepts that I have tried to define based on those discussed. I shall call them "technical leadership" and "institutional maturity". These are the two fundamental requisites for the development of any type of technical program. The first creates and forms institutions which can achieve their maturity and these at their time shelter the individual who can actually develop his creative capacity.

A good technical program is that one which is capable to effectively contribute to the development of the production, and the technical betterment

of the individuals should comply with the following specific requisites: 1) Should serve for solving well defined problems, actual and future; 2) Should have clearly defined objectives; 3) Should have the sufficient means, intellectual and material.

The leaders of these programs, themselves, should correspond to specific characteristics: 1) They should be technical leaders in their field of action, should have scientific respect and recognition and should have knowledge of the production field; 2) Should be capable of organizing the program administratively; 3) Should be desinterested men and capable of intrusting part of their development and responsibility to the technicians of the organization.

Assuming that the institutions and the leaders do exist, the following paths could be suggested which would permit the increment of specialists capable of being useful to society.

1. Technical preparation

a) Starting with the professional university level, it is necessary to organize Livestock Programs in the universities which would know how to introduce, into the consciousness of the students, the economical, technical and social importance of animal production;

b) Awaken the interest via on introduction into the world of living together with the animals and the caring for them. Periods of work in cattle operations are possibly one of the best schools. This opportunity must be offered;

c) The Zootechnist who leaves the university prepared in this manner has the necessary base for starting to develop his own technical personality. Here is where his leadership school starts. Thus, it is necessary to place him next to technicians capable of exercising their leadership and of training in daily work;

d) Within a short time the individual would comprehend that the knowledge acquired is not sufficient. It is necessary to develop a system of stimulation in order to continue the studies in a post-graduate school;

e) On his return he will be ready to receive and carry out specific technical responsibilities: This will be his "leadership test";

f) The final step in his preparation ladder is selection. If he passes the leadership test, then he is a technician destined to being useful to the program and to society.

2. Systems of stimulation

a) Assigning responsibilities. In my opinion, this is the stimulus which develops more rapidly the personality and technical capacity

of an individual, since it implies recognition and confidence in the work performed and is an implicit assertation that he is capable of managing his work projects and of taking care of the men and goods assgined to him;

b) Provision of work elements. In the modern technique and in the development of the creative capacity of a particular person, there exist a very ample series of work elements, many of which are indispensable; these should be foreseen. Slightly insufficient equipment and material will allow the man to develop his inventive and adaptation capacity. The excess of means could be harmful. In the institutions it is necessary to provide material growth with intellectual and technical growth in the work programs.

c) Salary. It is logical that the technician, like all men, needs to have available sufficient economical means in order to live and live well. A fair salary for this reason is fundamental; but just as important as the amount of money is the establishment of increment scales according to the dedication, the technical achievement obtained, and the execution of technical leadership. However, a good salary does not buy, in any manner, the technical and intellectual capacity of the men. It is only a system of stimulus.

3. Intellectual interchange

The institutions which close their doors to the flow of their technicians towards the outside and viceversa, are closing their doors to intellectual progress. The exchange of men make possible the exchange and development of ideas. In Latin America, with the great scarcity of institutional resources, can be developed the idea that the personnel trained by this institution should remain in it almost like one of their property goods. This is very serious mistake because, even if he is legally retained, he definitely would not be able to accomplish the developmental and leadership processes since what is retained is his presence and not his capacity.

I think it convenient to point out that this voluntary interchange, and competition for trained individuals, should be extended to private enterprise since there should be a great potential for technical development which can be translated into economical development of the countries at giant steps.

Inter-American Institute of Agricultural Sciences of the OAS
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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. C-2 Dr. J. V. Bateman, IRI, Brasil

Title: INSTITUTIONAL POLICY DEVELOPMENT FOR PROVIDING EXPERTS TO DEVELOP ANIMAL INDUSTRY IN LATIN AMERICA

Before rational policies can be developed there must be a clear idea of needs and goals of agriculture. Determining a goal is relatively easy. If any attempt is to be made to feed the growing population, the ultimate goal of agriculture must be improved productivity, defined as yield per unit of area. Determining the needs is more difficult. An analysis of the situation and continual up-dating of this analysis is, an will continue to be required. As cattle, both dairy and beef, are the most important domestic animals in Latin America, they may be used as a starting point for an analysis of what will be needed to achieve a greater and more efficient livestock production.

Although the yield of animal products is low, there are vast numbers of cattle in the area. Brazil, for instance, had 79,078,000 head in 1962. Salughter for that year was only 6,989,000 head, about 8.8%. By comparison the United States, with a beef herd of 98,034,000 head, slaughtered 34,759,000, an extraction percentage of about 34%. Although in size the Brazilian herd was 80% of the US herd, only 20% as many Brazilian cattle were slaughtered. Obviously an improvement in the Brazilian extraction percentage could reasonably be expected.

Because this situation is typical of many countries in South and Central America, development of the cattle industry will be principally a problem of improving management to secure greater returns. Unfortunately, knowing that better management is needed, and getting it, are two vastly different things.

What hinders the application of better management practices? Many things! Lack of incentive, lack of knowledge, lack of skilled people and lack of capital, to name a few. Not one is simple and all are interdependent. Lack of motivation ranges all the way from earning more gross than one needs from small unit profits on vast numbers, to not producing a better animal because it will cost more and one is only paid so much per head, or per kg., regardless of how good or how bad the animal may be. Lack of capital is closely associated with lack of incentive. Solving the latter problem will automatically attract more capital. Lack of knowledge affects all aspects of animal production. In almost every case the most urgent need is a knowledge of how to adapt known information and principles to solving local

problems. Lack of skilled people is the principal block to securing improved management.

What is improved management? Basically, it is the employment of improved technology. Specifically it is:

Providing adequate feed and nutrition
Controlling parasites
Controlling diseases
Improving breeding efficiency
Using improved culling practices
Using improved handling practices

Improvement in the application of these practices will improve yields of national herds, which will be reflected by higher extraction percentages. You will note that better breeds of livestock is not mentioned. This was not an oversight. Unless the above practices are improved, there is little point in worrying about what breed of cow you have. These same skills will be needed with whatever breed may eventually be used. A short course in thermodynamics or elementary physics and a little thought should dispell the dream of developing a cow that will produce on a starvation diet.

Fortunately, productivity is more related to technology than to capital investment. Therefore, improvement in productivity may be expected from the small farmer as well as from the large farmer, if better technology is employed by each. Employment of technology to improve production can only be made through management at the operating level. All efforts must be channeled toward improving management on the farms. The policies of our instituions must be shaped to produce the experts needed to insure that the improvement of management becomes a reality.

No matter how expert and prolific the investigators are, there will be no progress in development of the livestock industry unless their discoveries are put into use. Only the farm managers, herdsmen, cowboys and milkers are able to apply those discoveries to actual production. A great deal of teaching and field work are required before most research developments have an impact on production.

Research has show how to milk and how to handle the milk to avoid contamination, contamination that will, at best, cause storage losses and, at worst, constitute a danger to human health or life. These methods, and particularly the reasons for them, are not self-evident. To a person without the background of a scientific education there are no apparent cause and effect relationships. The methods and the theory behind them must be taught to milkers, milk handlers and their supervisors. Until this is done the findings of the researcher are of little value except to impress his contemporaries. They certainly will not affect agricultural production.

The researcher should not be expected to teach the use of his discoveries to those who will implement them. If his abilities are to be used to a maximum he doesn't have time. He may not be capable of teaching. He may not speak the same language as the workers, wither literally of figuratively, and he may

not know how to apply what he has discovered. The lines of communication between him and the manager are established and staffed by other experts, for example, extensionists. These lines of communication must be ample enough to handle the two way communications that are essential to the continual development of an industry. Once the recipients of research information are convinced that these people with new and often weird ideas have something to contribute, they will begin to request help in solving problems that have not yet attracted the attention of researchers. Such questions are the life blood of research institutes. There should be no fear that the unsophisticated members of societies in primitive agricultural areas will fail to ask important questions that will contribute to improved productivity. Several years of experience in dealing with illiterate of functionally illiterate workers, as well as with graduate students, has taught me that degree of literacy is not a measure of intelligence. I am convinced that an intelligent illiterate is a far more practiced observer than a highly literate person of equal intelligence. Unfortunately, his very limited background does not enable him to interpret his observations correctly. Once these people found that an effort would be made to answer their questions, it was soon evident that their range of curiosity exceeded that of most students. Furthermore, using some of their questions in qualifying and final examinations of graduate students caused a good deal of consternation among students, and even among staff members.

Many types of experts will be needed to improve management. In addition to expert cowboys, milkers, creamery men, herdsmen and managers, animal industry needs expert extension agents, expert extension subject matter specialists, expert medical veterinarians, expert animal husbandmen, expert teachers, expert researchers, expert processors and expert marketing agents. All are needed, and any development plan that fails to provide a means of training any one of these groups is doomed to limited success.

Recognizing that a variety of expert types is needed to develop a livestock industry, we are faced with the question of what type institutions must be developed for training them. Obviously, they cannot all be trained in the same type institution. It should also be obvious that developing institutions for only one segment will not be enough. Modern methods are too sophisticated to trust them to the untrained at whatever level the lack of training occurs.

Several types of institutions have been proven by use in agricultural education in other areas. These are extension services and through them the rural youth clubs, special courses in primary and secondary schools, semi-professional trade schools, undergraduate universities, and graduate schools. Although the exact form of each of these has not been the same in all countries that have used them, their success has been well proven as has their ability to complement each other in providing experts to develop agriculture in general, and animal industry in particular.

Each of these institutions must be staffed and, expect in the case of the graduate school, the final step in the formal education of a staff member is provided by a higher level institution. On the other hand, the university should be involved in the training of all experts needed to <u>teach</u> animal industry.

The general trend is to train teachers for all schools at the university level. Extension agents, too, are usually unviersity trained. Extension subject matter specialists must be university trained because their function is to put the highly technical reports of researchers into a form that extension agents can understand and pass on to the farmer. The university should also train some of those going to the farms as managers and all those going on to graduate school for a more specialized education. The university, therefore, will be very much involved in turning out "experts" of many different types, and must consider their varied needs.

With the primary mission of experts in animal industry being to increase output by improving management, they must be taught the various skills of managment. This will require men who know how to manage and who have the herds and facilities to test and develop new management practices. Fortunately, to some extent these facilities can also be used for teaching. Herds and facilities will be needed by graduate schools, universities and schools dedicated to training semi-professionals.

Each institute must have a clear policy on the establishment and maintenance of herds and facilities for animal industry. The institutional administration must understand that these are more expensive than experimental facilities for agronomy. It must also understand that maintaining livestock requires constant attention and support. It is not possible to let herds and pastures lie fallow between experiments, as may be done with agronomy experimental fields. Livestock herds and facilities cannot contract and expand on a year to year basis.

These herds and facilities cannot serve their purposes if the teaching and research staffs are concerned with them only on the day they are to be used for a laboratory class. The herds, pastures and creameries must be actively managed by teaching and research personnel. It is an unfortunate fact of life that livestock enterprises need attention seven days a week and 365 days a year. Herd management and operational tasks do not conform to office hours. Institute herds will always suffer from poor management and be inefficient tools of research and teaching until the staff and administration realize that they must be managed by scientists and not turned over to untrained labor foremen. Turning herd and pasture management over to responsible but untrained foremen is often justified on the grounds that they are practical and cheap to hire. A very apt definition of practical that fits in this case is "one who practices the mistakes of his father". The low wages of these men are also a delusion. Their use is very costly. There should be no place for such a manager in a university or other research herd, both of which should be dedicated to demonstrating proper management. Students must learn by example that active management by trained personnel is necessary for efficient production.

Policy must be established as to who will be responsible for the active management of the herd. Care must be taken in formulating this policy to ensure that it does not become a policy of how the herds will be managed. The "how" of how they will be managed whould be the subject of the research experiments under study. Administration must supply sufficient funds to secure trained men to aid research and teaching personnel. Ideally, these should be young men who will later move up to become leaders in teaching and research.

To teach livestock practices effectively, the teacher must know how to perform the actual tasks as well as how to teach them. Therefore, university students must be taught these skills. It cannot be assumed that they will have had livestock handling experience before entering the university. ninety-nine times out of a hundred, the Latin American student will come from the city and not the farm. He cannot be expected automatically to pick up the experience sooner or later. The longer acquiring the skill is delayed, the less chance that he will ever gain it. After he reaches a certain point he will hesitate to put himself into a position that will reveal his lack of ability. One point in policy should be to establish training in animal handling skills for all students.

Assuming that training will be available in different types of schools, the natural course of events will bring up the question as to whether it will be possible for the graduate of a semi-professional school to move up to one on the higher level and receive credit for training already acquired. There are many good arguments that he should, among them the success of those who already have done so. Graduates of two such Latin American schools have done very well when they were accepted into U.S. universities and received credit for studies completed in the semi-professional school. These schools are Escuela Agrícola Panamericana, El Zamorano, in Honduras and Escola de Lacticínios Candido Tostes in Juiz de Fora, Brazil. Not every graduate could make the transition nor should each be encouraged to try. Selection should be similar to entrance to graduate school from the university. Only the best qualified are accepted. This type mobility within the educational systems of Latin America is not usual. The advantages should be considered and a policy established.

In this same line there is another type of educational mobility that will be encountered. It is that of the successful semi-professional school converting to university level education, This is a natural aspiration for energetic and ambitious teachers and administrators. In view of the need for both type institutions, any conversions should be carefully considered. What will take the place of the semi-professional school when it becomes a university? If no replacement semi-professional training is planned, such a conversion should be discouraged.

Within the institutions engaged in research there must be some policy on what kind of research should be undertaken. Herds and facilities for research designed to improve management imply that research will be applied research. This is as it should be. Until yields are more nearly equal to those in more developed areas all available resources must be used to apply known principles and techniques. A clear policy on this point will avoid some of the controversy over basic versus applied research in the universities and graduate schools. Valuable as its potential may be, research guided only by the researcher's academic curiosity is a luxury that must wait until production is high enough to pay for it. Until a country's production has been increased enough to support the population at the desired level, the more affluent countries will have to support this type research. This does not mean that the researcher with a more abstract inclination does not have a place in the research needed. Adapting known methods and principles to new conditions is not a simple matter of applying a procedure. Analyzing why an imported method does not work will lead into research basic enough to satisfy anyone. Solving the problems

thus uncovered will require the best minds available. These minds must be better and more broadly trained than those needed for the academic type basic research. Basic research that is developed as the result of the needs of applied research should appeal to administrators. Justification for funds is easier when their use can be related to problems the legistaltive bodies can identify and understand. Care must be exercised in the involvement of administration in determining what constitutes support of applied research. Judging the relation of research to the basic problem should be a function of scientists, not administrators. However, the scientist must be ready to make the justification.

Producing more animals will be of little value if animal products do not reach the consumer in good condition and by an economical route. Progress must be made to improve handling and marketing.

Safe and sanitary processing of food is dependent upon biological facts, and conditions must be standardized to conform with these facts, regardless of the country or climate. In general, processing methods may be utilized without modification. These methods are quite sophisticated and require rigid quality and sanitary controls. Applying such controls requires trained men who must be supplied by the semi-professional schools and universities. Men will be needed in the processing plants, in control laboratories of processing plants, in regulatory laboratories of health departments and to do research on new products and modifications in older products to satisfy the tastes of a new body of consumers. All these men must know how and be able to do the plant work.

This training may be under animal production or under food technology departments. Who gives it is not so important as the fact that the training must be provided for those who need it. The agricultural student who needs special training must be able to acquire it without preparing for another degree. Milk handling is an excellent example. Quality and sanitary control must be constant from the cow to the consumer. A policy of flexibility in the courses required for graduation must be adapted to meet the requirements of those needing information from different departments.

Food technology and production cannot remain strangers, each devoted only to its own field. Modern marketing and often modern processing machinery require that crops be tailored to the needs of the processor and the consumer. This has had its parallel in animals, too. Turkeys have been made both smaller and larger to meet marketing demands. The pig, too, has been and is being revamped to suit changing consumer preferences. Who knows what the future Latin American consumer will demand when he has his needs satisfied and can begin to indulge his tastes?

I have discussed some of the problems and issues involved in improvement of animal industry, that indicate the types of agricultural specialities needed. I hope that it is clear that I believe no one type of institution can provide all the needed experts.

To recapitulate, providing specialists for the development of Latin American animal industry will require a definition of goals and institutional

policies on:

1. Types of institutions to be developed.
2. Relative roles of these institutions.
3. Mobility of students from an institution of lower academic rank to one of higher rank.
4. Subject matter fields to be covered.
5. Provision of herds and facilities and their financial support.
6. The use to which these herds and facilities will be put and the desired goals.
7. Who will manage these herds and facilities at the operational level.
8. The degree of practical training a student will receive.
9. The flexibility that will be permitted in tailoring a course of studies to fit the specific needs of a student.
10. The basic subjects that all students will be required to take before specializing.
11. What provisions will be made to insure that all specialized training units will continue to turn out graduates who will complement those of other specialties in reaching the final goals of improving animal industry.
12. The type of research that will be conducted.
13. Provision for publishing research results.
14. Provision for getting results into the hands of those who can use it.

Close cooperation between all the different types of institutions will be essential to reach the ultimate goal. The graduate schools must take the lead in formulating policies that will enable them to train men who will be prepared to join the staffs of other institutions and provide the leadership so urgently needed.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. C-3   Dr. R. S. Temple, FAO-Tecnological Institution of Monterrey, México

Title: DISTRIBUTION POLICY DECISION DUTIES AND RESPONSABILITIES FOR EFFECTIVE ADMINISTRATION IN ANIMAL SCIENCE TEACHING AND RESEARCH UNITS

> "The needs of the livestock industry in all countries were changing so rapidly that educational facilities and the curriculum should be flexible and capable of change in response to rapid changes in the structure of the livestock industry." FAO International Conference on Animal Husbandry Education. Göttingen, Germany 1966.

In developing this topic it has been kept in mind that the Panel is discussing "Postgraduate Education and Associated Research for the Support of Livestock Development in Latin America". Postgraduate should be underscored as one treats this subject somewhat differently than he would undergraduate teaching. However, thought has to be given to the undergraduate opportunities when discussing postgraduate training. At present, the type of training received at the undergraduate level is highly variable from country to country and even within countries. Some institutions give a scant requirement occupying a period of four years or less following "colegio" or high school training, while others require five to six years and some require a thesis. Some students desiring postgraduate training in animal science might even reach this point with little or no training in animal management.

In ascertaining how policy decisions, duties and responsibilities should be distributed for effective administration it is necessary to determine what decisions, duties and responsibilities are necessary. In this paper, three major decisions will be discussed: 1) What are the needs of teaching and research at the Institution level; 2) What will be the program of teaching and research at the Animal Science Department level; and 3) What should be the scope of activities of the individual teacher/researcher.

What are the needs of teaching and research at the Institution level?

Animal Science teaching and research is necessary in practically all environments, although in some areas, livestock production is limited either by the environment or the competition with more intensive agriculture enterprises or industry. The decision has to be made by the institution in cooperation with members of the livestock industry, as to what the animal production program will include. Where livestock production is very important a large animal science program will be required.

In most of Latin America the livestock segment of agriculture is important in comparison to other agricultural enterprises, but in some cases the actual needs are vague. Formal surveys of needs for education and research facilities are sometimes taken and are used for sound developmental planning. Such surveys

are often made by such organizations as F.A.O. or U.N., World Bank or the various Foundations. Every effort should be made to determine the real necessity of such facilities. If costs for establishment of facilities within a country are so great that economic benefit is doubtful over a given period, then other arrangements for postgraduate training will have to be made. This would include sending students to other countries or the establishment of regional centers of education. An example of such centers could be institutions for teaching and research in general disciplines such as Tropical Animal Science.

Tropical Animal Science needs much investigation as it is a relatively new scientific field. Therefore, the tendency at present is to set up many tropical research stations. The question arises as to how much of the teaching and research can be carried out at existing institutions without creating new facilities. For example, cooperative efforts among countries may be the most feasible. National pride always tends to put pressure on having schools and research institutions within the country; however, from an economical point of view, there is a great deal to be said for having "regional centere of excellence". This idea has certainly been tried at Turrialba and the pros and cons of this institution serving Central America and part of South America has been discussed.

Several large North American Universities are now developing centers of excellence in various fields of endeavor but these are located and financed within the Country. The one thread which becomes bare very rapidly in discussions concerning regionalized institutions where several countries are concerned is that of "nationalistic attitude". To have a successful intercountry institution there must be a true spirit of international cooperation through economic as well as intellectual support.

Intellectual support is often as important as economic support in developing countries because many do not yet have enough adequately trained personnel to carry out postgraduate teaching and research programs. In fact in many case there are not enough undergraduate or even middle level trained personnel.

Recognizing the need for people with training below the University level The FAO International Conference on Animal Husbandry Education, held in Göttingen, Germany in July, 1966, recognized that, "...in many countries, and particularly developing countries, the greatest quantitative need was for certificate training in animal husbandry and production (i.e. above the high school or secondary school level but below the university degree level) and that the maximum utilization of the services of such trained personnel could be a vitally important element in expanding animal production".

The Göttingen conference also recommended that the attention of member governments of FAO be drawn, "To the importance of developing countries taking immediate steps to ensure that their own nationals were trained as animal husbandry specialists, veterinarians and agronomists at the highest level either abroad or in their own countries so that each country could establish its own development policy in animal production and thus become as far as possible independent of external assistances." These two recommendations point to the need of all levels of training in the developing countries so that there can be, in the future, a greater supply of intellectual support.

Obtaining economic support of a continuing nature for an international institution is often difficult. To have a successful institution, there has to be a strong drive and interest on the part of one organization (preferably a union of the various countries or bodies concerned) or one individual to see that economic support continues. Contrary to the opinion "once it is running it will take care of itself", continued strong guidance is necessary. The over-all responsibility of getting funds for institutions, either new or old, generally lies with the administrators, however, individual researchers have a tremendous impact in getting funds from industry. In some cases, this may be the only way he can expand his program. Institutions which are supported by the state of federal governments, are often threatened by austerity programs and therefore search continually for other sources of funds. But the professor should if at all possible, have some security of a continuity of resources. Otherwise, wise planning is extremely difficult and often times inefficienty results. The point should also be stressed that the individual researcher/teacher should have at least some, if not complete authority over his own budget. Therefore, fund raising has to be considered a joint responsibility of the administrator and the researcher and the success of this task is one of the limiting factors affecting the size or scope of research and teaching activities.

The whole determination of scope of activities including budget and intellectual support should be considered by a group with a broad spread of disciplines and knowledge. This planning should be done with as little bias toward one's own discipline as possible since animal agriculture involves so many related fields. These have to be integrated for true success. Perhaps it will be the feeling of this group that it is highly redundant and maybe even insulting to make this point, however, progress is often deferred or diverted by bias and selfishness toward particular ideas, traditions and disciplines.

Dr. O. G. Bentley, Dean of the College of Agriculture, University of Illinois, has pointed out that some of the early responsibility of developing teaching and research stations in the United States of America came about with the passage of the "land-grant" act and establishment of the Department of Agriculture in 1862 and the creation of the agricultural experiment station system in 1887. This was a cooperative effort involving people and sources of funds from many states and disciplines. Perhaps the problems were fewer and the horizon less far off in the late 1800's in the U.S. than they are in many nations today, but it challenged us even more to employ ourselves and our resources at a level of sophistication in animal science research and teaching never before utilized. But the same cooperation and the same ideals of goals, as applied by the U.S.A. and, in deed, by many other countries, can be applied today in developing countries.

<u>What will be the program of teaching and research at the Animal Science Departmental level?</u>

The general departmental program has to be broad so the department can offer a range of activities within the limits of facilities and funds available. It will normally include the general areas of animal nutrition, physiology, genetics, management, and pasture management. It may include some additional specialized disciplines such as meat science, livestock marketing and economics, population genetics, etc. In addition, the departmental program depends on the

supporting departments in the institution and the courses they offer. For example, if a veterinary faculty exists, they can teach animal physiology, anatomy, and related courses. Courses in livestock economics and marketing can be offered by the Agriculture Economics department.

As discussed before, the improvement in teaching and research programs is determined largely by funds and the availability of adequately trained personnel. If sufficient funds are available then adequately trained personnel can be hired from other countries if they don't exist within the country. But to effect a "reverse brain drain" into the developing countries not only takes money for salaries, but it also requires giving adequately trained personnel the opportunity, through facilities and academic freedom to develop a program which continues their intellectual stimulation.

Now, let us assume that we have funds and professional staff. What type of program should the department choose? The School of Agriculture in conjunction with the Department of Animal Science should make the over-all policy decision and take the general responsibility. A program for Animal Science certainly has to be integrated with other disciplines. Dr. Ralph W. Phillips, Director of the International Organizations Staff, USDA, in referring to developing livestock production in developing countries has stated that "...an integrated approach is essential if man's ever increasing needs for food are to be met, in respect both to quantity and to quality from an efficient, balanced agriculture". This philosophy certainly should be adhered to in the developing countries and especially in educational facilities. A more narrow, strict, fundamental approach to particular problems of Animal Science can be accomplished or at least sponsored by the more developed countries. However, even if integrated planning is practiced at the Institutional or the College of Agriculture level, specialized fields of interest can exist, but they have to be part of the "large picture" and contribute to the integrated approach. A good example can be drawn from beef production research. The nutritionist, geneticist, physiologist, economist and marketing specialist, as well as the range specialist and agronomist all have integral parts in improving beef production. They can carry on their specific areas of work but they need to be tied together through a common approach. Some of the work of the nutritionist, bio-chemist, or physiologist might, in a sense, even be considered to be "pure" or "fundamental" research. We can all recall the early work on hormones--fundamental research until Stilbestrol, then it was applied; or the physiology of sexual mating of certain flies--the study developed into the irradiation of the male screw worm fly and it immediately became highly practical!

But the point to be emphasized is that there needs to be more projects with the integrated approach--not just to say, "we are studying how to increase livestock production through the most economic means", but definite goals, sub-goals and project objectives have to be planned so that the smaller individual projects can contribute to the over-all objectives. In developing an integrated, or perhaps we may say a coordinated, approach to animal science, the old projects and/or courses need to be looked at very carefully. Many changes in individual projects and courses may have to be effected.

What should be the scope of activities of the individual teacher/researcher?

The decision of what to include in particular postgraduate courses and what should be done in the associated research depends on: 1) the facilities which are available; 2) the staff available (or planned to be available); 3) the educational background of the potential candidates; 4) the funds available; 5) the environmental conditions of the area; 6) the cropping and grassland production and potential of the area; 7) the types and breeds of livestock available; 8) the traditional methods of livestock production and agriculture in general; 9) the economic situation of livestock production and probably other factors. All of these factors should be considered in planning a curriculum and the courses.

A specialist in a particular discipline of livestock production or teaching who is faced with the task of assisting the setting up or improvement of postgraduate education and associated research may hardly be able to "see the forest because of so many trees!" He has to consider the above factors and in addition, the results of the policy decisions, duties and responsibilities of all concerned above him in the chain of command. Also if there is inefficiency and/or poorness of pre-planning at the higher levels these problems may "settle to the bottom". Therefore, very strong people are needed at the ground level as researchers and teachers. It is readily recognized that the younger professional people with less experience need to start "at the bottom", but the point of discussion involves the professional people, teachers and researchers, who are guiding and carrying the load of responsibility. They need to be able to make important decisions.

The policy decisions with which the researcher is faced include the choice of actual projects, the methods of study, design and analysis and the interpretation of the data. The teacher of postgraduate courses needs to decide what material will be included in the course and how the material is to be taught. He may find that certain curricula at the undergraduate level were not available to properly prepare the students.

In presenting a paper recently on "New Dimensions in Instruction" to the American Association of State Universities on Land-Grant Colleges", Dr. Duane Acker, Dean of the College of Agriculture and Biological Sciences of South Dakota State University, pointed out that many universities are making new curricula available to undergraduate students. These are in response to the needs of society in managing natural resources as well as meeting the demands of expanding industries. He found out that in many U.S. universities, "...enrollment increases in agriculture have been primarily in these natural resource. related curricula and Animal Science...From about 1956 to 1965, a high proportion of colleges of agriculture developed, within their majors or curricula in traditional agriculture, options in science, production and business. There was a growing realization in the 1950's that 25 to 50 percent of the graduates of animal science, agronomy, or similar curricula take their first employment, and may remain in the non-farm industries allied to agriculture".

This specialization at the postgraduate level and certainly the increase in technology will demand a greater degree of specialized knowledge at the higher degree levels. It will probably be only a matter of time (and of course planning!) until a doctorate will be offered in Agri-business, Tropical Animal Production, Animal Behavior, etc. These are examples of what is happening in

a highly developed educational system and the creation of specialized curricula in developing countries is even more important. The curricula in developing countries may not be as highly specialized or advanced as suggested above but certainly attention has to be given to the special needs of the country or area. In fact, the opportunities for future development of specialized educational and research institutions are very great, in deed, for the developing countries. International Agriculture is only in its formative years and there are many opportunities for developing strong systems for international education.

It is important in the first stages of planning curricula that the researcher/teacher be included in some of the larger more important policy decisions reached at higher levels especially, since he has the responsibility of carrying out the action of these decisions. There are several more or less obvious reasons for this: 1) he is closer to the students and knows their needs; 2) he may see bottlenecks and pitfalls that the pure administrator may fail to see;3) he will generally be cautious as to what the program promises; 4) he probably has the best understanding of just how much financing is needed; 5) he will take a greater amount of interest in the project if he was involved in the planning; and 6) it is only fair that if he is going to be responsible, he has an active part in the planning. In fact, if he has not had the opportunity to be in on the pre-planning of the project as a whole, he can hardly appreciate all the reasoning behind the project and the real goals.

The most important duty and responsibility which the teacher of postgraduate courses has is disseminating the best knowledge available to his students. It has often been said that "there is no teaching until the student has learned". The ability to stimulate students may be a gift or it may be gained through experience, (or most likely, a combination of both) but it is an absolute requirement of a good teacher, even at the postgraduate levels. This responsibility cannot be delegated to anyone else. Granted, postgraduate students, as do undergraduates, receive a lot of stimulation and scholastic assistance from one another, but it can never be substituted for what the student receives from his major professor. The professor makes a fatal mistake when he relies on this method of teaching as a major proportion of the teaching process.

Dr. Acker related that many American universities have teacher workshops and awards programs aimed directly at improving the effectiveness of the instruction and stimulation of the teacher and quoted several universities where the College of Agriculture faculties have "agressive and productive" seminars. Many professors of Animal Science have not had training in teaching methods. Therefore, some basic fundamentals on teaching and use of visual aids can be of great use. Professors who teach postgraduate courses and guide research sometimes certainly need some stimulation. This can also be accomplished by sabbatical leaves or other types of periodic study. Exchange teaching or research assignments can be worked out with other universities which offer a great opportunity of broadening ones scope.

Realizing his responsibility to the student, the professor of postgraduate teaching and associated research is faced with a real problem of deciding what to include in the training. In reading material from various teaching symposiums

and from meetings on international programs of livestock development, one may first read, "The student of agriculture today must be a specialist following very specific lines of training and research" and then turn to another article which stresses, "A most significant change in teaching animal agriculture is the growing need for broad training so that the student can adjust to differing methods and systems of livestock production". When one tries to fit the student to both molds he may run out of material to fill the molds! The more general approach may be more appropriate for the student in the developing country, at least for the next 10-15 years. However, often times a man may dedicate the early years of his life to a technical field and later, through experience gained, he may work in a broader, more general area. This often appears to be the case in international agriculture.

Since there are these choices and so much information to offer, the professor may have a tendency to "over-stuff" the student. He may follow an approved course outline, but often adds so much interesting, but extraneous, material that part of the course is slighted. And, in deed, the extraneous material may be more up-to-date and of more use to the student than material which is included because of tradition. But, nevertheless, the course outlines, if well designed, should be followed using extra material only as examples. The material which is included in the basic outline must take into consideration what supporting courses are available and how much background, on the average, the student have. The student will have to "dig-out" a lot of the information for themselves, especially in areas of extreme specialization. This implies of course, that the students have available adequate library facilities and the necessary tools to be able to "dig" the information.

In the foregoing discussion, three levels were defined where decisions concerning postgraduate training and associated research are taken: 1) Institutional, 2) Departmental, and 3) Professorial. Perhaps a fourth should be added; the student, as he too takes decisions. The students responsibility should not be minimized as he is the ultimate recipient of the success or failure of the postgraduate training program. His decisions relate to what are his best possibilities for a succesful and rewarding life after he finishes his training. He will decide to work in a certain discipline if he knows that future employment if lucrative and satisfying. He will pick the institution which has the reputation of turning out top candidates. Therefore, his reaction to the postgraduate training offered by a department, or indeed an institution, is a measure of the success of the program. His opinion and suggestions for changes should be included in any evaluation.

The distribution of policy decisions, duties and responsibility for effective administration in animal science teaching and research units depends a great deal on the institutional structure and chain of command. The point has been emphasized that part of the responsibility for initial planning of programs, distribution of budgets and construction of facilities must be given to the teacher/researchers themselves.

Animal Science is a science of its own right and is of age in a time when all of its arms and legs are necessary for meeting the demands which the protein hungry world is placing upon it. It will mature even more in the next years as it faces many complex problems and it will be nurtured by the desires for animal improvement by those "arms and legs" the animal scientists.

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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. C-4 Dr. M. B. Willis and Dr. T. R. Preston, Institute of Animal Science, Cuba

Title: THE DEVELOPMENT OF RESEARCH PROGRAMMES TO ENSURE CONTINUITY IN THE FACE OF POLITICAL CHANGE

The implication in the title of this paper is that research programmes, particularly those in developing countries, are liable to modification following changes in the political climate. We are not convinced that this belief is valid. In fact, the principle objective of this paper is to show how, if research and education programmes are properly orientated, they need not be susceptible to political pressures.

We believe that in those cases when research programmes have been jeopardised as a result of political changes this has arisen in the majority of cases through inadequacy on the part of the researchers rather than excessive interference on the part of politicians. When well-orientated research has been affected by political change (e.g. the situation with regard to soviet genetics following the rise of Lysenko) there would appear to be no solution.

TERMS OF REFERENCE

Since our basic interest is in the development of the cattle production we have confined our discussion and examples to what is relevant to the cattle industry in general and to Latin America in particular as this is the area of the world with which this conference is mainly concerned. Although our specific brief was to discuss research programmes we nevertheless believe that these cannot be divorced from education and commercial development.

REVIEW OF PRESENT SITUATION

Research and development

Although there are many universities throughout Latin America the majority of them undertake little or no research in animal production. Of the independent institutes the best known, and effectively the only ones doing research of any consequence, are the IICA in Costa Rica, the ICA in Colombia and our own Institute in Cuba. In table 1 we have analysed these Institutes and other organizations in Latin America according to their contribution to the major international scientific journals and other scientific publications. The basis of

selection was the appearance of a summary in either Nutrition Abstracts or Animal Breeding Abstracts during 1968. Of the total papers published in cattle production only some 2% were from the Caribeean and Central and South America. This is a disprportionately small ratio particularly when it is compared with the cattle population of these areas which represents some 22% of total world cattle.

TABLE 1. Scientific papers produced on cattle production (1968)*

Country	Papers in		
	Major Journals	Minor Journals	TOTAL
Argentina	—	4	4
Brazil	—	7	7
Chile	—	6	6
Colombia	—	3	3
Costa Rica	—	6	6
Cuba	2	4	6
Panamá	—	1	1
Puerto Rico	—	5	5
Venezuela	—	4	4
West Indies	—	1	1
Latin America	2 (0.7%)	41 (2.7%)	43 (2.4%)
Rest	268	1487	1755
World	270	1528	1798

* Abstracted under general heading "cattle" in Animal Breeding Abstracts (1968) and Nutrition Abstracts and Reviews (1968).

In table 2 we have listed the cattle populations and the average *per caput* consumption of animal protein of the countries in Latin America. Only in the Argentina and Uruguay is there any equating of human population and animal protein intake. In addition to the need to feed the indigenous population there is a comparable need, often deserving priority, to earn foreign exchange in order to finance general development programmes. In this respect contrasting in marked fashion with their potential for cattle production. That production is low is not surprising in view of the FAO/UNDP report on Central America (1968) in which it was stated that calving rate was only 62%, overall mortality 13% (in young stock 22%); the average slaughter age of steers was 4.4 years and the productivity a mere 27 kg. liveweight gain/ha. This can be compared with a potential which we can, in fact, achieve, of some 1,200 kg. liveweight gain/ha, using productive crops (sugar cane) and intensive feeding methods applied to genetically superior cattle (Preston, 1969).

TABLE 2. Relative cattle production in Latin America

Country	Cattle/head of population	Animal Protein g/day		Beef[a] Production per head of kg/year		Beef[a] Exports per head of kg/year	
		Meat	Total	Cattle	Population[b]	Cattle	Population[b]
Argentina	2.07	44	59	51.3	106.2	8.53	17.7
Bolivia	0.57	8	13	13.7	7.9		
Brazil	1.07	10	20	12.7	17.1	0.23	0.25
Chile	0.33	12	28	46.6	15.4	Imports	
Colombia	0.80	14	26	27.7	22.2	0.19	0.16
Costa Rica	0.74	8	20	24.3	18.1	6.40	4.77
Cuba	0.85	--	--	29.1	24.9		
Rep. Dominicana	0.27	7	22	23.3	6.4		
Ecuador	0.39	8	14	21.4	8.4		
El Salvador	0.30	5	15	38.0	11.5		
Guatemala	0.26	4	9	28.2	7.2	5.04	1.29
Honduras	0.73	4	12	13.4	9.7		
Jamaica	0.13	8	23	58.3	7.6		
México	0.75	9	24	13.1	9.9	0.84	0.63
Nicaragua	0.76	6	29	11.5	8.7		
Panamá	0.78	13	25	31.7	24.8	1.39	1.09
Paraguay	2.61	17	23	21.1	55.0	0.18	0.47
Perú	0.30	8	20	22.3	6.8	Imports	
Puerto Rico	0.18	--	--	41.1	7.5		
Surinam	0.11	6	16	23.3	2.6		
Uruguay	3.05	45	69	28.2	86.2	6.57	20.1
Venezuela	0.74	10	25	25.2	18.7		
U. S. A.	0.55	35	67	85.8	47.5	Imports	

a Carcass

b Human

The above mentioned FAO report considered that the poor productivity was due to deficiencies primarily in middle-level technicians. As a solution to the problem the report called for greater research on pasture utilization and forage conservation together with the introduction of grass-legume associations. This report echoes the kind of conclusion drawn with unfailing regularity by this organization in nearly all the developing countries with which FAO has worthwhile development in livestock production in these countries; it is a conclusion with which we are in profound disagreement.

It is extremely naïve to believe that one particular crop can possibly be the solution to cattle production throughout Central and South America; it is equally naïve to imagine that pasture is always cheap particularly when plans are put in motion for improving its natural productivity. Finally, beef and milk production are not simple entities, each comprises two distinct phases,

one of which is of low productivity, namely reproduction in the case of the beef herd and raising of replacements for the dairy, while growth and fattening and milk production are of inherently high productive efficiency and hence need feeds of equally high energy potential. Intensification must therefore be considered at the begining of any livestock programme, and not as something of minor consequence to be postponed indefinitely. This approach requires that the first stage in any cattle development plan should be a survey of the country's natural resources and ability to grow specific crops so that the best feeding systems can be chosen according to the climatic, economic and social environment.

If the situtation is confused in the field of nutrition it is even more so in therealm of genetics. Thus French and Ledger (1957) speaking of East Africa considered it unwise to select for improved genetic types, and that genetic studies ought to be carried out on a maintenance level of feeding. Earlier, Faulkner and Brown (1953) expressed doubt about the use of European breeds in the tropics while Williamson and Payne (1959) stated that "cattle of the improved breeds cannot thrive under tropical conditions and their potential productivity may be of no account". The height of absurdity in this area was reached by Webster and Wilson (1966) who classified the tropics into six regions, giving for each the "most suitable" proportions of *B. taurus* and *B. indicus* "blood". In the face of such advise it is not surprising that there has been no real genetic improvement of the cattle population in the tropics. It is this type of peseudo science which needs to be subject to political pressure.

Education

Up to the present time agricultural education in Latin America has tended to be orientated towards the production of veterinarians. Most courses are such that attention is divided between the needs of veterinary science and animal husbandry. The result is the unhealthy compromise of a graduate with little detailed knowledge of either aspect (Raun, 1968). Moreover, when graduates are sent for their higher education to the developed countries, particularly the US, those participating in agricultural courses represent only some 4% of the total foreign students (Stonaker, 1968), despite the fact that agriculture is the major industry in virtually all Latin American states. There are few universities in Latin America which grant higher degrees in agriculture and related fields and none granting higher degrees that would be considered of international level.

In view of the foregoing there is a great lack of trained scientists and it is not surprising that little or no research is undertaken in the universities. Moreover, when it is undertaken it is frequently orientated towards animal health and traditional pasture improvement methods rather than to increased animal production.

THE ROAD TO IMPROVEMENT

Research

The FAO/UNDP Commission (1968) rightly concluded that there was no need for additional technical assistance to universities. We are in agreement that

universities should not have priority in projected schemes of assistance as the majority are already overcommited with graduate teaching. There seems little point in trying to create research centres at the universities while they are still unable to do a good job at producing competent graduates. On the other hand we do not agree with the FAO report that the deficiency is with the quality of the medium-level technician, i.e. the farm manager.

We believe the primary need in Latin America is the creation of more independent research centres and for the expansion, and more specifically the improvement, of those already in existence. The initial emphasis should be on the execution of applied research of economic significance to the problems of the country or region, and the development of such research into livestock production systems through integrated field trials and cooperation with the larger and more progressive farmers. At the same time these research institutes should be developed as centres of post-graduate training with a view to producing not only more and better investigators, but also better university teachers. The final stage of this development is affiliation with apropriate universities, but this is only feasible when the research centre has proved a success in its own right.

What is <u>not</u> needed is the proliferation of planning and creation of coordinating bodies which probably do as much to retard development as to advence it. As a general rule most developing countries suffer from too much advice, too much planning, too many commissions and not enough action.

The problem, as McMeekan (1969) has rightly pointed out, is not money but people. It is not a need for more research of an academic nature, but rather the application and development of existing knowledge. We must transform concepts already known and understood in developed countries into viable livestock production systems for the developing areas.

The crucial step in developing a new research institute, or rejuvenating an old one, is the appointment of a competent director and with him a team of principal scientists to form the nucleus on which the research programme should either be created or expanded. In almost all cases such scientists will have to be recruited from North America, Western Europe or Australia. The qualities required are a comprehensive basic training and subsequent experience in applied science, together with a recognized record of productivity. The emphasis should be on an interdisciplinary approach with the object of developing systems of animal production which are fully integrated. An interest in economics is essential and at least one member of the team must be a competent practical statistician. Ranking equally with academic ability are personality traits which must include a sense of humor, a somewhat impervious skin and a non-compromising attitude to what is scientific method. At the same time there is need for a flexible approach to matters political and an absence of nationalism. It is essential to be understood in the indigenous language, but the emphasis is on being understood rather than proficiency; linguistic ability should always come second to scientific capacity.

The second stage, which in a new institute will follow after the appointment of a director, is the creation of physical facilities for applied investigation.

The emphasis here should be on scale rather than on detail large numbers of cattle pens are more import nt than laboratory or office furnishing, particularly in the early stages. Recruitment of local staff is best confined, as far as possible to those recently graduated from university and to young technicians whose qualifications need be no more than basic intelligence, interest and enthusiasm. For the graduates a rudimentary knowledge of the English language is an essential qualification for entry. However, prior experience in any branch of animal farming may well be a disadvantage.

The broad lines of a research programme should be related to natural resources, national requirements and general economic problems. The order of priorities will invariably be: 1) Nutrition and 2) Genetics; with other disciplines e.g. biochemistry, veterinary science and microbiology being used purely in a supporting role to the applied research and development programme.

If a host country wishes to develop a research programme in cattle production and if it, or an international agency, is prepared to give financial support then both must agree to appoint a director with the power to direct and execute the chosen research programme. Similarly the principal scientists must be given administrative responsibility. In our opinion there is no place for codirectors, joint project managers or assessors. The desire for joint management springs understandably from a desire on the part of the host country to have ultimate control and to feel involved in the direction of the project. However, the desire for independence will, in the long term, be met by the creation of a viable and successful institute. This is much better met by the employment of top-class imported scientists for a finite period during which indigenous personnel are trained to direct and to eventually take over the institute and maintain the standards which will have been set if the right men were appointed in the first place.

Education

The local graduate student should be incorporated in a triple role: He should not only continue his studies but also be an experimental officer participating in research; and above all he must be a worker getting both his hands and his clothers dirty!

In our opinion, graduate training in such an institute should, in the early stages, involve the minimum of formal teaching other than English and Biometrics. There should, however, be maximum participation of graduates in seminars, staff talks, the planning and execution of experiments and their subsequent analysis and writing up in the form of scientific publications for international journals. There should be easy access for students to both the director and the senior scientific personnel and teaching must be mainly on a tutorial basis.

Representation of graduate students at international congresses is not a priority; in fact it should be actively discouraged in the early days until graduates are sufficiently competent to present and understand scientific communications and then be a credit to their institute and country.

The building up of a library is as important as the creation of physical facilities for research. It must be done selectively and, if funds are limited, the emphasis must be on journals and not text books. With respect to the latter it is also much more important to buy a large quantity of the better and more recent texts than to attempt to be comprehensive and buy large numbers of indifferent ones.

The first essential is for abstract journals followed by the major applied animal science journals which are almost without exception written in the English language. We feel that there is a definite need for an international journal published in Spanish and have attempted to go some way to resolving this deficiency in our own institute. It nevertheless must be emphasized that our appeal is not for more journals but to elevate the standard. We must have one major journal in Latin America which will attract papers solely on their scientific merit irrespective of origin. Our own experience in this respect suggests that it is possible to have extensive participation in such a journal by scientists from developed countries, particularly if the journal has an equivalent edition in English.

Extension

We do not feel that extension services should be considered as separate entities in the development of an overall research andeducational plan. It is the responsibility of any institute to see that its research programme is oriented in a practical direction and that it is utilized commercially. To this end open days, intensive short courses, visits from university students and representative of commercial bodies interested or involved in cattle production, are a necessity. Probably the best method of ensuring that research is both applied at the farm level and also maintains close contact with actual problems is to develop coordinated field trials on commercial farms. Finally, while the output of a research institute is primarily scientific publications in the world literature, there is a particular need in developing countries for the interpretation of this work at a practical level in the form of popular articles in the appropriate farming press where this exists.

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APPENDIX 1. Population and cattle statistics a/

Country	Population Human	Population Cattle	Beef Production	Exports
	'000		'000t	
Argentine	22,700	47,000	2410	401,000
Bolivia	4,700	2,700	37	
Brazil	84,700	90,500	1450	20,800
British Honduras	109	35	1	
Chile	8,750	2,900	135	(8,600)[b]
Colombia	18,700	15,000	415	2,900
Costa Rica	1,490	1,110	27	7,100
Cuba	7,840	6,700	195	
Dominican Rep.	3,750	1,030	24	
Ecuador	5,330	2,100	45	
El Salvador	3,040	922	35	
Guadalupe	319	70	2	
Guatemala	4,580	1,170	33	5,900
Guyana	662	350	4	
Guyana Francesa	37	3	--	
Haiti	4,490	700	12	
Honduras	2,360	1,720	23	
Mexico	44,100	33,100	435	27,700
Nicaragua	1,720	1,310	15	
Panama	1,290	1,010	32	1,400
Paraguay	2,090	5,460	115	980
Peru	12,000	3,640	81	(6,900)[b]
Puerto Rico	2,670	487	20	
Surinam	386	43	1	
Uruguay	2,750	8,400	237	55,200
Venezuela	9,030	6,700	169[c]	
Other Islands	4,514	490	27[c]	
Total	254,107	234,650	5980	
U. S. A.	197,000	109,000	9350	
World	3,430,000	1,075,000	346,000	
L.A. Proportion	% 7.4	21.8	17.3	

a Source: FAO Production Yearbook, 1967

b Imports

c Incomplete

Inter-American Institute of Agricultural Sciences of the OAS
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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. C-5 J. C. Glenn, University of Florida

Title: EXPANDING RESEARCH AND POST-GRADUATE TRAINING THROUGH COOPERATIVE AND EXCHANGE PROGRAMS

The idea of cooperative programs where a University or other Institution with special capabilities in a particular area assists, at the National or International level, Institutions seeking to develop proficiency in this area has a long history. Since the end of World War II the United States has been deeply involved in this system as a means of assisting Universities and Governments of developing countries to become self sufficient in agriculture, engineering, basic sciences, etc.

The use of exchange programs with the developing countries is a more recent development and has become possible due to the increased level of training of local staff in these countries.

There have been many questions and comments as to why the cooperative and exchange programs in the developing countries have not been as efficient in their results as similar programs in Europe after World War II. Those who have posed such questions apparently were not aware of a basic difference in the problems of Africa, Asia and Latin America and Europe. In the case of the latter area there was a pre-existent pool of technically educated individuals which required, more than anything else, the economic means to allow the application of the knowledge and talent which was available.

In the developing countries no such broad base of education existed and there was and is the necessity of developing education systems from the primary through the University level in order to prepare individuals for the guidance of national progress.

With this general background I would now like to limit further discussion to the past, present and future status of the cooperative and exchange programs within the developing countries in the field of agriculture. The same basic principles apply to all phases of this field and thus to our specific area of interest which is animal production.

Throughout the history of the technical assistance program of the United States (Technical Cooperation Administration, International Cooperation Administration, Agency for International Development) there have been two broad types of approaches to the program of technical assistance. First of all there has been the direct hire system whereby individuals from various universities, industries and governmental agencies have been employed by the assistance

program to assist in training, research and extension. Although there are exceptions, the general results of this approach have been less than desirable and in some cases disastrous.

There are a number or reasons for the poor showing of the direct hire system but the more important ones have been the employment of inadequately trained or inexperienced individuals. This has been due in many cases to the unwillingness of more qualified individuals to become involved in the "red tape" of the program, to the lack of career opportunities in technical assistance and to the policy of rotating individuals with such frequency that they could not terminate long range projects as they would like.

Another basic problem of this system has been the lack of direction and planning. In part this has been due to political pressures which cannot be completely alleviated but could have less importance. There has also been insecurity and wide variation in annual budgeting which has not allowed adequate long range planning.

The second general approach to cooperative assistance has been through contracts with U.S. Universities. Although a very small percentage of funds have been expended in this way the results have, on the average, been much more favorable. These too have been plagued by short time contracts and improper planning but the fact that the responsibility for the success of the program has been placed on a University has improved the efficiency of each project.

This is not to say that there have not been failures on the part of the Universities. There have been and still are. The greatest failing again, as in the direct hire technique, has been the contracting of poorly qualified professionals. In too many cases the individual departments have used assistance programs to clean out the "deadwood" from their staff. University, College and/or Departmental administrators have actively discouraged the participation of the better qualified staff because of the threat to their own program. Often this is justified if the staffing of assistance programs does actual harm to the local program.

During the initial stages the idea existed that these assistance programs should be filled with low training level technicians who would give practical training to foreign nationals. In most cases the Universities with a real concern for the success of their programs have realized that due to the change in climatic, soil, forage and animal conditions, it is necessary to have an extremely well trained individual who can apply his basic scientific knowledge to the changed environment and not merely try to transplant techniques from his home state to the foreign program, as a result they have tried to upgrade the training level of their staff on foreign assignment.

Howpefully, however, some of these problems are now being resolved and with the new direction which possibly will be given to assistance programs under a director with an agricultural background we should look for methods which can improve cooperative and exchange programs.

Before discussing improved programs we must fairly evaluate the problems which such programs face in assisting in the development of postgraduate training programs for agricultural specialists.

1. First of all no university which does not have a strong undergraduate program should consider the establishment of a graduate program. Particularly in the animal science field there is a serious shortage of qualified professors to adequately prepare graduates at the B.S. level. The practice of using university graduates with no postgraduate training in changing but a very high percentage of the professors are still at this level. A minimum of M.S. should be required for a professor teaching undergraduates and before a graduate program is initiated a large percentage of professors should hold the Ph.D. degree.

The presence of well selected, trained professors will, at a continually increasing rate change the quality of teaching at the B.S. level, will alter the goals of the university in the field of agriculture and will increase the impact of the university in the community through direct action of the professors and the abilities and attitudes of the graduates.

The vicious circle of inadequately trained professors producing additionnal inadequately prepared university graduates must be broken before postgraduate training should begin. This is particularly true in the field of Agriculture where a combination of educational system and improperly prepared professors have produced university graduates with generally adequate theorical knowledge but a complete lack of practical training. Since in most cases the professor does not know the practical aspects, he cannot teach this and usually will not admit his own inadequacy and try to learn together with his students. The professor thus does not become involved in research or extension and the idea of the pure academician is promulgated generation after generation.

2. The quality and background of the students in agriculture is another real problem to be considered by universities considering a cooperative and exchange program. Since high schools are located in urban areas, students fulfilling the requirements for university admission are from urban background. The opportunity must be provided for students with rural background to obtain university training. This is now being done in some countries which allow graduates from Agricultural Technical Schools to enter the University after additional pre-university training. This trend should be continued and expanded even if it is necessary for a few years to lowe the purely academic entrance requirement of the University. This is the type of student who will be willing and often eager to work in the isolated areas to assist farmers or actually become a producer.

3. One of the essentials of a post-graduate training program is adequate research facilities to train the post graduate student. These do not normally exist in the average agricultural college of the developing countries. Some of the reasons for this were mentioned in the first point related to training of the professors and the historical educational system. The sudden provision of these facilities, even if economically feasible, will not automatically cause them to be used. This utilization is an evolutionary process and one which should be well underway before the establishment of a post-graduate program is considered.

4. The ability to provide a full range of academic and research programs for post-graduate students is slow to develop. Usually one area, for example

Animal Nutrition, will be sufficiently strong to train students at the level of the M.S. but the inability of other specialities to give a well rounded program should be considered. In other words, is the individual able to obtain the type of training which will allow him to compete with M.S. graduates from other institutions.

5. Post-graduate training in agriculture increases tremendously the costs per student as compared to undergraduate training even in animal production which is already an expensive curriculum. The University should consider whether resources are available, without reducing undergraduate programs, to finance this. Usually the existance of a large undergraduate program is essential in order to reduce the average costs of the individual post-graduate trainee.

6. Effect of local post-graduate training on the variability of training and experience of the student. With a limited number of professors and facilities the student is frequently not exposed to new ideas or techniques when he continues in the same university with the same professors for the M.S. degree. The University in a developing country which is considering the establishment of a graduate program should seriously study the ability to expand the horizons of the trainees as compared to sending them abroad. This is not to negate or condemn the establishment of post-graduate programs but to emphasize the necessity for serious consideration to determine if the University has achieved the level of naturity necessary to provide an adequate, competitive post-graduate education. Perhaps a combination of training for a post-graduate degree with a portion taken at the local institution and the remainder in a foreign country would overcome the problem of "inbreeding".

Having considered some of the problems which often are encountered in the establishment of post-graduate training in Latin American Institutions we should now discuss the means whereby the establishment of cooperative and exchange programs may be effective in assisting the organization and function of this level of education.

1. The most important factor to determine the success of such efforts will be the level and duration of financing. All other factors to be mentioned are closely related to this primary one. The development of educational institutions is a long term process. The effects of duration of financing is well documented in the book published in 1968 by A.I.D. entitled "Building Institutions to Serve Agriculture". Although this book deals primarily with undergraduate programs, the principles apply equally well to post-graduate training. The original grant or contract from a private or governmental agency should assure both parties of the program a minimum operative period of five years and the possibilities of success are increased tremendously if this is funded for ten years or more.

2. High quality staff should be required of both participants in the cooperative program. Institutions and programs are built by individuals and the average level of achievement of post-graduate training may be closer to the potential level of the poorest qualified members of the staff than to that of the best qualified. Any University in the United States accepting a cooperative and exchange program should recongnize the obligation to provide the

best qualified staff possible. Any University in Latin America entering into such a program should accept the same responsibility. Although it has been pointed out that this has not been true in the past, if the two parties to the contract are assured of continuity in financing it is much easier to recruit qualified individuals since they can be assured of a certain longevity of opportunity. At the same time the administration of the U.S. institution can adequately staff to carry on their local as well as the foreign program.

It should be pointed out that qualified staff indicates not only adequately trained individuals but also those who see their foreign activities as a career or as an integral part of their professional development. They should be willing to meet and know the people of the country where they will live, to learn the language, to be able to adapt to a different environment or people and possess a real interest in international activities.

For the host institutions, the provision of qualified individuals indicate those who are open minded to change, academically capable and willing to have a career in University work. This latter characteristic is closely related to the intrest and ability of the local government and University to pay competitive salaries which will allow the individual and his family to live comfortably without the necessity of having one or more extra sources of income.

In order for the exchange program to function the local institutional staff must be generally equal in training and ability and better in specific areas than their counterparts in order to be accepted for research and teaching at the U.S. or European institutions.

3. Flexibility of programs and curricula. This applies to both participant groups. In the developed countries, often times the type of research and teaching in some specialities are not pertinent to the needs of the developing countries. Possibilities should exist to alter programs, where feasible, to provide more adequate training. One very positive symptom of the acceptance of this idea in U.S. institutions has been the recent change to allow foreign students to conduct research for a post-graduate degree in his own country. Another has been the conducting of field courses in various countries by local staff on short term assignment.

Within the host country this flexibility should allow the establishment when necessary, of completely new philosophies and/or programs to utilize new educational and research techniques which will produce graduates capable of solving the most important technical problems within their speciality. The programs must eradicate the separation of the University graduate from the producer who after all is the reason for the existence of the professional agriculturist.

4. Education of University Administrators to the reasons for the importance of cooperative and exchange programs. Already there has occurred a notable change in the attitude of U.S. administrators toward these activities. In many cases they are no longer considered as secondary or sideline projects but as an integral part of University function. The administration has seen the technological advances obtained as well as the broadened outlook of

participating faculty. With the improvement of planning and financing much of the justifiable criticism of these programs will be alleviated and a more general acceptance will be seen.

In the developing countries the technical personnel have been quick to see and appreciate the value of cooperative programs. The administration, often due to lack of knowledge of modern agriculture, has not been willing to provide the necessary local resources to assure the development of agricultural training either at the undergraduate or post-graduate level. They must however, be made aware of the impact that graduates and research data from properly staffed and financed agricultural programs can have on the agricultural and industrial development of the country. They must be educated to the uniqueness in requirements of agriculture, in the level and timing of financing and facility and mobility requirements of staff and students.

5. Increase emphasis on cooperation rather than technical assistance. While it must be recognized that the developed country participating in a cooperative project has certain advantages in training and experience of staff, without this there would probably be no program, it must also be realized that the cooperating institutions have a common goal. The acceptance of the idea of cooperation places equal responsibility for both successes and failures on all involved and tends more toward a collaborative than a technical assistance relationship. The establishment of this attitude, while it can be stated at Government and University administrative levels can only be achieved at the individual level and is a result of attitude and not legislation.

Summary

The establishment of cooperative and exchange programs normally involves three basic entities, the funding agency, a University in the developing (in this particular case Latin America) country and a University in a developed country.

Each of these has specific obligations and responsibilities. These are presented perhaps in an oversimplified manner below:

I. Funding Agency
   1. Provide adequate, long term support.
   2. Allow flexibility in program development.
   3. Alleviate as much administrative detail as possible.

II. Latin American University
   1. Provide adequate, qualified staff.
   2. Build strong undergraduate program before considering post-graduate curriculum.
   3. Increase salary levels to provide longevity of staffing.
   4. Improve level of administration knowledge and support of program.

5. Staff graduate program with individuals trained in various institutions.

6. Do not allow local graduate training to replace entirely educational and research experience in other countries.

7. Provide sabbatical leaves for professors to teach and conduct research in other countries.

8. Establish priorities of teaching and research to provide for local needs.

9. Retain flexibility of program.

III. University in Developed Country

1. Recruit staff with interest in a career in international agriculture.

2. Provide adequate language training.

3. Provide stability for local and international programs so that one doesn't compete with the other.

4. Develop curricula to fill needs of foreign students.

5. Encourage foreign students to return to their own country after graduation.

6. Allow research by U.S. and foreign graduate students to be conducted outside the U.S.

7. Encourage professors on sabbatical leave to teach and do research in other countries.

8. Recognize international programs as a cooperative effort and an integral part of the University function.

9. Maintain flexibility.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-1 Dr. Durward Olds, University of Kentuky

Title: RESEARCH HORIZONS IN ANIMAL REPRODUCTION AND SOME IMPLICATIONS

With the world population increasing at an alarming rate, it is pertinent to consider ways and means of producing food for hungry people. About 70% of the earth's surface is covered by water and there are about 10 acres of land for each person. Of the 10 acres, 1-2 acres are tillable, 2 acres are grass, 3 acres are forest and 3-4 acres may be considered as waste.

The cereal grains (rice, wheat, corn et al.) provide about half of the world food needs. However, livestock and poultry provide most of the other half (perhaps 40% of the total). Ruminants are particularly useful on account of their ability to digest cellulose, which comprises about 25% of dry matter in most forages. Most dairy cattle can produce 0.25 lbs of consumer TDN per lb of TDN intake and this is more than any other species of farm animal (swine 0.20, poultry 0.16, beef cattle 0.06 and sheep 0.05). While the day may come when we can no longer afford to process plant stuffs through livestock, it seems certain that attention will be given to the improvement of animal productivity for at least a few decades, if not longer. Perhaps fish farming will become one of our most important enterprises. In the meantime, let us give consideration to the topic at hand -- "Research Horizons in Animal Reproduction."

Reproduction is, of course, essential for propagation of species. High rates of reproduction are very helpful to a program of intense genetic selection. In the case of milk producing animals, maximum productivity can only be attained when reproduction occurs not only frequently, but also at optimum time with regard to age, season, and other environmental factors. In my part of the world (Kentucky, U.S.A.), dairy cattle produce more milk if they calve in the fall or winter. Also, it appears advantageous to have short calving intervals (12 months) and to feed heifers for rapid growth and early breeding (Holsteins may be bred at 12-14 months of age if they weigh 600-700 lbs).

Artificial insemination has markedly increased the power of selection among males. While about 10-15% of the bulls born would need to be used for natural breeding, only 1-2% of those born in registered herds on test would be needed for artificial insemination. However, female selection cannot be nearly as intense. Under U.S.A. conditions, about 22% of the cows are replaced each year and 10 of these are for reasons beyond the

control of dairymen. In other words, about 12% of the cows can be culled for low production. If high fertility and low mortality rates are enjoyed, perhaps up to 20% could be culled for low production.

Even if all calves born were heifers (through sex control), only about 55% of the herd could be culled for low production (top 45% retained). Of course it would be necessary to produce some bulls, presumably from the top 2-3% of the cows. If ova from 2-3% of the cows could be used to impregnate the others, then female selection could be brought to a level comparable with male selections.

Superovulation has been used in cattle to produce an average of 21.9 ovulation points, 11.6 ova recovered, and 61.5% rate of fertilization (2). Assuming this could be done twice to a cow, this would only increase her genetic contribution to a herd by a factor of 3 or 4.

The first successful surgical transfer of bovine ova was reported by Willett et al. (35) in 1951. Since that time, successful surgical transfers have been made by Avery et al. (3) and Johnson et al. (14). Non-surgical transfers have been reported by Mutter et al. (22), Sugie (32), and Rowson and Moor (27). It appears that distention of the uterus with CO_2 after depositing the ova prevents expulsion of the ova.

In 1934, Nicholas and Hall (23) dissolved the zonas from 2-cell rat ova and separated the blastomeres with a fine jet of water. When these blastomeres were transferred to the uteri of suitable recipients, entire embryos were developed but no live offspring produced. In 1952, Seidel (29), obtained live rabbits from 2 and 4-cell ova in which all but one of the blastomeres had been destroyed by puncturing with a glass needle. Likewise, Tarkowski (33) obtained six living mice from 2-cell ova in which one blastomere had been destroyed. In 1964, Mintz (18), dissolved the zonas from mouse ova up to the 8-cell stage and fused varying numbers of blastomeres from two different ova. She cultured these to blastocyst stage and then transferred them to the uteri of recipients. Many live young were obtained. Tarkowski and Wroblewski (34) have reported that blastomeres separated at the 4-cell stage generally did not develop an inner cell mass while those separated at the 8-cell stage never developed inner cell masses. The "blastocysts" are referred to as "trophoblastic vesicles". It appears that blastomeres attain the ability to secrete blastocoelic fluid at the end of the 5th cleavage regardless of whether they develop together or separately. However, in the frog, Gurbon (12) has transferred nuclei from endodermal gut cells into denucleated unfertilized ova and produced normal embryos and frogs.

The ova of many species have been seen to cleave once or twice _in vitro_. However, only those of the mouse and rabbit undergo appreciable development (13). Rabbit ova will cleave readily from 1-cell to morulla in a medium containing 50% or more of rabbit serum (1). However, blastocyst expansion fails to take place. Mouse ova can be cultured from late 2-cell stages to blastocyst, but require certain 3-carbon compounds, a fixed nitrogen source, and a relatively high concentration of carbon dioxide (6, 7). An oviduct environment appears to be necessary for the first cleavage (4). The culture

of rat ova from 8-cell to blastocyst has recently been reported (10). Pincus (25) observed some cleavage of bovine ova when they were cultured in blood serum at 38ºC. Sreenan and Scondon (31) were unable to get cleavage of bovine ova in blood serum media, but cleavage to 24-cell stages was obtained in bovine follicular fluid. Development to blastocyst was achieved when bovine ova in follicular fluid were placed in the uteri of pseudopregnant rabbits for four days. Swine ova have been reported to undergo one or two cleavages in modified Brinster's medium, but no gilts conceived when the ova were transferred (28).

McLaren and Michie (17) have estimated that about 50% of the mouse ova might be expected to survive when transferred to the uteri of suitable recipients. Noyes and Dickmann (24) have estimated 70% for the rat. They pointed out that ova younger than three days or older than five days do not survive. The recipient should be either in the same stage of cycle as the donor or perhaps one day younger (the ova may be either delayed or can wait this long). Moore and Rowson (20) found that 49% of the sheep ova survived when transferred to oviducts.

Moore et al. (21) have reported that single blastomeres of 2, 4, or 8-cell rabbit ova did not survive transfer to the oviducts of recipient does regardless of whether the blastomeres were naked, enclosed in their own ruptured zona, or injected into an evacuated host zona. They suggested that leucocytic invasion of the zona and destruction of the blastomeres might occur. Spears (30) observed that rat blastomeres did not survive when placed in the oviduct. Mintz (19) has produced many live offspring from the transfer of mouse blastocysts to recipient uteri. However, Biggers (5) found that only 7.5% of such blastocysts developed to the 17th day of pregnancy.

These techniques of ovum culture, blastomere separation, and ovum or blastomere transfer are entangled with problems, but appear to offer a means of obtaining previosuly unheard of genetic selection and the production of large numbers of genetically identical offspring.

Gas chromatography has been used to some advantage for the assay of steroid hormones such as estrogens and progesterone. However, in recent years radio-immuno-assays have been developed for insulin, growth hormone, HCG, FSH, Lh, prolactin et al. (8). With this test it has been possible to measure the HCG in as little as 0.1 ml of urine or blood.

Efforts to develop birth control measures, including the "pill" and I.U.D.'s, have led to a better understanding of corpus luteum and uterine relationships and to estrous cycle synchronizing methods (11).

There is still need for conclusive information on the "capacitation" of sperm. Some evidence indicates that amylase treatment of semen increases fertility of bulls about 1-2% (15).

In recent years, a considerable amount of information has been acquired regarding the effects of chromosomal aberrations in mammals (9). Ionizing radiation, drugs, viruses, temperature shock, and aging of gametes have all

been incriminated to some extent. In cattle, the freemartin condition is apparently due to chimeric tissue resulting from an exchange of embryonic migratory cells.

For those of you from countries having hot humid climates, it may be well to consider the losses of nitrogen and minerals by way of the skin (16). Where feed is scarce, it may be well to keep in mind that underfeeding delays puberty (26) and according to some, prolongs the interval from calving to first heat, and lowers conception rates in beef cattle (36, 37).

Graduate students majoring in animal reproduction will require firm foundations in mathematics, chemistry, and physics with broad, but intensive, knowledge of cytology, histology, anatomy, embryology, genetics, physiology, nutrition and perhaps microbiology, immunology, and pathology. Aggressive students will be applying refined methods of biochemistry, cytology, endocrinology, and statistics in their research. Adequate laboratory and library facilities are essential. However, we must not forget the people on farms who must also be educated and informed of new developments so that the fruits of research can materialize on the farms of our countries.

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Inter-American Institute of Agricultural Sciences of the OAS
and
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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-2 Dr. C. F. Chicco, Ministry of Agriculture, CIA, Venezuela

Title: ESTABLISHMENT OF RESEARCH PRIORITIES IN LIVESTOCK PRODUCTION FOR TROPICAL AMERICA

The establishment of priorities in livestock research in the tropical region of Latin America, requires a previous study of the principal characteristics of the corresponding countries in relation to the land, inhabitants and conditions of the livestock exploitation.

The Latin American tropics extends from Central America and West Indian Islands to the major part of South America and includes, total or partially, the following countries: Costa Rica, Cuba, El Salvador, Guatemala, Haiti, Nicaragua, Honduras, Panamá, Dominican Republic, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru and Venezuela. Similar conditions are also found in certain lower regions of Mexico.

Although the influence of the climatic factors is changeable between the mentioned countries, as also within some of them, it can be assumed that the major part of the region has a warm and moist climate, with two marked seasons, the rainy and the dry. The exceptions are the mountainous regions of Bolivia, Peru, Ecuador, Colombia, Venezuela and some Central American countries. The southern part of Brazil, approximately from the parallel of Sao Paulo (24º South), is found in the sub-tropical zone and even the temperate climate. In certain regions, especially those directly influenced by the nearness of the oceans, the pluviometric regime is more uniform and the dry season never shows up.

Generally, the beef cattle in the Latin American countries, is developed in large and sparsely populated territories, away from the principal consuming centers, as are the Colobian and Venezuelan plains and the north region of Brazil. The dairy cattle are located near the great cities, and in distant regions, but with good roads or highways. The sheep and goat populations are found in the mountainous regions, the last occupying the arid zones. The commercial exploitation of the swine, more developed in the zones near the major populated centers, supplies only one part of the market, the other part being covered in a primitive way by small farmers.

In order to determine the comparative importance of the different types of commercial production, it is necessary to from a criteria on the principal conditions of the region, in relation to the urban areas, terrain, availability of pasture, animals and of cattle products. The last available information is found in the "1967 Production Yarbook" that pertains to F.A.O. (F.A.O. 1968).

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The summary of this information is shown in Table 1 and it contains the most recent information with which the international organization counts on. The figures in Table 1 show that in reference to the population and availability of land, the conditions of the countries of Central America are notably different form those of South America. The principal characteristics of the first region is a high density of population (44.3 habitants/km^2), larger that the United States (21.0 habitants/km^2) and more than four times that of South America (10.0 habitants/km^2). For this reason, the figures corresponding to the first region are presented separately in order to facilitate the comparison with the rest of tropical Latin America. Besides, Table 1 contains the information corresponding to the United States, considering that this country is one of the more advanced in the cattle exploitation and with the population very well provided in the best way with animal products.

TABLE 1. Statistical information of the Tropical Region of Latin America in comparison with the United States.

	Tropical Regions in Latin America			United Stated of America
	Central America	South America	Total	
1. Population				
a. Thousands of inhabitants	30,539	136,491	167,030	196,920
b. Density per km^2	44.3	10.0	11.7	21.0
2. Surface				
a. Total (1000 ha)	68,972	1,363,646	1,432,618	936,322
b. Plains and pastures (100 ha)	12,532	189,435	201,967	260,362
c. % of plains and pastures	18.2	13.9	14.1	27.8
3. Existence of animals (1000 heads)				
a. Bovines	15,665	126,132	141,797	108,862
b. Ovines	1,201	47,901	40,102	24,734
c. Goats	2,417	21,263	23,680	4,222
d. Porcines	6,946	71,925	78,871	47,414
4. Number of animals per 1 inhabitant (weighted averages)				
a. Bovines	0.51	0.92	0.86	0.55
b. Ovines	0.04	0.35	0.29	0.13
c. Goats	0.08	0.16	0.14	0.02
d. Porcines	0.23	0.53	0.47	0.24
5. Carcass yield (weighted averages)				
a. Bovines kgs	151.6	186.3	183.3	262.0
b. Ovines kgs	14.1	15.9	15.8	23.0
c. Goats kgs	18.4	10.9	11.1	-
d. Porcines kgs	39.8	65.5	63.5	68.0
6. Availability of food per capita (weighted averages)				
a. Meat kgs	41.7	74.6	70.7	282.0
b. Milk kgs	233.4	214.7	216.9	673.0

The figures show that in all of the hemisphere, the principal exploitation is the bovine. The average bovine per capita in Central America is similar (0.51) to the United States (0.55) but about double (0.92) in South America. These figures are weighted averages that do not include the extreme cases of each region. So the average per capita of the island countries, Haiti (0.16) and the Dominican Republic (0.27) as well as Guatemala (0.26) and El Salvador (0.30) are much below the general average. The same case is observed in the South American countries of Peru (0.30), Ecuador (0.39) and in a smaller degree Bolivia (0.52). Some of these countries complement the deficiency of bovines with the production of smaller ruminants, which are generally scarce in the hemisphere. The goat population per capita in Haiti is (0.24), in the Dominican Republic (0.26), in Peru (0.33), and in Bolivia (0.26). The ovine population per capita in Guatemala is (0.18), in Peru (1.27), in Ecuador (0.38), and in Bolivia (1.31). These figures are much higher than the ones observed in the other mentioned countries and the regional averages. Nevertheless, the low weight of this stock does not compensate for the defficiency of the bovine meat to adequately. The production of pork is better developed in South America (0.53 animals per inhabitant) than in Central America (0.23) being similar to the United States (0.24). It is obvious that the similarity between these last regions is not due to the same causes. In the United States the limited breeding of pigs is a consequence of the market demand, whereas in the tropical countries it is due to the technical and economic difficulties of the regions.

The main differences between the United States and Tropical America is found in the yield of the slaughtered animals and the availability of the products for the supplying of the population. The average weight of bovine carcasses is 151.6 kgs in Central America; 186.3 in the South and 262 kgs in the United States. Similarily, the overall average of the ovines is 15.8 kgs in the tropics and 23.0 kgs in the north. Only the swine of South America (65.5 kgs) have a yield similar to the United States (68.0 kgs); those of Central American being notably inferior (39.8 kgs).

The milk production (Table 2) expressed as the average annual production per cow, total production and availability per capita, shows that in this item Tropical America is far behind. The main difference between the yields of the cows in Latin America and in North America is principally due to the fact that in the latter milk production is concentrated in specialized farms, while in the former a great part of the produce is obtained from cows of indefinite type, with a strong influence of double purpose animals.

The most important figures in Table 2 are the ones referring to the per capita availability of products of animal origin. In comparison to the inhabitantants of the Unites States one person in Central America can scarcely obtain 14% as much meat (including the fowl) and 34% as much milk and dairy products. The corresponding figures for South America are 26.5% and 31.9%, respectively.

The deficiency of products of animal origin in Latin America is also noted in the availability of animal protein (meat and milk) per inhabitant/day that is shown in Table 3.

TABLE 2. Milk production in the Tropical American countries and North America

Region	Country	Average Production kgs	Total Production T.M.	Availability per capita kgs/year
Central America	Costa Rica	1,700	125	283
	Cuba	770	1,190	
	El Salvador	670	111	234
	Guatemala	1,120	161	107
	Haiti	420	18	
	Honduras	450	143	187
	Nicaragua	2,750*	183	620
	Panama	880	65	180
	Rep.Dominicana	1,170	48	238
South America	Bolivia	2,900*	87**	145
	Brazil	440	6,903	209
	Colombia	273	2,033	283
	Ecuador	500	401	100
	Paraguay	600	86	177
	Peru	680	471**	206
	Venezuela	700	694	252
North America	United States	3,861	54,535	673

* Average specialized farms.
** Total production including ovines and goats.

TABLE 3. Availability of animal protein (meat and milk) per inhabitant/day in Tropical Latin America in comparison to the United States (weighted averages).

	Gr/inhabitant day	% of availability of United States of North America	Gr/inhabitant day	% of availability of United States of North America
United States	35.2	100.0	23.6	100.0
Central America	5.9	16.8	7.9	33.5
South America	10.0	28.4	7.5	31.8
Total for Latin America	9.6	27.3	7.5	31.8

These figures confirm the information presented in the preceding figures and it can be summarized that the countries of Tropical America are poorly supplied with products of animal origin and the increase of the production is an urgent need, considering especially the explosive increase of the population observed during the last decade.

Among the products of primary importance meat and milk, priority should be given to the first. On one hand, meat is more deficient than milk, since the average availability per capita in comparison to the Unites States is 26.5% for meat and 27.3% for protein, while the corresponding percentages for milk are somewhat higher, 31.9% and 31.8%, respectively. On the other hand, the importance of meat is greater in the human diet. Finally, under conditions of Tropical America characterized by small population density and a great area, actually only 14.1% is suitable for permanent pastures or ranges but with great potential for development. These areas are suitable for utilization with beef cattle which also require less investment and a modest technical preparation by stockfarmers.

Among the two principal types of animals that are producers of meat, cattle and swine, this latter has little probabilities of increasing. The commercial production of pork requires the supply of great quantities of concentrate feeds of high nutritive value, principally cereals. These products are scarce in Tropical America and their prices are very high. The increase of the production of cereals should be alloted firstly for human consumption, which is also deficient in this region. The maintenance and fattening of swine under a pastoral system or with pastoral system or with roots and tubercles (yucca and sweet potato) is not possible at the moment, since among the tropical pastures there is no variety available, with adequate characteristics, and the production of roots and tubercles is scarce and is fundamentally used for the human nourishment.

The minor animals are used very little in tropical America. The average per capita ovine population is hardly of 0.29 and 0.14 for goats. Their production is concentrated in the mountainous regions, the most important countries being Bolivia with 1.31 ovines and 0.26 goats per inhabitant and Peru with 1.27 and0.33 animals, respectively. Because the smaller ruminants are of limited regional importance, little attention is given to them in this paper.

Summarizing what has been discussed previously, the considerations of principle importance to livestock production of Tropical America, can be put as follows:

1. Beef cattle.
2. Dairy cattle.
3. Swine.
4. Small ruminants.

Following this order of priorities, the importance of research, within each of these industries will be established.

1. **BEEF CATTLE**

The figures in Table 1 show that the number of bovines for each inhabitant of Central America (0.51) is almost the same as that of the United States (0.55) while the corresponding number in South America is almost double this number (0.92). The figures show that in Tropical America there are sufficient cattle populations in existance.

On the other hand, the yield of carcasses in Central America (151.6 kgs) and South America (186.3 kgs), are less than the average of the United Sates (262 kgs) in proportions of 57.9% and 71.1%, according to the existing figures of cattle and carcass yield considered jointly. The inhabitants of Central America should be deficient in the supply of meat in comparison to the North Americans, but those of South America would be in an opposite situation, having larger quantities of the product. Nevertheless, the figures concerning the availability of meat are contrary to the last assumption.

Obviously, the deficiency of the product is not due to the number of animals raised but rather to their productivity. In other words, the cattle that are produced in Latin America have smaller daily weight gains and reach the market at an older age and at lesser weights than the ones produced in the north. This difference, undoubtly, is due to the different methods of feeding and management used in the two regions, and also to the types of animals. The systems used in the U.S. will not be described, since they are widely known. On the other hand, we will pay some detailed attention to the tropical conditions.

Beef cattle production in the tropics is of the pastoral type. Most of the pastures used in this zone are the natural pastures, poor in nutritive materials and of low palatability. During the rainy season, these pastures support the herds in a satisfactory manner, even though floods, the moisture in the soil, the high temperatures, and the incidence of plagues (mosquitos,etc) make normal growth and fattening difficult. During this time, the animals gain weight, although in a less efficient way, than in a temperate environment.

The critical period is the dry season when the pastures turn dry and the animals are obligated to travel great distances in order to consume the minimum quantity of forage. The conservation of pastures is almost never practiced due to the high operation cost of planting the recommended species for this purpose. Concentrate suplementation is ignored, due to the high price of these feeds and to the difficulties of supplying them equitably to animals in distant pastures. During the dry season, the animals lose weight, the death rate rises as does the incidence of abortions and stillbirths. Also, the animal's resistence to diseases decrease. Due to the malnutrition suffered at this time of scarce forages, the cattle, during the rainy season when there is abundant pastures, lose a great part of the period in the process of recuperation and only take advantage of the rest of the time for the effective production.

These are the principal reasons why the bovines in the tropical countries reach the market weight (300-400 kgs) at the age of 3-4 years, in comparison to the normal market age of two years in regions of temperate climates.

The management of animals in typical commercial beef production is very primitive. There are regions where the farms have no surrounding fences and the cattle of various owners graze together in large territories. In others, where perimentral fences exist, the division of pastures is not done and all of the herd forms one lot, in which the stronger animals take advantage of the best pastures at expense of the weaker ones. The bulls do not separate from the cows and the breeding of heifers generally occurs during the first heat period. The births are not grouped at the proper time and the calves born during the dry season or the floods, are less able to survive and grow slow and irregularly.

Health and sanitation problems are of less importance than in the above mentioned situation. Although the control of the major contagious diseases, tuberculosis and brucellosis,is not practical in all of the countries in an adequate form, the damages caused by these are not decisive.

Periodical vaccinations are carried out against foot-and mooth disease and the outbreaks are very isolated. Undoubtedly, the incidence of intestinal parasites is relatively high and it is necessary to study economical control methods. The diseases transmitted by ecto-parasites and the ones caused by blood parasites do not present a serious problem (excluding the tripanosomiasis), since the animals are generally resistant or develop a natural resistance when they are calves.

The breeds that are raised in the tropics are the Criollos of Bos taurus ancestary and among the Bos indicus in Brazil, are the Nellore, Guzerat, Gyr and Indu Brazil, and in the other countries the American Brahman. But the principal composition of beef cattle are formed by the hybrids between Criollo and Zebu strains. The morphological differences that exist between the mentioned types are of certin importance. The Criollo cattle are small and of poor beef conformation in comparison to the Zebu. Among the Zebu the animals of asiatic breeding are more heterogenious due to weaker selection as compared to the American Brahman, which has been selected specifically for beef production. Undoubtedly, the utilization of the Zebu would be more recommendable than that of the Criollo and upgrading to the Zebu is plainly justified. Nevertheless little can be obtained toward genetic improvement, unless the feeding and management conditions are modified.

Even the Criollo cattle, in adequate conditions, produce meat in a satisfactory manner. So, in a crossbreeding project with beef cattle, being carried out in Venezuela (Cooperative Project, MAC-UCV, 1969), the animals of different breed types maintained in dispersed pastures during the dry season, produced, in 1968, the following daily increases in weights:

TABLE 4. Daily weight gains of animals of different breeds types during 1968 (unadjusted figures).

	kg Weight Gain/Day	
	205 days old	18 months old
Pure Crillo	0.686	0.705
Criollo x Brahman	0.720	0.908
Criollo x Santa Gertrudis	0.708	0.841
Pure Brahman	0.654	0.798

Although the figures in Table 4 were obtained from groups with unequeal numbers of animals and were not adjusted for the principal influences, such as sex of the calf and age of the mother, the increases show that feeding and adequate management throughout the year, permits obtaining commercial weights of about 350 kgs from natural tropical pastures without concentrate supplements at the age of 18 months even with the less productive Criollo cattle.

Summarizing the above description of the conditions in the commercial production of beef cattle, the following order of priorities of research can be established:

1.1. Feeding
1.2. Management
1.3. Genetic improvement
1.4. Health and Sanitation

1.1. Feeding beef cattle

The geographical and economical conditions of Tropical America shows the need for maximum utilization of the extensive, uninhabited lands. Consequently, the explotation of the beef cattle should be of the extensive type, in which the pastures are the base of the nourishment of the animal.

1.1.1. Research on the forage species and varieties most applicable for the different regions.

The ecological conditions in the different regions of the American tropics are very changeable, especially in relation to the texture, fertility and drainage of the soils. It is necessary to determine the types of pastures most recommendable for each region. For this, it would be convenient to begin by studying the adaptation in experimental parcels of introduced pastures, and later carry out the determination of the content of nutritive materials, of the yields by cuts and by year, and in commercial plantings, of the acceptance by the cattle, consumption, digestibility and resistance to trampling.

It is very important to include in the study the varieties for harvesting, which could be useful for conservation in the form of silage, including legumes. Of importance are the natural pastures, which, in some regions of specific characteristics, present better results than the introduced varieties. Finally, works on the genetic improvements of forage plants could be initiated.

1.1.1.2. Pasture management and agronomic practices

In the selected pastures (natural and introduced), the best form of utilization should be studied. Within this plan, it is necessary to determine the best time and planting system, frequency of cutting or of grazing, initial and routine, fertilization, weed control, pasture rotation, effect of the employment and frequent use of the different types of machinery (mowers, reapers, choppers, etc.), most convenient size of pastures, and number of animals per hectare.

1.1.1.3. <u>Preservation of forages</u>

The preservation of forages is practiced very little in regions dedicated to the beef production, due to the unknown techniques and the high operating costs. Nevertheless, the improvement of the productivity will not be possible, unless the herds are supplied with forages during the dry season. Among the two principal preservation techniques, ensilage offers better possibilities than the cutting and drying of hay. The strong rains prevent the pastures from drying during the best vegetative growing time. On the other hand, the operation can be done in farms without irrigation only once a year, once the rain begins. Artificial dehydration of forages is apparently not economical. Besides, the pastures which are best adopted for making hay are weak stemmed and fragile and yield less than the species used for silage.

The most important research work in relation to silage production, is the determination of the species of plants and the types of silos which are more suitable for the different regions. In this study, the topography of the region should be taken into account, as should the type of pasture used, the location of the silos on the farm, the costs of construction materials including transportation, the availability and value of the preservative supplies, and costs of machinery and labor. According to the specific characteristics of the region, the different types of silos (trench, bunker, towers, etc.) should be investigated in a comparative way. It is necessary to determine the cost of the preparation of the ensilages and the losses in nutritive materials, according to the different types of silos.

Besides the study on the preservation of the cultivated pastures for this purpose, it is of great importance to investigate the possibility of ensiling the typical pastures of each region. In both cases, attention should be given to the use and dosification of preservatives, especially the weeds. In later tests, it will be necessary to determine the possibility of the use and the benefit of the utilization of non-protein nitrogen sources in the ensilage. Although the possibility of supplying the herds with hay during the dry season are less that in the case of silage, this system should also be studied. It is important to know the metereological information of the region for exact short dry intervals during the rainy season. The existence of these periods, frequent in certain regions, will permit hay making two or more times a year.

The studies on dehydration should take into account the possibility of making hay from typical pastures of the region, the degree of preservation of the nutritive materials, the most recommendable techniques, the machinery and labor necessary, the storage of the hay and the economy of the operation. In hay as in silage, it is important to investigate the most economical and practical methods of the supplying forages to the animals.

The last method of preservation, that with difficulty could be defined as such, is the dry pasture that is not harvested in the pastures. By leaving an ample surface of forage without pasturing during the last months of the rainy period, it is possible to preserve for the animals a certain amount of feed in the form of "standing hay". There are observations in which animals have maintained or increased their weights while consuming dry pasture,provided that the area grazed was sufficient in relation to the number of animals. This way

of maintaining the herds during the dry season is the most economical and requires less exact technical preparation by the cattleman.

In this field, little work has been done in the tropical climates. It is of urgent necessity to investigate the nutritive value of the typical dry pastures of the region, determine the number of animals per hectare that can be maintained in dry pastures, the duration of the resting period that should be given to the pastures before the dry period begins, and the agronomic practices that are more applicable in order to obtain the greatest quantity of nutritive materials per unit area. Since fires are very frequent in the beef cattle zones, it is important to determine the best way of protecting the dry pastures against fires.

1.1.2. <u>Supplement of the rations for beef cattle</u>

1.1.2.1. <u>Supplement with protein and energy sources</u>

It is widely known that slow growing animals, as those raised in Tropical America, nourished with a sufficient quantity of green pastures, do not need protein and energy supplements. Furthermore, when these are supplied, the increase in the growth or fattening does not justify the additional costs of the supplements. This situation changes during period of scarcity of forages. The deficiency in nutritive materials makes the animals weak, and encourages reproductive disturbances, diseases and high death rates. Even though the prices of the protein and energy supplements are very high in Latin America, cattlemen in some cases are forced to provide them to their herds during the dry season.

In order to resolve the problem of the supplementation, it is necessary to study the local, low cost feedstuffs available in the region such as the by-products of rice, corn, oils, coffee, cacao and the citruses. It is valuable to know their nutritive composition, their palitability, digestibility and consumption characteristics. Assays with animals maintained on basic rations of hay, silage or dry pasture in the field and supplemented with mixtures based on the materials studied, should show the technical efficiency and economy of their use. In these assays it is advisable to measure the changes in the weight of the animals, the residual effect under the lattter feeding with green pasture, yield in the slaughter house, quality, etc. It is also of interest to investigate the possibility of the autoregulation of consumption of the protein and energy supplements with the introduction of large amounts of salt for the purpose of reducing the number of feeding times and to assure consumption of the supplement by all of the animals.

1.1.2.2. <u>Supplementation with non-protein nitrogen</u>

The advantages of supplying to ruminants sources of non-protein nitrogen (NPN) are known as are the conditions necessary for its best utilization. Among these, the quantitative and qualitative content of the basic ration has a very important role. The supplementation with urea, due to its low cost, can be practiced as much in the period of abundance pasture, as in periods of pasture scarcity. Nevertheless, it is necessary to conduct a broad program of studies in order to obtain the best results with this practice. Considering that the utilization of NPN and its tolerance may be different under tropical conditions, it is useful to determine the optimum quantities of urea that should be administered to animals of different types. Since urea

can not be consumed alone, it is necessary to investigate the best and most economical mixture with the rest of the ingredients of the supplement, with the inclussion of molasses and the grain or tropical fruit by-products. This study should be conducted separately for feeding during the rainy season (green pastures), and dry (hay, silage, dry pastures). The experimental technique with the animals would be similar to that previously desribed.

1.1.2.3. <u>Mineral supplementation</u>

Very few studies have been made in Tropical America regarding the mineral contents in of soils and plants. Chicco and French (1959-60) reported that in the principal regions where the beef cattle are grown in Venezuela, a deficiency of calcium was uncommon, whereas a deficiency of phosphorus was commonly found over a large portion of this zone.

We could imagine that a similar situation exists in the regions of other tropical countries. The use of mineral supplementation is not commonly practiced in extensive beef cattle production. In order to study and demonstrated to the cattlemen the importance of this practice, it is advisable to initiate studies, on a regional scale, of mineral supplementation. Since the deficiency of minerals is frequently shown in a subclinic form and is reflected in different stages of life, as are growth, development, maturity, gattening and reproduction,the investigations should be at a long term and introduction, the investigations should be at a long term and introduce the control of herd performance, as well as physiological studies with selected animals. Due to the importance of the principal minerals in the diet as with calcium and phosphorous, it is advisable to initiate studies with these elements, in order to proceed with others, such as magnesium, copper, zinc, manganese, molybdenum, and selenium, etc.

Upon determining the need of the supplementation or the correction of a toxicity, the next phase would be to study the most economical methods of the providing the minerals under extensive commercial conditions. For example, as fertilizations of the oils, dissolving of the supplements in solution, or supplying the mixtures in feed throughs, etc.

1.2. <u>Management of the beef cattle</u>

Unfortunately, in numerous commercial beef cattle enterprises in Latin America, all of the animals form only one herd and pasture together in the entire area of the farm, or oftentimes when there are no exterior fences the cattle from various neighboring farms run together. The consequences of such practices (as mentioned earlier) does not need further comment. In order to improve the situation it is necessary to conduct studies and demonstrate to the cattlemen the advantages of the measures that are described as follows:

1.2.1. <u>Division of the herds and determination of the comparative importance of the groups formed</u>

Considering that on a beef cattle farm, the quality and quantity of the available forage varies very much during the year and that the feed requirements are different for the different types of animals, it is necessary to establish a minimum number of groups in which the herd should be divided,

as well as the demands of each of these lots. As a tentative division, the following could be considered:

a. Weaned calves, sub-divided by sex or forming only one group if the males are castrated.

b. Young males for fattening.

c. Growing heifers too young for breeding

d. Heifers for breeding or during early pregnancy.

e. Heifers in late pregnancy or nursing calves.

f. Lactating cows.

g. Pregnant dry cows.

h. Bulls.

It is necessary to investigate the possibility of dividing the typical farms of a region in the adequate number of pastures, taking into account rotations and the preservation of forage for the scarce period. Concerning the various groups of animals, some priority should be established in reference to the number of pastures which should be maintained. The technical and economic feasibility of grazing two or more groups together could be compared to a system of one group (or more) following another in a "clean-up" grazing rotation. This work needs to be conducted in the two climatic seasons of the year. The results obtained in the research of the nutrition with pastures and supplements should be applied in an experimental form to the animals of different lots.

1.2.2. Reproduction in beef cattle

In the common system of running the bulls with the herd throughout the entire year, the calves are born during any season. During the dry season, the number of abortions and stillbirths of calves increase and those born are weak and have has weight. The small quantity of the milk of the mothers' tend to inhibit the growth and normal development of the calves. At the same time, the calves born during the intense rainy season suffer from the humid atmosphere and soil, as well as parasites and diseases. In like manner, the supervision of the calves and the husbandry practices (identification, dehorning, castration and weaning) are more difficult when the births occur throughout the entire year.

Likewise, the control of the reproduction of the cows is difficult and it is impossible to prevent the premature impregnation of heifers. Also, the bulls are not utilized in an adequate manner according to their capacity.

These inconveniences can be reduced to a minimum with the selection of a limited breeding season best suited for each region.

Before recommending this measure, it is important to study the minimum duration of the period, the percentage of the pregnant cows in comparison to service during all the year, the maximum number of cows for each bull, and the most advisable time for the birth of the calves.

Furthermore, it is necessary to establish a criteria for weight and age of the heifers of the different types as minimum conditions for the first service, the influence of the nursing a calf during the service period, the duration of the dry period in the cows on their fertility, the possibility of eliminating the cows that are not pregnant during the season as a measure for the improvement of the reproductive indexes of the herd, the preparation of the bulls for the service period and their sexual conduct, including the competition between various bulls within a group.

1.2.3. <u>The raising of the calves</u>

Although the raising of calves is done under the natural nursing system in the pastures, information is needed on the most advisable methods of accomplishing the routine duties.

The principal problem is the best duration of the nursing period. This problem should be investigated in conjuntion with the growth and development of the calf and the fertility of the mother. Besides, the climatic season in which the weaning will occur, should be taken into consideration. In some cases, it would be advisable to test the supplementation of the calves with concentrates during the period before the weaning, inmediately after weaning, or both.

It is also important to determine the effect of castration of males on their growth, fattening and tameness. Upon verifying the benefit of such operation it would be appropriate to investigate the best time (or age of the calf) for castration. The same could apply to dehorning. In the case of not castrating, it would be useful to establish the age in which the sexual development is completed of both sexes, in the different breed types, in order to recommend the opportune separation of males from females.

1.3. <u>Genetic improvement</u>

1.3.1. <u>Records of production and reproduction</u>

The genetic improvement of the herds is not possible without having the basic information on the performance of the animals. As a previous condition, it is important to develop and put into practice records of production and reproduction within the herds. For this purpose, it is necessary to study the best way of obtaining the information of primary importance, as are the weights at birth and at weaning time and the other periodical weights of the calves, of their mothers at the beginning of the service period, upon calving and weaning the calf, the weight of the bulls before and after the service, etc. It is necessary to determine the factors of correction for the different breed types in relation to sex, age, birth period of the

calves and the weight, age and the dry period of the mother before calving. Individual records should be made of the both parents, with the inclusion of the pedigree, the informtaion corresponding to its growing period, and on the reproductive efficiency. Only by utilizing the records can the studies be converted into genetic improvement.

1.2.3. Improvement of the native types of the tropical regions

The native cattle of Tropical America, called Criollos in Central America and Venezuela, San Martinero and Costeño with horns (more of the dairy type) in Colombia, Caracú and Mocho National in Brazil, are generally considered degenerated types, of little value, whose destiny is to disappear in order to be replaced by animals of asiatic origin. Only two breeds of native animals of the region are taken into account for improvement as pure breeds, the Romo Sinuano and Blanco Orejinegro of Colombia. The latter is found in the cooler climatic regions of high altitudes 1000 mts. above sea level. The unfavorable attitude toward native cattle is principally based on its inferior performance in comparison to the half-breed obtained from crossing between *Bos taurus* and *Bos indicus*. This superior performance can be attributed, largely, to the influence of heterosis, which is found in the hybrid animals.

Nevertheless, the latest published report shows that the Criollo cattle, under an above maintainance system, produce similar results to the Zebu. So Muñoz and Martin (1968) obtained weaning weights from calves of pure breeds and their reciprocal crosses wherein it was noted that Criollo calves perform much the same as the imported breeds. These figures are illustrated as follows:

Male		Female	Weaning weight
Criollo	x	Criollo	203.0 kgs
Criollo	x	Brahman	204.2 "
Criollo	x	Sta. Gertrudis	213.1 "
Brahman	x	Brahman	190.3 "
Brahman	x	Criollo	230.6 "
Brahman	x	Sta. Gertrudis	228.4 "
Sta. Gertrudis	x	Sta. Gertrudis	207.6 "
Sta. Gertrudis	x	Criollo	211.8 "
Sta. Gertrudis	x	Brahman	205.7 "

According to these figures, it should be noted that the elimination of the Criollo cattle is unjustified and that they should be preserved and improved as valuable genetic material, especially due to their good resistance in the environment and their abundance.

Among the imported breeds, it is necessary to pay greater attention to those that withstand the tropical conditions and, above all, the regime of pasturing throughout the year. The specialized beef breeds of English origin (Shorthorn, Hereford, Aberdeen Angus) should not be taken into account, as

much for their little resistance in the environment, as for their nutritional demands. Among the Zebu breeds, the principal attention should be given to the American Brahman, due to the possibility of its importation the United States being a country that is free of foot and mouth disease and their greater degree of selection for high production. Among the asiatic breeds, the ones from Brazil (Nellore, Guzerat, Gir and Indu Brasil) are of interest because they are raised and selected in the typical conditions of the American tropics. The Santa Gertrudis breed, selected for beef production in an arid environment, is worthy of the researchers interest, although they may not be very well represented in Latin America.

In relation to the purebred cattle, it is advisable to intiate the work with a comparative study in order to determine the most promising breeds within each specific region. Upon verifying their usefulness, it would be wise to start with the selection and genetic improvement, taking into consideration the reproductive efficienty, death rate and diseases, growth and development, feedutilization, conformation and carcass yields. For the selection of bulls it is indispensable to introduce comparative growth performance.

1.3.3. Improvement by crossbreeding

The advantages of crossbreeding are widely known, as much in transformation of animals of unproductive breeds in improving yields, as in the utilization of hybrid vigor in the crossbred animals. The good characteristics of imported animals have incited an interest among the cattlemen of the tropics and have induced them to initiate indiscriminate crossing of their cows with imported bulls. The first results have been very flattering due to the large effects of the heterosis. Recent research work has confirmed this observation. In Venezuela, Muller et al (1968) found 7.6% heterosis in the birth weight of the half-breed Criollo x Brahman and a high correlation between the initial weight and the weaning weight. In Costa Rica, Muñoz and Martin (1968) in reciprocal crosses that included the Criollo, Brahman and Santa Gertrudis, observed 5.1% heterosis in the birth weight, 7.9% in weaning weight, and 13.4% in later weight gains.

Due to the great success in the first crosses, cattlemen have continued with the use of imported bulls, although the progress observed in the first generation decreases in later generations. Actually, various tropical beef cattle are heterogeneous due to hybrid ancestory from native cattle (Criollo) and the Zebu. In Brazil, this process is much more advanced, counting on numerous pure herds of Nellore, Guzerat, Gir and Indu Brazil for crossing. (the Indu Brazil was formed by the other three breeds). In other countries, American Brahman breeding predominates.

The decrease of the hybrid vigour in later generations, have provoked among the cattlemen, certain restlessness and the desire to look for new methods for improving their herds, with the object of replacing the system of upgrading as practiced up to this time. Nevertheless, its advantages have not been utilized in a reasonable manner due to the consequence of the lack of selection in the crossbred herds and also among breeding sires. For this reason, upgrading can not be discarded by the researcher especially in the regions where the introduction of imported blood has not reached high levels.

According to our criteria, the research in the improvement by crossing should be divided into two parts: the first for the Criollo and for animals with little Zebu breeding; the second for the high grades or animals "pure" by crossing. In the first group, it is important to compare the upgraded animals, resulting from well planned matings and adequate selection, with the alternate types. The improved breeds should be chosen from among these available in the region which show a better productive adaptation to the environment. The Criollo should not be discartded before its efficiency in various crossing combinations has been established. It is advisable to try various breeds since the effect of hybrid vigor may be different in various breed combinations.

In the second group, only the alternate crossing with the introduction of one or more improved breeds can be recommended. Among them, the Charolais and Santa Gertrudis should be given first consideration as they show more resistance in the environment, as does the Brown Swiss, which is of the best adapted among the dairy breeds, with a proven efficiency in the crossing with the Brahman (Koger, 1969). The crossings between the different breeds of Zebu should not be discarded, especially those with marked morphological differences (as the Gir). In both cases, the investigator should depend on groups of purebreeds for crossing in order to obtain contemporary comparisons between animals.

1.4. <u>Health and Sanitation in the beef herd</u>

In most of the countries of Tropical America, the governments have control programs against foot and mouth disease and tuberculosis and in a lesser degree against brucellosis. The incidence of the other infectious diseases is not high.

Apparently, the high death rate is due the nutritional problems. Among the diseases that cause more worry to the cattlemen, the following can be mentioned:

1.4.1. <u>Diseases caused by blood parasites</u>

With the exception of the imported animals, anaplasmosis and the piroplasmosis do not present a big problem in the typical beef cattle regions, provided there is not much movement of the cattle from distant zones that may bring foreign infections to the region. Preimmunization is a natural process.

The major worry is the tripanosomiasis and babesielosis, that appear sporadically and are virulent in animals of all ages.

1.4.2. <u>The parasite diseases</u>

Endoparasites exist in all of the regions of Tropical America and their damage to production has not been well studied. Effective treatments are known for the control of intestinal and pulmonary parasites, but its application is very difficult due to the extensive systems of production. It would be very important to study the control of the parasites in the calves in a

massive way, incorporating the medicines in feed supplements and studying the technical and economical feasibility of their use.

1.4.3. Genital diseases

Unbalanced nutrition causes many problems in reproduction. Abortions are very frequent, as are retained placentas and the subsequent diseases of the genital tract. The lack of the control of reproduction allows females with infertility problems to remain in the herds during long periods, causing maintenance costs without contributing returns.

In order to avoid these problems, it is necessary to study the herds in order to identify and eliminate the sterile animals, determine the causes of the irregularities and the possibilities of their prevention and to recommend to the cattlemen the practical and economical systems of treating sick animals.

2. DAIRY CATTLE

The figures in Table 2 clearly show that the milk production per/cow/year in Tropical America is very low, oscillating in the majority of the countries between 300 to 800 kgs. Undoubtedly this low production is due to the limited specialization of milk production enterprises, to the use of dual purpose herds, to the irregulatity of the milking, and to the effects of the unbalanced rations during the year. The solution for most of these problems does not require the intervention of the research, since these aspects are well known, the practical solution can and should be conducted through extension education. For this reason, in the present discussion, the principal attention will be dedicated to the problems of the milk production in specialized farms.

Tropical America includes a great number of countries, zones and regions, whose ecological and economic characteristics differ at high degree. The price of the product is very high in some countries and lower in others. In the same manner, the production costs vary according to the different items such as feedstuffs, labor, animals, buildings and equipment. The intensity of commercialization depends, directly, on these factors.

High yielding tropical pastures, of low nutritive value, when consumed voluntarily in their optimum state, will support levels of production of 6-8 kgs of milk per day. The cows with a greater genetic capacity for production can show their potential only by consuming concentrated supplements. The possibility to intensify productivity depends then, to a great extent, on the relation between the cost of the concentrate and the price of milk on the market. In regions where the price of the land is low and the costs of labor is cheap, but the cost of the supplements are high, commercial production will continue for a long time under an extensive systems, using cattle which are not specialized. In other areas of opposite conditions, the amximum intensification of the production and the introduction of new types of animals, are necessary. The cattlemen do not always have sufficient preparation to enable them to decide on the most appropriate type of production and cattle for their regional or their particular farm conditions. It is the work of the investigators to study and to resolve these types of problems.

Recent works on dairy cattle in the tropics indicate that the belief of the impossibility of utilizing specialized European cattle is baseless. According to Branton et al (1966) and Marples and Trail (1967, the European cattle offer good possibilities, provided that the adequate conditions of management and nutrition are administered. The numerous reports on the performance of the half-breeds, representing native tropical and the European breeds, show that the genetic improvement over the tropical cattle offer good prospects. The principal problem consists of determining the best commercialization systems, mainly feeding and management.

Based on these reasons, the priorities of research on the milk cattle should be established in the following order:

2.1. Determination of the commercial production system which is more applicable for each region.

2.2. Feeding.

2.3. Management.

2.4. Genetic improvement.

2.5. Health and Sanitation.

2.1. <u>Determination of the commercial production system</u>

The main factors that determine the commercial system which is most applicable for a region are: 1) cost of the land, 2) cost of concentrate feeds, 3) labor costs, 4) cost of the buildings and fencing, 5) types of animals, 6) transportation costs, 7) price of the milk and derivate products.

Recognizing the magnitud of each one of these factors, the researchers should make the necessary calculations in order to establish the maximum value of the cost for the production of 1 kg of milk and based on this information, recommend the most practical type of commercial production. Without going into details, these can be described based on three systems.

2.1.1. <u>Extensive production</u>

The principal characteristics are the availability of much land for pastures, a low cost of labor that will permit maintainanace of a large number of less productive animals, and the feeding and maintenance of cattle in pastoral conditions. It sometimes also includes a minimum supplementation with concentrate feeds, the possibility of raising and fattening the male calves, sale of fresh or proccessed and, in certain regions, cheese making on the same farm.

The most appropriate type of cattle are rustic, tolerant to the conditions, and produce 2000-2500 kgs of milk per lactation, this quantity being obtained with the indiscriminate consumption of tropical pastures throughout the year.

2.1.2. Semi-intensive production

This system is similar to the previous one with certain improvements. It would be typically in the intermediate regions between the consuming centers and the zones of extensive production. In this system many of the same conditions exist, as mentioned above, but with an increase in the cost of production, a decrease of the transportation cost and a better possibility of obtaining higher prices for the products. The grazing of pastures can be combined with the supplying cut forages during the dry season. It is necessary to pay more attention to the preservation of forages and offer the cows a ration of concentrate feeds in order to assure respectable milk production. The raising and fattening of the male calves generally would not be advisable for such enterprises. The farms should be more technical, providing shelter for the animals, feed throughs for cut forages and concentrates, and, if possible, mechanical milking. The milk can be sold for pasteurization or for industrial use.

The type of cattle should be improved but maintain a resistance within the environment, and maintain a production above 2500 kgs per lactation. Generally, this comprizes crossbred cows between the native types (or Zebu) and European types.

2.1.3. Intensive production

Near the fluid milk markets in regions generally characterized by a high cost of the land and labor only the intensive enterprises with highly specialized cattle, capable of covering high production costs would be justified.

On the farms the cows should be kept in stables or semi stables and eat fresh-cut or preserved forages with ample rations of concentrated supplements. The raising of the males would be possible only in the case of pure animals, to be sold as breeders. Among the female calves born, generally only the daughters of the best cows would be kept to provide a sufficient number of replacements. All of the milk would be sold to the pasteurizing plants for fresh liquid consumption.

The most appropriate cows for this type of exploitation are the purebred European or high grades, as they are the only ones that can assure a production average of 3,500 kgs of milk per lactation.

2.2. Feeding the dairy herd

The principal feed source for dairy cattle, for beef cattle, is pasture, although in the case of dairy cattle concentrate supplementation has more importance.

2.2.1. Rough forages for milking cows

According to what has been mentioned before, the feeding of forages to dairy cows can be based on a grazing system or a system of cut pastures. In the first case, the recommendations made in the beef cattle chapter are valid.

The cut pastures need a series of investigations. Generally, the cut pastures are of greater growth than those of grazing. The stalk-to-leaf relationships are less favorable. Although their nutritive values are similar to those to grazed pastures, the animals consume less because they have less opportunity to select since the forages are supplied in the form of a mixture of all parts of the plant.

In order to improve this situation, it is necessary to select plants which have more favorable relation of leaves-stalks. These plants also should be easily propagated and have a long life under the cultivation system. In different parts of the world new varieties have been developed and also hybrids of Sorgo and Elephant grasses which should be tested in different regions of Tropical America. Later on, the most promising species or varieties should be submitted to complete agronomic and husbandry studies in relation to the time and frequency of cuttings, irrigation, fertilization, preservation, animal consumption, etc.

Particular interest should be given to the species and varieties which combine a good vegetative growth with high yields of grains, as do some Sorgo hybrids. The cultivation and supply of such plants can notably reduce the use of the concentrated feeds.

Since there is limited information from the American tropics regarding the well adopted, high yielding legumes, it is advisable to intensify studies on identification and the best utilization of the existing ones (Desmodium, Dolichos, Stylosanthes, Centrosema, etc.) both in pure stands and in association with grasses. Also, it is often necessary to increase the introductions and evaluations of the legumes of tropical countries, especially from Australia.

2.2.2. <u>Protein and energy supplementation</u>

In the semi-intensive dairy production enterprises of Tropical America the use of concentrate supplementation is common practice. Nevertheless, errors of application are frequent, as much in improper formulation of the rations, as errors relating to the elemental nutritive contents of the raw materials used, and the abuse of using non-protein nitrogen (NPN) sources of nitrogen in the rations.

In order to reduce the cost of the concentrate feeds, through research, guidelines should be established for their maximum use, and at the same time nutritionally usefull NPN, especially urea. These studies should be made with a large number of animal types representing dairy cows of different production levels, dry cows, growing heifers, weaned calves, etc.

In order ot avoid losses of foreign exchange, it is important to conduct experiments substituting commonly importated raw materials for those produced within the country. The protein supplements such as cotton, sesame, peanuts do not require much additional research, since their use is widespread and substantial information already exists in literature. Major attention should be given to the sorgo and to the by-products of rice, coffee, cacao and citruses. In certain countries, where production costs of such crop are

justified, it would be necessary to investigate the use of certain roots (yuca) and tubers (sweet potato).

The rationing of animals (nutritive plan) should be studied with long term experiments in order to determine the influence of the rations on the growth, production and reproduction of the animals. It is very important to express the results of these investigations in a practical and understandable way to the cattlemen, such as kilograms of feed per100 kilograms of weight, or kilograms of milk produced per kilogram of feed.

2.2.3. Mineral supplements

The use of salt and some sources of mineral materials is commonly practiced with dairy cattle in Tropical America. The best use of these products should be a work of the extensionists.

In some countires the commercial companies sell to the cattlemen, at high prices, certain mixtures which contain a long list of minerals. It would be important to determine the regions which lack minerals and make recommendations to cattlemen regarding the elements which are truly limiting.

2.3. Management of dairy cattle

2.3.1. Calf raising

In the extensive type of commercial animal production, calves are nursed by the cows. The most general practice is to leave some milk in the dam's udder for the calf. It is often said that this method is necessary, since the cows will not let-down their milk without the calf present. Besides, natural nursing decreases the costs of labor. Nevertheless, the negative effect of such a system on the growth of the calves and on the economy is unquestionable, since the calves continue to nurse throughout the lactation.

The problem of the needing the calf to be present to stimulate let-down among rustic cows, needs special investigation. Apparently, old cows which are accustomed to this practice, will not let-down their milk without the calves being their to stimulate them. Nevertheless, the majority of the heifers, whose lactation is initiated without sucking calves, do not have this problem. Besides, there are some indications that among such heifers only the poor producers have such a problem (Carnevali and Bodisco, 1966).

As the possibility of eliminating the practice of milking with calves is shown, it becomes necessary to find an easy and economical method of calf feeding. In addition to supplying milk or milk substitutes, it is advisable to study the use of nurse cows such that each one can nurse 7-8 calves, twice daily throughout their lactation. The principal problem involved in this system is the reproduction of nurse cows which generally are is seriously damaged.

On intensive and semi-intensive cattle farms, the principal task of research is to find the most efficient and economic method of feeding, comparing types of milk and establishing the minimum time before weaning, in

relation to the future activities of the animal. On the other hand, it is necessary to determine the best feeding system for the calves comparing individual vs. group feeding, the appropriate time need to be kept under roof, and the minimum age to be turned out to pasture, as well as to study the effect of the pasture against the stabling and semi-stabling.

In long term studies, it is necessary to determine the effect of the rearing systems on the subsequent productivity of the animals and establish criteria (weight, age) on the best time of commence breeding.

All of the studies should take into account the conditions of the different regions, the climatic seasons, the calving season and the breed involved.

2.3.2. Reproduction

It is widely known that the reproduction of imported breeds is strongly affected by tropical environments. Research should uncover the reasons for this phenomenon and provide some possible solutions. Also, it is necessary to determine optimum norms for interval from parturation to breeding, duration of dry periods, the estrus cycles in different breeds, duration of estrus, and time of ovulation, as well as the best time for insemination.

2.3.3. Management of the cows herd

Up to the present time, there is a lack of a management system for European cows in Tropical America which can guarantee the adequate protection against the climatic factors, especially those which prevail during the change of seasons (beginning of the rains).

It is necessary to study the influence of pasturing in relation to the complete stabling or semi-stabling of European cattle in comparison to the tropical types or low grade crossbreds. For corral stabling it is useful to determine the minimum space needed per cow, including the roof area, the most useful type floor bedding material, as well as the number, capacity, and distribution of the eating and drinking troughs. Also, it is of interest to pay attention to the hour and frequency of milking in relation to the facilities of the farms, and the production and habits of cows.

Finally, it is necessary lend much attention to pregnant heifers and to dry cows in order to determine the best method of preparing them for calving.

2.4. Genetic improvement

Up to the present day, genetic improvement of dairy herds has been based on the crossing of native cows or half-breeds with imported European bulls, generally Holstein and Brown Swiss. Only in a few countries has selection been practiced with purebred Criollo cattle (Costa Rica, Colombia, Venezuela) or Zebu (Brazil).

2.4.1. Production records

The improvement of dairy populations is difficult without production records, which are carried out only in some regions of few countries. Without

utilizing this type of service it is impossible to obtain the information necessary to develop criteria regarding the factors which limit progress in the various regions such as; a) the adaptability of the different breed types to the environment, b) the success with the use of the improved breeds, and c) the genetic composition most favorable for the different environmental conditions. Neither it is possible to establish the genetic parameters or to determine the correction factors within and among different types of cattle.

There is an urgent need to establish a system of production testing with electronic computors. Being such a complex and costly enterprise, it is of great importance to promote international collaboration in order to develop a uniform system. This would permit some of the countries, who have the equipment and technically trained personnel, to assist others, who lack these necessary elements for processing such information.

2.4.2. <u>Artificial insemination</u>

Artificial insemination is used in a large or small scale in almost all of the tropical American countries. Basically, it deals with obtaining and distributing the semen from bulls acquired on the basis of pedigrees and general inspection. Apparently there are no services of artificial insemination available which are associated with a genetic plan established for any given region. So, a large measure of the potential benefit of this service is lost.

It is necessary to unite the efforts of the geneticists and of reproduction specialists in order to obtain a coordinated program of work. This would permit plotting and conducting a planned program for genetic improvement, including avoiding inbreeding, distributing the offspring of the various bulls evenly and, above all, proving the bulls.

2.4.3. <u>Proving the bulls</u>

The upgrading that has been practiced during the last 15-20 years, has transformed a large part of the native herds, in certain regions, into nucleous of high grade cattle. In other regions, this process is still in progress. In the beginning of this process, any bull of European breeding could be considered as superior to the native cattle. Actually, in many herds it is necessary to pay more attention to the selection of the bulls since only some of them would increase production in the future herd. In this plan, the importation of proven bulls or of the semen could be considered. nevertheless, the surest route is the testing of the young bulls within the regions, especially if evidence indicates strong genetic-environment interactions.

2.4.4. <u>Selection for adaption</u>

No broad programs of direct selection for adaptation to the environment are known in the tropics. Generally, in herds of imported or upgraded European cattle, whatever selection that exists is natural selection since the less adapted cows leave fewer descendents.

In many countries there are populations existing representing several

generations of importes cows. Unfortunately, these third and fourth generation animals born in the tropical countries relates only to the maternal ancestors since their male ancestors are generally imported bulls. The results is that while nature tries to select animals that adapt themselves to the tropics, reducingreducing the reproduction of those with unfavorable characteristics, man impedes this effort by regularly introducing nre germ plasma. An aspect that still is not resolved refers to the choice of trying to maintain and increase production using imported bulls or semen, as compared to seeking better adaptability using bulls born and tested or proven within the country. It is very important to attempt to resolve this problem, with long term, experiments utilizing proven bulls of different breeds from imported and local stocks.

2.5 Health and Sanitation

The investigations in health and sanitation dairy cattle basically are the same as the ones in beef cattle. More attention should be given to the internal and external parasites and the diseases caused by blood parasites, since dairy animals are less resistant.

Studies are needed on the incidence and control of mastitis. One problem in the stabled cattle, particularly in the Brown Swiss breed, is the frequency of the injuries. It is of utmost importance to prevent these conditions.

3. SWINE

Among the Tropical American countries, Brazil has the best developed swine industry with 0.74 animals per inhabitant and with an average carcass weight of 68 kgs. Good weights are also obtained in Haiti (65 kgs), Bolivia (60 kgs) and Panama (53 kgs), but the availability of pigs per inhabitant is very little: 0.30; 0.15; and 0.13, respectively. In the rest of Tropical America, the production of the swine is not well developed being at the lowest level in Guatemala with 0.12 animals per inhabitant and 28 kgs average carcass weight.

A possible explanation for the low number of pigs in the zone, relates is the feeding requirements of this species. In the countries where the grain production generally are not sufficient to supply the demands of the human population, pork production is in direct competition for these feedstuffs. The development of the commercial production of swine in the American tropics will only be possible upon developing and proving efficient feeding rations based on inexpensive, non competitive raw materials.

The low carcass yields are fundamentally due to the form of primitive production practices on the farms. The small native, mis-shapen, slow growing pigs live in the backyards of the homes and are fed leftovers of the farmers table. They are crude animals that rustle for themselves for their nourishment of the fields, and eat pastures, seeds, roots, insects and small animals. Due to their slow growth, they obtain slaughter weights (50-70 kgs) at the age of 2 or 3 years.

The market demand for these animals makes commercial pig production difficult in relation to the sales prices which adjusted generally to low

quality. On the other hand, the local consummers habit' do not discriminate against the poor quality of this type pork.

Almost all of the imported swine breeds developed in the temperate climatic regions, have been tested in Latin America. Experience has demonstrated that all of them adapt well to the tropical environment, without serious difficulties, provided they are given a minimum of attention. Some of the works of crossing of the native types with the imported breeds show that, in the local environment and under the primitive raising system, the crossbreds do not offer major advantages over the local types, because the conditions necessary for high production do not exist. The commercial production with crossbreds are notably inferior to the imported breeds. The rapid reproduction in swine do not justify the formation of commercial lots based on crossing.

Apparently health and sanitation of pigs do not present special problems in the tropical environment. Nevertheless, the limited experience of the pork producers and the general importance of these problems in such an intensive husbandry, imposes some consideration on the part of researchers.

Based on the above mentioned reasoning, the priorities of research in swine production should be the following:

3.1. Feeding
3.2. Management
3.3. Health and Sanitation
3.4. Genetic improvement

Research can contribute little toward improving swine production on the subsistance farm level without a basic change in their social systems. For this reason, the discussion of priorities in this field will relate only to commercial swine production.

3.1. <u>Swine feeding</u>

The pig is an efficient animal for utilizing high quality feeds. The principal feed for pigs are the concentrates, whereas pastures, roots and tubers can be considered secondary or complimentary under commercial production conditions.

3.1.1. <u>Concentrate feeds</u>

One of the principal criterias for the success in animal production is the efficiency of feed conversion. Wallace (1969)considers that, under Tropical American conditions, from 4 to 4.5 kgs of feed inputs per 1 kg of weight gain is satisfactory. In other countries better conversion rates such as 3.2 to 3.5 kgs per unit gain have been obtained.

Feed conversion depends on a series of factors, the composition being one of the most important. Apparently the feed standards developed under temperate climatic conditions are applicable in the feeding of the swine in the tropics because they are monogastrics, free from the stress resulting from increased body temperatures caused by the fermentation in the bovine

rumen, and by the nature of the feed itself. For this reason, it is not necessary to check the efficiency of the recommendations standards, in regards to energy, protein, aminoacids and minerals. The evaluation of locally grown, low cost raw materials as substitutes for imported or high priced feedstuffs is a fertile field for investigation.

The classical source of energy in the swine feeding is corn. In the tropics, the production of corn is low and its price is high. The substitutes may be the sorgo, rice by products and some dryed roots (yucca, sweet potato, etc.) It seems fundamental that research should define ration formulation with a maximum substitution of corn with these by-products, without sacrificing feed efficiency or producing capacity.

Another indispensable ingredient in the diet is the soybeans because of the high biological value of their protein. Considering that up to the present time in the tropics an economic level of cultivation this legume has not been developed, it is necessary to find suitable substitutes or replacement feedstuffs among the by-products of the tropical oil-producing crops (sesame, peanuts, and cotton).

The use of materials of animal origin is considered indispensable in the rations of swine, although they may be minimum quantities. In the tropics, the by-products of the slaughter house, such as the various fish products, although of inferior quantity, are not very differentiated from the same products in the temperate zones. It is of great importance to study their effect in the feed mixes for pigs and the minimum quantities necessary for animals of different ages and types.

Finally, another feed ingredients of high nutritive value is alfalfa meal, an expensive product that is difficult to obtain in the tropics. Unfortunately, among the tropical leguminous not one is capable of replacing alfalfa in the swine ration. Nevertheless, it is necessary to continue with the studies of the most promising plants (Ramio, Crotalaria, Yucca leaves, etc.) in order to emancipate the Latin American countries of their dependance on alfalfa.

3.1.2. <u>Pastures for swine</u>

Although pastures consumed in large quantities reduce the digestibility of concentrates and limit growth and fattening among pigs, its use as a complement to the ration, or as the basic diet of certain groups (dry pigs, and reproducers) is of importance.

The tropics are characterized by having large pastures low in nutritive value, that are not appropriate for grazing pigs. The assays made with some legumes (tropical Kudzu) have not given satisfactory results, since these plants do not withstand the growing and rooting habits of the pigs. Among the grasses, the best result have been obtained with the tender Pangola, although its relatively high fiber content decreases the digestibility. Among the plants considered weeds, some (sweet pyre, white) have good palatibility and are very well utilized by swine.

It is necessary to follow through with these studies, extending them with the introduction of new plant species, agronomic improvements of the existing

ones exist, fertilizations, etc.

Some tropical fruits (auyama, yucca, sweet potato) could substitute for pastures in pig rations, but their production is scarce and expensive.

3.1.3. Feeding of the various groups

Apparently, the feeding of the principal groups of pigs in the tropical environment, is much the same as in the temperate climates. Nevertheless, recent reports (Wallace, 1969) on the feeding of pregnant sows show a negative influence of high level energy on the viability of the fertilized ovum with a recommendation for high level feeding (8 lbs. of feed/day) in the period before the service, followed by a decrease during gestation (3.4 lbs at the beginning and 5-6 lbs in the last month). Since this system has not been tested in the tropics, its evaluation is advisable.

3.1.4. Mineral supplements

No unique problems regarding mineral supplementation of pigs have been noted in Tropical America. In the Andean regions, it would be of interest to study the manner and the minimum levels of iodine needed. Throughout the region some attention could be given to the problem of supplying iron to the newborn sucking pigs.

3.2. Management of swine

The high environment temperatures thoughout the year apparently has little influence on the growth, development, fattening and maturity cycles of swine. Nevertheless, it is necessary to compare the different systems of rearing and management of pigs, already in use in the temperate climates, in order to determine the most advisable modification needed in tropical regions.

3.2.1. Raising of sucking pigs

By experimentation, it is necessary to determine the most advisable length of suckling period, from the viewpoint of the best growth of the piglets, as well as from the reproductive aspects of the mothers.

3.2.2. Brood sows

A recent practice in swine production (Wallace, 1969), is to keep brood sows in the herd not more than 5 or 6 parturations. Generally, it is considered that the females should be sold after their 2nd or 3rd litter, in order notto maintain the sows too big and overweight and also to accelerate the process of genetic improvement.

Without doubting the above observations, the need of conducting studies in the different ecological and economic regions of the tropics may be suggested, in order to determine and demonstrate the comparative advantages of the different methods.

It is also important to determine the advisability of maintaining dry brood sows under a pastoral regime so as to provide obligatoty exercise and

maintain a stable weight.

3.2.3. Reproduction

Normally, the heat period in the sow appears at about 2nd or 3rd days after weaning and remains for 2 or 3 days.

Thereare contradictory opinions regarding the advantages of only one or several servicesduring the heat period as well as on the best hour and day. It is of interest to clarify this situation under tropics conditions.

Generally, it is recommendable to use the young boars as much due to its light weight, as to the possibility of castration, with less risk in animals of reduced size. Since the information relative to the tropics does not exist, it is necessary to dedicate a series of studies to this problem, complementary with the determination of the maximum number of female that can be serviced by a boar during a season or year.

3.3. Health and Sanitation

The infections diseases and parasites of swine in the tropics are the same as those prevelant in other regions. The only regional disease, not found in the United States, is foot and mouth disease, against which national campaigns are made.

Regarding health and sanitation problems, research should be directed towards resolving the problems of the best vaccines and preventive treatments and the determination of the best times and frequency of their application.

3.4. Genetic improvement

3.4.1. Selection criteria

In Latin America, the selection of swine is not guided by well established firm criteria but is performed in an empiric way. Taking as an example the system employed by the University of Florida (Durrance, 1969) it would be recommendable to initiate, in an experimental form, selection, on private farms of replacement animals based on the following criteria: use only animals from litters with no less than 8-9 weaned piglets. Do not save animals with less than 7 pair of well developed evenly spaced teats, keep for replacement 25% more than the required number. Base the selection on the efficiency of feed utilization and average daily weight gains.

It is important to know the thickness of the backfat over the loin, the loin area the length of the carcass and the percentage of lean meat in the sires and the close relatives of the selected animals. Since the breeding males are of great interest, making comparative studies among the group of descendents, based on the preceding criteria, are needed in order to choose the sons of the best boar.

3.4.2. Selection of breed and their crosses

The most popular breeds in Tropical America are the meat type including the Landrace, Tamworth and the modified Duroc Jersey.

Being animals with short generation interval, it is important to take advantage of the hybrid vigour in the crossbred animals. Toward this end, studies on alternate and rotational crossings are needed with two or more breeds in order to inform the producers of the most advisable system for this purpose.

4. SMALL RUMINANTS

The commercial production of sheep and goats is not well developed in the Tropical America. Only the Andean countries, Bolivia and Peru, have a relatively large number of sheep (1.31 and 1.27 animals per inhabitant, respectively), due to their particular characteristics of the mountainous regions. Goats in small numbers are raised throughout the region, as a complement of the family nourishment of the farmers.

The commercialization of sheep and goats are not specialized. From the sheep, meat, milk and poor quality wool for the home-made production or crude weaving, is obtained. The goats are kept for the production of milk for the family and for sale of goat meat, that has a great demand in certain countries.

Determining research priorities in small ruminants has no purpose without having first estimated the future possibilities of these enterprises.

4.1 Commercial sheep production

An ecological and economic study of the specific regions, should be conducted to determine the possibilities of commercial raising sheep in the American tropics.

It is necessary to determine the possibilities and limitations of the meat production under as affected by the tropical climate. Upon verifying the economic possibility, it would be appropriate to determine the best type of animal for this purpose.

Since wool production hardly offers sufficient economic incomes, it would be necessary to search for new systems, methods and types of animals that would permit combining two and even three types of production: wool, meat and milk.

Only upon resolving this problem is there a need of initiating detailed studies on nutrition (forages), herd management, genetic improvement and sheep health. Basically,these studies can follow the course described for cattle, with the introduction of specific changes, typical for sheep production.

4.2. Commercial goat production

Goats, generally speaking, are raised in arid or semi-arid zones where no other type of animal can suvive. The existing types are small animals, misshaped and slow growing, but extremely adapted to their environment. improvement of this animal would have no purpose, without changing the living conditions, especially, the availability of feeds.

In order to improve the commercial production of goats, it is necessary to start with the search of plants that are resistent to pasturing and lopping twigs in the dry mountainous regions, of systems of their massive propagation

and the agronomic measures which permit maintaining the fragil natural equilibrium of the soil and vegetative resources of these regions. Apparently, it would be necessary to look for possibilities of using aerial plantings in these regions, using mixtures of seeds and fertilizers. Only on the lands with vegetative growth occupied by the goat would it be possible to think about improvement of rearing systems, utilization and improvement, with the objective of improving their producing capacity.

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Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-3 Dr. H. H. Stonaker, University of Nebraska
Mission in Colombia

Title: ESTABLISHING RESEARCH PRIORITIES FOR LATIN AMERICA LIVESTOCK ASPECTS

By and large, research efforts are so beneficial that it is a task to determine which ones should receive priority. This infers that we will continue to live with a shortage of funds, and most of us have had much experience of that kind. However, in addition to a sufficient quantity of money, there are other fiscal situations in which we must seek some assurance of make recommendations before we develop opinions on priorities.

Sometimes even when there are funds available in rather large quantities, they cannot be well utilized because of the fluctuating manner in which they are available. Allocations may be so sporadic, that it is feast of famine and research continuity becomes almost impossible. Those of us in the life sciences know how difficult it is to adjust to such a situation. There has been a worrisome amount of this in the United States during the past decade. The heavy shift toward the funding of research on a grant basis makes it difficult to maintain a good research organization. The Viet-Nam eras pre, early and present have shown us how extremely cyclical in nature research funding can become. Solutions for this must be found in the interest of maintaining good research organizations and in providing good prospects for careers in research.

The system of operating on the basis of research grants, and, incidentally the associated skills in obtaining them for an institution, grantsmanship, have built into them many of the advantages of obtaining efficiency in research production through a competitive business like approach. This makes the method of specific research grants attractive to those responsible for the administration of large research budgets. Success reflects upon the granting agency if the payoff from certain grants is particularly high. On the other hand, the method offers a very easy method to immediately discontinue an unproductive project without the headaches of what to do with those professionals and facilities that remain in the hands of some hapless university department. Good scienctists should not tie their careers to such a roller coaster existence. The Universities and other research institutions will have to evolve some modification of the grant system which can assure continuity to good programs.

My dwelling upon this problem of continued support is related to the assigned subject in that again we must avoid wasting effort in developing

research which has little probability of being continued. Recently I heard an account of one Latin American country in which 6 to 8 agricultural research stations had been built and opened when there was a surge of interest and availability of funds. But now, all but two of these are closed, and even these are having financial problems. Undoubtedly, at the time, under the circumstances, good judgment prevailed, but perhaps there is something to be learned from such an experience. The point again is that somehow there must be continuity. It is built into other institutions which serve the public and is an essential requirement for research institutions, as well.

In contrast, we could all enumerate examples of excellent results when fortunate combinations of scienctists, projects, locations and assured support have been put together and the work maintained at an adequate level for at least two decades.

These are things we hope for and must have in the development of high projects for the livestock industry in Latin America.

IMPORTANCE OF RESEARCH WITH RUMINANTS IN LATIN AMERICA

The case for livestock research of a considerable magnitude in Latin America rests basically upon the magnitude of grass and forage production. Colombia, which is best known to me and which is not atypical in this regard, obtains its greatest agricultural contribution to the national economy through its pastures and forages. This, of course, is harvested primarily through cattle. There is interest in other ruminants, as well, but in much of South America, cattle are the principle ruminants involved in this harvest.

Perhaps for this audience, this in itself should be a sufficient indication of where priorities should go in Latin America. However, this will certainly not suffice for many who will have an influence on decision making. It becomes helpful to develop some kind of a model as a guide in decisions regarding priorities.

The concepts presented herein are related to their probably impact on gross national product. This is not the approach some would take because of considerable current interest in research that relates directly towards reversing trends of rural people to migrate to urban centers and in research that can help in changing the structure of land ownership. Thus there is an appreciable concentration of interest in the socio-political aspects of agricultural research at this time. However, results that can increase efficiency can lead to fuller employment, regardless of the structure of land ownership.

If we have to make the decision of how many resources are to be mobilized for use in commodity A versus commodity B, we need this information:

1. The current contribution of the specific product, such as beef or milk, to the gross national product. Results of research that can be applied to a great quantity of product versus a small quantity obviously contribute more to the gross national product. This type of information

can be obtained from FAO or national statistical reporting services.

2. Probable rate of return from research. There have been some useful estimates of rate of return from research investments. Perhaps one of the best known estimates is that developed by Dr. T. W. Schultz for the USA, which indicated remarkable returns for agricultural research investments. I think large returns in U.S. do not necessarily indicate large returns elsewhere. Adoption of new technology is necessary and that requires a good extension program, which most countries do not have. I think his estimates were made even before the tremendous payoff was realized from the rapid spread of improved varieties of wheat and rices through many areas of the world where food shortages have been common. As to what area of research within agriculture will now give the largest rate of return, I would not like to hazard a guess, for there would be no faster way to bring pathologists, geneticists, nutritionists, physiologists, economists, etc. to sword points. Who will make the next big breakthrough is the question that makes research interesting. But we do not need to involve ourselves in this type of hopeless debate, for all areas are needed in a team approach to complex production problems. Could we dispense with such a debate by indicating that in varying lengths of time, they can all surely contribute to a doubling of production. So for the sake of simplicity, let us use the factor of two as the immediate goal for increasing production through research.

3. Time to reach a given stage in an area of research. Obviously, the time to produce a generation of cattle is different from the time required to produce a generation of corn. Time is money. Scientist years and facility-years are going to be different for different kinds of research.

4. Cost in time and money to get adoption. Again this is highly subjective, but some type of estimate should be within our grasp. Adoption of new methods in cattle production cannot be felt in the economy as rapidly as they can in the production of a grain crop, assuming a similar organization of extension, nor will adoption be as quick for 5% increase as for a 200% increase in production.

5. Probability that the research may be undertaken by government or private industry. This is a factor of great importance to foundations, for example. Some things are almost certain to gain sufficient public interest to assure support, other have sufficient promise of being patentable and profitable to attract industrial interest in research. Often, however, there are excellent opportunities that have low probabilities of implementation through these important sources of research fuding.

The flexibility and ability for filling these vacuums is a particularly important justification for the existence of private foundations. Their abilities in this regard have many times proved how much they can contribute.

Thus the foundations perform the important function of complementing research areas in the tax supported research institutions. As we proceed

to see what can be done with some sort of a model for appraising priorities, we will not concern ourselves with this probability, realizing however, that it is very important. We can empirically test these ideas as to their importance to the economy, rate of return from research, time and costs for doing the research and getting adoption. If we use some of the information available in Colombia, we can come to a general ranking of anticipated results from a given investment.

In the comparison we will use the examples of beef vs. swine vs. dairy vs. corn research in Colombia. Each product is further broken down into broad types of research; that is, breeding, nutrition, and health. For corn it is broken down into breeding, soil fertility and plant protection. The estimated results in terms of relative research returns over a period of thirty years are shown in Table 1. The basic information of estimates on present contribution to the economy in money, increases in annual production expected from research, and time for research and adoption also are given. Relative costs of doing the research are not given, but it is believed that these may not be greatly different, as in livestock research the great net cost is in scientists and in the cost of operating laboratories. In the case of using experimental farm animals, the net costs are probably less or not much different than for other types of laboratories. There is, of course a difference in the original capital requirement and this has always plagued the opportunities for good research with farm animals.

TABLE 1. Empirical estimates of relative returns from research in beef, dairy, corn and swine for Colombia.

	Estimated Value of Production in 1966 (Min.of Agr.)	Returns Due to Research over 30 year period	Relative Research Returns	Years Needed for Research (R) Adoption (A)					
				Breed		Nutr.		Health	
				R	A	R	A	R	A
Beef	3,668,000,000	61,150,000,000	100	10	10	5	5	5	5
Dairy	1,872,000,000	31,200,000,000	51	10	10	5	5	5	5
Corn	813,000,000	19,312,000,000	32	5	2	3	3*	3**	3
Swine	589,000,000	12,544,000,000	20	5	5	5	3	5	3

Colombian pesos   *Soil Fertility   **Plant Protection

Over a period of thrity years in Colombia, research in beef should return over five times that in swine, three times that in corn and double that in dairy. It would be expected; however, that many of the results from cattle research (beef or dairy) would be interchangeable, and perhaps it is unwise to separate them. Over 61 billion Colombian pesos would be expected to be returned to Colombia from the first stages of research used in beef cattle long over that thirty year period, or over 100 million dollars per year.

Additional priority for improving the cattle sector comes from the economic potential of beef as an export possibility. It is thought that beef should produce a greater multiplier effect in generating employment and exchange than may exist for products, such as corn, sugar or coffee. The latter chronically encounter problems of competition, demand and quotas on international markets.

THE CIAT STUDY TEAM IN THE ANIMAL SCIENCES AND SOME OF ITS RECOMMENDATIONS

Last August, CIAT through a Ford Foundation grant group of animal scientists made up of Dr. J. J. Callis, Director, Plum Island, Island Animal Disease Laboratory, USDA, Dr. J. T. Gallo Sub-Director National Swine Program, ICA Colombia, Dr. L. J. Lambourne, Head Beef Cattle Research Group, CSIRO, Australia, Dr. K. L. Turk, Professor of Animal Science and Director International Agricultural Development, Cornell University, USA and myself made a brief study of the livestock research activities of Colombia, Ecuador, Brasil and Venezuela (countries which include much agricultural land in the tropics of Latin America), and reported its observations to the newly formed Centro Internacional de Agricultura Tropical, (CIAT). Parts of this study pertain to the subject of this paper. While the emphasis of the study team was not necessarily to develop priorities, there were interesting comments relative to opportunities that might presently produce the greatest rewards. An important observation was made that there is a very great shortage of advanced training in the animal sciences, particularly at the Ph.D. level, and that the research now required necessitates this type of education.

Members of the team expressed views such as these. The bigger chalenges to research workers and to the economies now lie in the more remote and difficult grazing areas, which are not presently served by strong research facilities. It is necessary to concentrate on fewer but better production oriented topics which must be studies primarily in cattle country. It was not felt that there should be a great expenditure on "fundamental" types of work at this time as there are many well equiped laboratories and staffs presently in operation well able to undertake the type of problem that is likely to occur in the tropics. Stressing production oriented research is not to indicate a lack of appreciation to those who are engaged in research that is less directly tied to immediate production problems. It is simply a matter of attempting to orient scientists toward problems that now limit the productivity of these regions. The depth or quantity and quality of the research that is required in doing this will challenge the very best scientists and students that can be interested in a serious involvement in this work. The team did not involve itself with the debate of basic versus applied. Research in this instance is to solve problems which will ultimately improve productivity and in so doing, help the people to help themselves. That should be enough of a challenge for any thoughful scientist desiring to make this contribution and reputation.

Stress was given to measuring the persistence of improved legume-grass of grass pastures with grazing cattle. Use of tropical legumes in contrast with the economics of fertilization must be done in close conjunction with pasture

crop programs. Year-round continuous grazing studies and their relationship, not just to short time gains, but to reproduction, time to slaughter, and in fact life time cycle work in relation to cattle production were urged. Practical production systems were emphasized in relation to pasture studies. Mineral and nutrition studies on the same bases need to be integrated with the legume-grass studies. Package production programs were indicated.

Heavy involvement in the extension of present world wide effort for such things as fundamental involvement in aftosa research was unanimously discouraged by the team. This could easily absorb all of the likely resources, and fine laboratories are already established for this research, this is not to imply, however, that they are all obtaining adequate support. Particularly, PAHO, the Pan American Foot and Mouth Disease Center in Rio de Janeiro was not obtaining the support originally planned. Cooperation of a close nature was urged in livestock laboratories with new developments and the testing of control measures of the important hemoparasitic diseases and ecto and endo parasites as related to pasture managment. Vaccines for many diseases, including reproductive ones were felt to have rather high transferrability from one region to another. It was felt that private industry had much to offer in assistence in testing and the development of useful and dependable vaccines and medicines. It seems that good research was being done on rabies vaccines in the USA, an important cattle disease in Latin America.

The opportunity appears to exist now in cattle and forage breeding much the same as existed 25 years ago in rice and wheat breeding. The economic impact of such research in Latin America could even be greater. Prevailing knowledge and practice in cattle breeding resemble that known to the team in the United States in the forties, which then had practically the same orientation as had existed for the previous century. Further it seemed unlikely that there can be much transfer of improved beef genotypes from temperate regions, where rapid development in genetic improvement is now taking place. More critically, despite recent indications of the benefits from the use of Criollo breeds in crossing, there has been a rapid grading away of these breeds with Cebu and few attempts are being made to isolate and improve the Criollos.

The team felt that dairy cattle problems and beef problems in many cases were sufficiently similar that the results would be highly applicable to both. Thus nutrition and grazing projects would also have high priority in dairy research. Special interest was expressed in reproductive problems in dairy cattle and with lactation physiology as related to milk let-down. The importance of the preservation of some of the better Criollo milking strains for use in the long term improvement to dairy animals for the tropics also was stressed.

Major limitations in swine production in these tropical areas were noted in the fields of nutrition, management, and diseases. While it was felt that much of the overseas research with swine is transferrable to tropical Latin America, the wide variety of tropical sources of feed energy and protein that may be adaptable to swine production needs investigation. Management, housing,

control of parasites, and marketing were other areas that need investigation. Training of personnel in swine production and research was indicated to be highly important for the further rapid development of swine production in tropical Latin America.

We hope to look to the new organization, CIAT, for stimulating an implementing much activity in these research and training areas related to important livestock problems in the tropical zones of Latin America.

Another completely different organization that will perhaps become the one that contributes heavily to the long term direction and development of high quality research and dissemination of results is the indigenous organization ALPA "Asociación Latinoamericana de Producción Animal" For a young organization, it is showing unusual strength and rapid development. At its second meeting in Lima in December, 1968 there were 254 registrants and 150 observers with the following countries represented: Argentina, Bolivia, Brazil, Colombia, Guatemala, Mexico, Panama, Paraguay, Peru, Puerto Rico, United Kingdom, United States, Uruguay, and Venezuela. One hundred and eighteen papers were given, with 65 in nutrition, 34 in reproduction and genetics, and 19 in pastures and forages. Therein is the stimulation to the international scientific community for doing sound research that retains close relationship to the actual problems of Latin America. Thus this organization will soon efficiently indicate priorities as well. The rapidity of communication of results will be much enhanced by ALPA. All of us will do well to give it maximum support.

The enormous pasture-forage resource in Latin America, which exceeds any other single agricultural resources dictates emphasis on <u>life cycle production-oriented research</u> with the ruminants, particularly cattle. Investigation will have to be in the areas where cattle production often is the only presently feasible agricultural enterprise. The stimulus for highest quality livestock research and rapid communication will best come through the strengthening of ALPA. The emphasis on ruminant research does not mean that there will be relatively less payoff with swine or poultry research in the region. Some of the most rapidly advancing animal science is and will continue to be with these species.

A bright future exists for the livestock industry's contribution to the economy of Latin America, if it can receive the benefits of many innovations which only research can provide.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-4 Dr. J. Blydenstein, FAO, Rome, Italy

Title: ESTABLISHING RESEARCH PRIORITIES FOR LATIN AMERICA: LIVESTOCK ASPECTS

The word priority means giving precedence to one thing over another. The force of circunstances may be such that one thing gets pushed in front of another, but usually we intend to have better control over the situation and the act of giving precedence implies a conscious selection. This choice must be made whenever there are more problems than we can cope with at one time because of restrictions in facilities, time or money. Of course, it is possible to avoid making a choice, by lifting the above restrictions. It is to a Director's benefit to seek more funds for the institution he administers, since his reputation depends on the impact of the total work it accomplishes. But here he is battling for priority at a higher level where the interests of livestock as a class must be weighed against other agricultural, or even industrial pursuits. Once the Director has fought his battle, the first restrictions have been set and the work is necessarily limited by them. It is now up to the next lower level to determine how to work most effectively within these limits, and the problem of priorities remains.

To establish research priorities valid for all of Latin America is clearly an impossible task. The diversity of ecological environments creates a wide range of problems with different priorities in different regions. For an educational institution with continent-wide responsibilities this poses quite a problem and it is intended in this paper to study the establishment of research priorities within this institutional framework.

Two viewpoints

The scientist likes to think that his approach to the selection of priorities is positive. He will analyze a complete system of production, identify specific problems which limit productivity and assign these problems a priority in relation to their restrictive influence. Such an analysis is of course limited to the particular system under study and the priorities determined are valid only for that system. Research priorities for livestock raising under the humid tropical conditions of Turrialba may not be the same for the wet and dry tropical conditions just 100 miles away on the Pacific Coast of Costa Rica.

The administrator is usually known for his negative viewpoint. Faced with a series of demands which go beyond available resources, he has to cut and reduce until they fit the size of his budget and facilities. Sometimes this is simply done by a blanket reduction of all requests, and the question of priorities is ignored. The better approach, however, is a careful selection amongst demands and the adequate support of some at the expense of eliminating others. In this process, the technical advice given in support of various demands may be quite contradictory. A good scientific case can usually be put up for the importance of any project proposed. Thus the administrator often depends on such non-technical factors as long-term commitments, stability of personnel, even political pressures.

As the exercise of setting up priorities is quite sterile if it does not result in policy decisions, the deliberations leading up to priorities should take into account not only the technical problems but also the practical possibilities and limitations. For example, a higher level policy decision may already have restricted the freedom of choice. At the Department of Animal Husbandry of the Graduate School of Turrialba it was decided some time ago to work exclusively with cattle. This automatically eliminates all proposals for studies on chicken feeding or horse breeding until the whole question of priority of cattle over chickens or horses is reviewed at a different level. Another restriction, which cannot be modified, is the climatic environment. This problem was recognized and considered important enough to make funds available for a special livestock training centre of the Graduate School of IICA in a temperate environment. A third restriction is the emphasis on teaching and the secondary role of research in support of education. Again this is a higher level policy decision and not up for review at the level under discussion.

The forementioned restrictions illustrate how priority decisions at a higher level (cattle over other livestock, education over research) have implications on the freedom of choice at lower levels. This is a recurrent effect at every step, down to individual research projects.

Definition of the system

The scientific approach can be used more easily to set up priorities for research to be carried out at an experiment station, because the station presumably serves a defined region of which it is representative. An analysis can be made of livestock production systems within this region and research priorities can be drawn up in accordance.

With an educational institution, however, the task is not as easy. Students come from many environments with a wide range of problems. The institution must prepare scientists to work in these potentially very varied environments and the training cannot be limited to the problems of local importance at the site of the training centre. Thus the desired training becomes all-encompassing and only the restrictions of environment become binding and unarguable in the sense that somethings just cannot be demonstrated at the site of the centre.

When making the choice on what to eliminate and what to strengthen, it must be clearly understood that in this case we do not deal with priorities in a livestock production system, but within an educational system. Our basis of

selection is thus not a technical question of what limits production of livestock, but rather of what to teach a livestock specialist in order for him to work effectively.

First consideration for elimination

When faced with having to eliminate something from a complete theoretical programme, the first choice often is to eliminate that part which is the least loss. In a research, as well as a training programme, this can include important sections which are already being worked on elsewhere with results applicable to the local situation. An example in livestock research might be the whole field of veterinary investigations. This important aspect is adequately covered by several specialized institutions in various environments, and the elimination of research in this particular field from a specific livestock training programme will not prevent those who are interested, from getting this training elsewhere.

At the same time, such an elimination will free a large amount of resources for a stronger programme at the institution concerned, in other aspects of livestock production. This is an important consideration which should receive high priority in a training-oriented research programme. It is often on the strength of its accomplished research that a training institute is judged and a strong programme in carefully selected aspects of livestock production is better than a more general but mediocre research programme.

Implications of inclusion

The implications of excluding a certain phase of research are rather clearcut as far as the institution goes; more resources are available for something else. But the implications of including that "something else" are more difficult to evaluate and must be studied carefully from both the technical and administrative viewpoint, before assigning priorities and making policy decisions.

Maintenance costs may far exceed original purchase costs, and the ability for sustained support of a particular research programme must be weighed. Natural development of some research projects may lead to too much concentration in a narrow specialization of the total field of livestock production and tie up too many resources, which unbalances the overall programme. In some cases, a unique set of circumstances may make concentration of work in one particular specialized area very fruitful and this possibility should certainly be considered. But for an institution basically interested in education, the balance should rather be towards a more general programme, with a couple of well-selected points of focus.

The time factor

A regular research programme usually is designed to solve specific problems. The quicker the results are available, the better. Thus there is always a tendency towards short-term research. An educational institution, on the other hand, can afford a more long-term view and is more independent of the immediate pressures of local problems.

There are also other considerations when deciding on priorities between research programmes of equal merit but with different timetables. On the side of the longer term is the argument that it is better to start something right away, so the results are available when the need becomes apparent. This, of course, always involves a certain element of risk, as the needs predicted for twenty years hence may change in time. For example a breeding and selection programme for adaptation to a certain environment may lose its usefulness if advances in management and health care change this environment considerably.

Research to support a graduate training programme also must fulfill the requirement of flexibility and divisibility, so individual students can complete research problems on small sections of a general programme within the short time they are at the institution. Faculty research can give the desired long-term coherence to such a programme.

Priorities in livestock training and research

From the above, we can see how certain restrictions on our freedom of choice are imposed by the educational system which we chose to examine. Other systems will have different sets of limitations. Within the educational framework, the basic choice of priorities is in the selection of focal points for a research programme which plays a supporting role to a general educational emphasis.

Some judicious combination of specialization is possible. For example, certain practical aspects of animal health research can be taken care of within a general animal management programme, and animal physiology research can be carried out within the framework of a nutrition programme, all to an extent which is adequate for training purposes. The reasons for the de-emphasis of these particular aspects of research are that emphasis on an animal health programme implies the allocation of a large amount of resources in a narrow field and a very unbalanced general programme. Similarly, advanced work in animal physiology becomes rather basic in nature, and expensive, and has little direct relation with agricultural training.

This reduces our possibilities to three basic research aspects: Animal breeding and selection, animal nutrition, and the closely realted subject of pastures and fodder crops. Breed improvement and cross-breeding programmes are long-term projects which are difficult to split up into discrete units for student research. The proper use of bulls with cow breeding units, selection on the basis of productivity, and other such aspects, are more of a demonstration than a research programme. They properly fall under good management. Long-term breeding programmes also have a tendency to occupy a large share of available facilities, as adequate numbers of animals are needed to draw valid conclusions.

All above considerations would point toward a lower priority for animal breeding than for nutrition and pasture work in a research programme supporting training and education. It must be remembered here, that we started out by defining priority as giving precedence of one thing over another. If resources are adequate to do both, animal breeding would be high on the list of things

to include. In the process of making a decision on its inclusion or elimination, it does not compete with other animal husbandry research but with programmes in other Departments of the educational institution. As far as animal husbandry goes, it is a clear second choice, but the question is how does it compare with strengthened programmes in, for example, solid physics, silviculture or coffee cultivation.

All this leaves us with animal nutrition and pastures. Both aspects are closely integrated and their separation would be difficult. Cattle are roughage converters and transport costs on bulk are too high to permit a separation of the functions of cattle raising and fodder production. With swine or poultry it is a simpler matter to buy a variety of concentrated food stuffs, but earlier we mentioned a high-level policy restriction to work with cattle only and thus we are stuck with pastures.

At this stage we whould have reached a point in priority selections where we should be within available resources. To do adequate work in two fields, in this case animal nutrition and fodder production, is a minimum as far as research support for an educational programme is concerned. If this minimum cannot be supported, we are right back to examining priorities at the highest level and we must ask the question if livestock has a high enough priority to get adequate support at all. Assuming that this question was answered in the affirmative, our priority deliberations at this stage move to the lower and more technical level of selecting which experiments are to be carried out within the general fields of animal nutrition and pastures. Personal preferences of individual investigators, availability of supporting research in other Departments, outside stimulations, all of these play increasingly influential roles at this level. Political decisions based on factors of personnel stability or long-term commitments may become a matter of personal disagreement but are beyond changing at this level.

Now a new set of restrictions is operating in a new system: The Animal Husbandry Department. As in the case cited of the Institution Director, here it is the Department Head who fought his battle for priorities at the higher level just discussed, in competition with programmes of other Departments. Now this priorities have become policy decisions and the priority deliberations at a lower level concern different problems which should be reviewed within the system framework at which they operate. The problem here becomes the choice between emphasis on concentrate feeding, use of supplements with fodder, calf nutrition, or forage plant introduction, grazing systems, fertilization trials just to list a few of the many possibilities in each field.

Concluding remarks

At each level of decision making, setting priorities is a function of the system at that level. At the highest level, we are working with a mainly political system, and purely technical considerations have little influence. However, the resulting high-level policies have a restricting influence on the freedom of choice at lower levels and the policy makers should be made aware of the technical implications of their decisions at that level.

Only at the lowest level do purely technical considerations have a dominating influence, even though here they have to compete with personal preferences as the decisions become individual matters. Here the problem under investigation becomes the system and it can be described in technical terms, requiring technical solutions.

It is at the intermediate levels, that priorities become most critical, as the restrictive influence of resulting policies becomes much more keenly felt at the lower technical levels. The systems here are the successive levels of institutional organization, each with a restricted and usually farily well-defined radius of action. We must review our priorities against the background of these systems, with both technical and political factors influencing our decisions. The purely technical review is not acceptable to the administrators who have to take into account the more political system at the next higher level from which the supporting resources are derived. At the same time, a purely political review is not acceptable to the technical people who will have to translate the decisions into technical programmes.

In this paper an attempt was made to carry out such a review on a mixed basis, taking as the system under consideration the theme of this panel: Post graduate education and associated research.

Inter-American Institute of Agricultural Sciences of the OAS
and
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Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-5 Dr. Laurence Snook, FAO Officer IICA-CEI, Costa Rica

Title: THE NEED IN LATIN AMERICA FOR LONG-TERM STUDIES ON PASTURE MANAGEMENT.

One of the most important objectives of this Panel is to determine which forms of post-graduate training are most likely to stimulate increased production from livestock. But the prime essential is to recruit men of top quality. To do this it is essential to show that animal husbandry is a field of endeavour in which the work is interesting and the results worthwhile.

The simplest and most obvious way to increase livestock production is to provide the animals with more food of better quality. The importance of correct feeding and good management is readily acknowledged by everyone. Unfortunately, all too often, the acknowledgement is made but no action is taken. For this reason it is necessary to impress on every student -and on every lecturer- that the well being of domestic animals is influenced all the time by the quality of the feed which is available, and by the skill of the management. For grazing animals these two factors are interdependant because the quality of an established pasture is determined primarily by the management. This paper has been prepared to attract attention to the importance of the attributes which constitute good management, and to show that in this field there are opportunities to carry out applied research which will be fascinating in itself and which could also yield results of major economic value.

Advantages of production from pasture

During recent years much publicity has been given to efficiency of livestock production in feed lots, and in "intense" factory units. It is important, therefore, to emphasise the fact that there are many advantages in the use of pasture, and that in the foreseeable future man is likely to become more, rather than less, dependant on grazing animals. Pasture is by far the cheapest feedstuff. Particularly is this so in tropical and sub-tropical countries where livestock can remain out-of-doors throughout the year. Admittedly much of the land which is now being used to grow pasture will in due course be required for the production of food which can be consumed directly by man. But there will remain extensive tracts of country which are too stoney, or too hilly, for the growth of arable crops. Such areas can be used very profitably to provide pasture for grazing animals. In Australia and New Zealand, for example, large numbers of sheep and cattle are reared in rugged country which not long ago was by-passed as being valueless. Aeroplanes are used to distribute the initial planting of seed along with fertilizer, and are then employed to apply the annual top-dressing. The use of aeroplanes

for this purpose has proved so economical that aerial contractors are commonly employed to apply fertilizer to flat land previously serviced by the farmer's own machinery. No doubt aeroplanes are, or soon will be, used for a like purpose in Latin America.

In countries with extensive areas of low rainfall country, a very profitable system of "mixed farming" has been developed in which grazing animals are used to build up fertility on pasture land which can then be used for crop production for one or two seasons. With improved pasture management, this system is becoming more and more efficient, both for the production of cereal grain and livestock.

Improved methods of pasture production on areas with marginal rainfall are now permitting a spectacular increase in the number of grazing animals which can be maintained with safety. Particularly is this so in tropical regions. All-in-all, there is every reason to anticipate that the fruits of research in pasture production will be put to good use for many generations ahead.

How can production from Pastures be increased?

In general, the productivity of a pasture is determined by:

1. the climate.
2. the fertility of the soil.
3. the plants in the pasture.
4. the management.

Very little can be done about the climate - except to provide irrigation water - but the other three factors are very much within the control of man. Initially most Australian soils were so infertile that it was impossible to grow any pasture at all until the correct fertilizers were applied. Likewise just about every productive pasture species had to be introduced. This being so, perhaps it is understandable that Australians attach great significance to fertilizer trials and to plant introduction. During recent years, however, more and more attention has been given to pasture management, and in particular to the very important influence of the grazing animal on overall production.

In contrast to Australia, there are extensive regions in Central America with a generous rainfall, soil of reasonable natural fertility, and an excellant variety of indigenous grasses and legumes, In regions with such advantages perhaps the most important immediate requirement is improved management. In fact, it seems that in most cases all that is required is phosphatic fertilizer and good management.

What is known about pasture management in Central America?

To most people pasture management means rotational grazing, regular mowing to control weeds and rank growth, and harrowing to spread dung pats. These practices fit in very well with long established conventions and seem so logical that it is a matter of surprise that anyone should query their validity. But even if we accept this convential system of pasture management, there are many questions which can be asked. Which is the best system of rotation? How often should the mower be used, and at what height, for the different types of pasture? Should large numbers of cattle be used to graze a small field quickly,

or should smaller numbers be used over longer periods?

And then there are heretics who talk about grazing pastures continuously, and who query the use of the mower. But before we discuss whether these innovations have any place in Latin America perhaps we should review some of the results achieved elsewhere.

The need for an objective

In order to encourage research workers to enter a particular field it is necessary to provide an objective which will serve as a challenge, and provide a stimulus. Perhaps the best way to do this is to show what has been achieved, in the hope that this will generate the desire to do even better in new environments. Research results achieved at the Ruakura Experimental Institute in New Zealand provide an excellent example of what can be done, and should give every encouragement for the planning of similar work in Latin America. At Ruakura, in the 1959-60 season, an experimental herd of 40 Jersey cows restricted entirely to 35 acres of perennial rye grass-white clover pasture, produced 500 lbs of butterfat or the equivalent of 12,500 lbs of 4% milk per acre (14,200 kg milk per ha). This very high level of production was achieved entirely from the pasture grown on the allotted area-no concentrates were fed, nor was any roughage brought in from outside. The only fertilizer used was 224 lbs of serpentine superphosphate per acre (255 kg/ha.). (McMeekan and Walshe, 1963). The yields quoted above are from single lactation in one year.

It was several years before this high level of production was again achieved but in 1965-66 a herd of 80 Jersey cows averaged 626 lbs of butterfat per acre of pasture, or the equivalent of 15,650 lbs of 4% milk/acre/annually, (17,780 kgs. milk/ha). This again was achieved entirely on the pasture grown on the alloted area, in a season during which there were 75 frosts and a lengthy drought period. If the New Zealanders can achieve this high level of production in such a climate, what should be the goal in the more favoured parts of Central America? There is no justification for assuming that dairy cows will be less efficient in the Turrialba valley, or on the mountain slopes of Costa Rica where Channel Island cattle thrive. In fact there is every reason to claim that much of this country could be transformed into a dairy cow's paradise. It would be a stimulating project for an Institute such as IICA to set out to emulate the target set by the Ruakura herd. Incidently, it is of interest to note how quickly standards change. Twenty years ago, in an article prepared to show the efficiency of production entirely from pasture, the standard of excellance quoted was a mere 7,000 pounds of 4% milk, or 350 pounds of liveweight gain, per acre (Cooper, 1948). These yields have already been more than doubled and the main credit for the increase must be given to the determined research workers who were prepared to challenge conventional thinking. If more emphasis could be given to the high economic returns which can result from such research work, it would be easier to attract the best of the current crop of graduates to undertake similar studies.

Equally high production targets should be set for the production of beef from pastures on the hilly slopes which are less suitable for dairy cattle. Initially the objective could be one thousand kilograms liveweight gain per hectare annually (880 lbs/acre). It should be easy to achieve this under the favourable conditions which prevail at Turrialba.

Research work to determine the best systems of livestock management seems much more urgent than breeding studies to determine which type of animal will give the highest returns. This was demonstrated very clearly in New Zealand by the distribution of identical twin heifer calves among commercial dairy-farmers, one of each pair going to a productive farm and the other to a less productive farm. Records collected over the ensuing years showed that the productivity of the animals was determined to a much more significant degree by the management on each property than by the genetical capacity to produce. But despite such evidence farmers with low production are much more enthusiastic about A.I. than they are about pasture improvement. One is tempted to say that a cattleman is not successful because he has good bulls but that he has good bulls because he is successful.

Research projects awaiting attention

What is the best grazing system?

Most of us assume that some form of rotational grazing will produce the best returns from pasture. The record-breaking production at Ruakura in 1965-66, for example, was obtained from a herd which was rotated through 15 paddocks under a system which permitted the closing of some areas during "the flush" so that fodder could be conserved. It is important to decide, however, to what extreme should the subdivision be taken. Thus in Costa Rica right now trials are being carried out to demonstrate the high production which can be obtained by rotating cows on successive days through a series of 30 fields, or on successive strips marked out by an electric fence. No doubt excellent production will be obtained under such management but such a system is expensive in labour and equipment and one wonders if the extra yield is worth while. There is even doubt if there will be any extra yield. A trial over two lactations was carried out in Victoria, Australia, on productive irrigated pasture to test this very point (Freer, 1959). Herds of equal size were dependant entirely on equal areas of pasture but one group was subjected to strip grazing (2 shifts daily) and the other to rotational grazing with shifts every 5-7days. The much simpler system of stock management gave the same level of production, which is a very important matter to the practical farmer.

In Australia and New Zealand during the last 15 years there has been a pronounced swing from rotational grazing to the opposite extreme of continuous grazing or "set stocking". As would be expected, this shift aroused considerable controversy and for some time occasioned real concern among those with conventional training. One of the earlier experiments which demonstrated the principles involved was conducted with young sheep in northern New South Wales (Roe, Southcott, and Turner, 1959). The experiment began in 1949 and was designed to test the vulnerability of young sheep to internal parasites under increasing densities of stocking when grazed continuously on the same pasture (this practice was then considered to be bad husbandry). Not only did these young susceptible animals remain virtually worm-free, but wool production per unit area increased progressively with heavier stocking. This result was in direct conflict with conventional thinking and this possibly explains why publication of the results was delayed for 7 years. Since then a great deal of experimental work has been carried out in which the returns from rotational and continuous grazing have been compared. There is no point in referring to these investigations. It is sufficient to state that continuous

grazing is now fully accepted in Australia as one of the effective systems under which pasture may be utilized. Dairy farmers have been much more hesitant in adopting continuous grazing and for this reason it is interesting to note that in a very detailed trial conducted at Ruakura the production of a herd rotated through 15 paddocks was only 7% better over two lactations, than that obtained from the same number of cows on an equal area divided only into a day and a night paddock (McMeekan and Walshe, 1963).

Perhaps the most important lesson to be learned from the successes achieved under continuous grazing, is that it is dangerous to accept conventional ideas without submitting them to periodic critical examination. The theoretical advantages to be obtained from rotational grazing seem so logical that it smacks of heresy to question them. But many factors play a part in determining the returns from pasture and every aspect must be kept under constant review.

What is the best stocking rate?

It is now recognized that the most important factor influencing the productivity of an established pasture, is the density of the stocking rate. The emphasis has now changed from returns per animal to returns per unit area. The principles involved are demonstrated very clearly in the following summary of a trial conducted in Victoria, Australia (Freer, 1958).

Test period: 249 days		Butterfat per cow (lb.s)	Butterfat per acre (lb.s)
1955/56	1.0 cow per acre	239	246
	1.7 cow per acre	223	362
1956/57	1.2 cows per acre	242	286
	2.0 cows per acre	215	437

From this table it can be seen that although production per cow may decline appreciably when the stocking rate is increased, the return per unit area can increase by as much as 50%. Similar studies have been conducted in New Zealand which likewise demonstrate the over-riding importance of stocking rate (McMeekan and Walshe, 1963). The same effect can be shown with beef cattle under the more difficult low-rainfall conditions commonly used for beef production. A typical result can be quoted from a trial in West Australia in a season when 28 inches (600 mms) or rain fell during a growing period of 8 months (Sprivulis, 1967).

Acres per steer	1.0	1.5	1.9
Initial weight per head (lb.s)	463	463	463
Final weight per head (lb.s)	879	880	931
Net gain per head	416	417	468
Net gain per acre/annum	378	277	246
Net gain per acre/annum as a %	154	113	100

An enthusiasm for high stocking rates must be tempered with discretion. In most under-developed countries serious losses occur in most years because feed

supplies become exhausted during the lean period. A careful understanding of the conditions which prevail in any specific area is essential before recommendations are made to increase stocking numbers. Even under the best of conditions good judgment is needed in order to make maximum returns from pasture.

In order to obtain the benefits which result from the correct stocking density it is essential that the pasture should contain productive plant species, and that these should be correctly fertilized. Given these conditions the stocking rate has a marked and very important effect on the botanical composition and the quality of the herbage which is eaten. In general, the proportions of legumes in a sward increase with increasing densities of stocking. This can be illustrated from the trial with beef cattle previously mentioned (Sprivulis, 1967), from which the following data were obtained at the end of the trial.

Acres per steer		1.0	1.5	1.9
Percentage of:	Annual Clover (*Trif. subter.*)	48	23	9
	Annual Rye grass	13	16	38
	Inferior grasses	35	51	49
	Others	4	10	4

In the main, the marked increase in production which is achieved by the introduction of more animals during the growing season results from the pronounced increase in the growth of legumes. With more intense grazing the grasses are suppressed and the legumes are favored. This change in botanical composition is particularly important where there are prolonged dry periods.

Instead of a reserve of mature, unpalatable dry grass of low feed value, under heavy stocking the grazing animals will have a reserve of relatively nutritious dry leguminous foliage on which to subsist during periods of drought. Experimental data are available which show that through most of the growing season stock at high densities will sometimes make inferior gains to similar animals at lower stocking rates in adjacent fields. But because of the much higher percentage of legume which develops in the closely grazed pastures, the animals on the high rate of stocking will continue to gain weight during the ensuing dry season when the animals which were lightly stocked suffer serious losses in weight on a ration consisting entirely of dry grass (Mann et al, 1966).

At this stage it is interesting to recollect that the practice of continuous stocking at high densities would have been considered utter folly not so long ago. Maybe there are members of this Panel who still have reservations on the matter. If so this will give added emphasis to the need for more research in pasture management. The successes which have been achieved with non-conventional systems of livestock management in Australia and New Zealand, are the direct result of research work carried out by determined people who labored stubbonly to prove their point. Academic rebels who are prepared to work should be encouraged to carry out similar researches in Latin America.

Is it profitable to feed concentrates?

In Australia and New Zealand most farmers endeavour to develop a system of farming which will free them from the need to purchase concentrates. In contrast, in Central America most dairy cows receive supplementary feeding, although the level of production is less than that of similar cows in Australia. Here again is another important field for research work, both for the agronomist who aims to provide pasture which is self-sufficient, and for the economist who seeks to determine which system of management produces the maximum net profit.

Similar work is required to determine if there are advantages to be gained from fodder conservation. Here again it is a great advantage if livestock can be maintained without the need to conserve hay or silage. The Turrialba region seems particularly well suited for the development of a livestock industry based entirely on pasture harvested by the grazing animals.

Why use a mower?

In Central America it is customary to make regular use of a mower in pasture maintenance. It is doubtful if this widespread use is justified. In the first place, mowing costs money. Of more seriousness is the fact that mowing can seriously damage the trailing-climbing legumes which can be so productive in tropical pastures. During grazing, cattle will strip the leaves from these runners which then remain to produce a fresh crop of foliage. If the vines are cut with a mowing machine the plant can receive a serious set-back - in fact some vines will rapidly be killed. Erect tussocky grasses such as Guinea grass can also be checked in growth if cut back frequently. To illustrate the effect, the following results were reported from a grazing trial with a Kudzu-Elephant grass mixture in Puerto Rico (Vicente Chandler et al., 1964).

	Gain in Liveweight by Cattle per Acre Annually. (lbs.)
Pastures mowed once a year	778
Pastures mowed every 2 months	584

It was stated that the difference became more marked as the trial progressed.

It is realized that many high-yielding pasture plants must be grazed short at regular intervals, if high yields of nutritious herbage are to be obtained. But this beneficial effect can be obtained from heavy grzing with better results than from mowing and with this management the plants that suffer when cut short will not be harmed. It is not suggested that hard and fast rules can be made about the frequency with which pasture should be mown, but it seems safe to say that if a mower is required frequently on a well-established sward, there is some serious fault in the management.

How can weeds be controlled?

It is strange but true that weeds are commonly a serious problem on poorly managed pastures when on neighboring properties, which are well managed, weeds require no attention and never cause any concern. There is no doubt that good management and the correct fertilizer favors the productive pasture species at the expence of weeds. Again it is dangerous to generalize but in my experience if a permanent pasture becomes infested with weeds this is because there is some fault in the management.

Comments on an observation grazing trial

Some of the points discussed in this paper have been subjected to a practical test in an observation grazing trial now being conducted on the IICA Livestock Farm. Since January, 1969, an attempt has been made to renovate 19.5 ha. of pasture with heavy stocking and rotational grazing. The area contains two samll fields totalling 3.6 ha. which some years ago had been planted with Pangola grass, but which were neglected so that weed infestation became serious. Another field of 8 ha. contained Pará grass over-grown with "Gamalote" (Paspalum fasciculatum), a vigorous perennial weed of low repute as a pasture plant. The remaining area of 8 ha. consists of land which is unsuitable for cultivation and which could be classified as unimproved pasture land. It is doubtful if the test area collectively supported the equivalent of one animal unit per hectare during 1968.

The circumstances indicated that the prime cause of the low productivity, and the steady degeneration of the pasture, was due primarily to understocking. This had resulted in the accumulation of rank inedible herbage and the unchecked intrusion of weeds. In January a test with heavy stocking was recommended.

Fifty cows with 50 calves by beef-breed bulls are being rotated through these four paddocks according to the amount of feed available. During April and May regrowth was retarded by an unusually prolonged spell of dry weather. During the early months the cows lost weight, particularly during the stages when the animals had to eat appreciable quantities of the residual low quality roughage. With the onset of the wet season, however, there has been an excellent regrowth of highly nutritious herbage so that the cows are now gaining in weight and, as can be seen from the following table, the calves are making very good growth indeed.

July 3, 1969. Liveweight (kg) of Calves in the Observation Grazing Trial
Average Values

	Number	Age in Days	Body Weight (kg)	Weight per Day of Life (kg)
Males	21*	159.5	159.2	1.00
Females	27	162.6	140.0	0.86

Total weight of 50 calves on July 3, 1969 = 7340 kg.
Calf liveweight produced by July 3, 1969 = 376 kg/ha. (331 lbs/acre)
Average gain per day by 50 calves over last 33 days = 0.82 kg. (1.8 lbs.).

* 2 fostered calves from the dairy herd are not included in this average

The quality of the pasture has improved to a marked degree since the heavy stocking was commenced. Weeds are no longer a problem and it seems that "Gamalote" is quite a useful pasture grass if kept short by frequent grazing. It is anticipated that the area will provide ample feed for the cows and their growing calves (or an equivalent group which can be obtained by exchange at weaning time) until the end of the year, when the calves can be "sold" and the mated cows can be carried on in the same area to produce a further crop of calves in 1970.

If some such result is achieved this will mean that this area of unpromising pasture land will provide ample maintenance for the cows, and produce something like 700 kg. of babybeef per hectare (616 lbs/acre) in the first 12 months. This very encouraging level of production will have been achieved at remarkably low cost, so that the net return per unit area should be quite high. An attractive feature has been the consistent good health of the test animals, this despite the fact that some of the test cows appeared to be quite lean and run-down when the trial began. The area was never subjected to mowing but triple phosphate and urea has been applied in strips in an attempt to obtain some indication of fertilizer requirements.

The results from this simple observation trial have been reported because they lend support to the thesis that controlled heavy stocking will improve pasture quality and so permit a marked increase in production from grazing animals dependant entirely on pasture. It should be possible to plan detailed long-term experiments which will give detailed information on the levels of production which can be expected with different methods under different conditions. It seems certain that such experiments will show that very profitable production can be achieved over extensive areas of Latin America. Good management will pay high dividends but good research is required to determine just what must be done. Graduates of top quality must be enlisted to do this research.

Let me conclude on an historical note. Some 2,000 years ago the Roman stateman, Marcus Cato, was asked what is the best source of profit on a farm, and he replied "Good pasture". When asked "And what next?" he replied "Fairly good pasture". This answer is still the correct one and is likely to remain so for a further two thousand years.

SUMMARY

1. Data are presented to illustrate the remarkable changes which have taken place during the last 15-20 years in the productivity of pastures grown in temperate climates.

2. These increases have been made possible by research work which has established entirely new concepts in pasture management.

3. This research has stimulated significant changes in conventional thinking and has shown that:
   a) There can be merit in continuous grazing.
   b) Stocking rate is the most important factor which determines the level of production from an established pasture.
   c) Profits are determined by production per unit area, or per unit of capital invested, rather than by production per animal.

4. In tropical regions there is an urgent need for carefully planned, long-term programmes of applied research which will show which are the most profitable systems of livestock management.

5. It is considered that this Panel should give serious attention to the need to encourage post-graduate research workers to concentrate their attention on the practical problems which at present limit production from pasture lands.

6. This encouragement can be given by showing that this type of research can give considerable personal satisfaction, and also produce results of major economic importance.

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Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-6 Dr. C. V. Plath, FAO Officer IICA-CEI, Costa Rica*

Title: INTERDISCIPLINARY INVESTIGATION TO SUPPORT AGRICULTURAL DEVELOPMENT

Agricultural development is an important, and critical, part of the total economic development of Latin America. This statement is now generally accepted as axiomatic, at the present stage of world development, even though the degree of application is subject to some variation from country to country. However, I want to emphasize the development of the livestock industry as an important sector of agriculture. Obviously, the magnitude of the importance of the livestock industry to the entire agricultural sector, an therefore its relation to the total economy, varies widely from country to country. Nevertheless, with the possible exception of certain small Caribeean islands, livestock constitutes an important part of the agriculture of all countries of Latin America. Furthermore, I expect that contribution to the economy to increase relatively more than the plant-science sector of the economy of most Latin nations. I foresee a greater proportional increase in the contribution from livestock products to the domestic and export economies of Latin America than from plant products. This forecast is made in spite of the fact that the animal products compete more directly with those from temperate climates than most of the tropical fruits, vegetables, and edible oils.

Naturally, such a prognostication is based upon the present stage of development, relative to the potential production, and upon the anticipated increase in world demand for the two kinds of agricultural products as the per capita purchasing power increases in less developed countries. It appears to me that the livestock industry of Latin America is less developed, relative to its potential, than the production and marketing of many of the important plant products. Therefore, the goal and objectives of this international meeting, focused upon the "why" and "how" of the development of the livestock industry in this rapidly growing region is timely; indeed, it could truthfully be described as overdue and urgent.

Granted that animal production is now at a level far below its potential, and that the demand for livestock products seems to be increasing more rapidly than production (as evidenced by declining per capita consumption and rising retail price trends in the region), what is the role of interdisciplinary research as a contribution to the resolution of the problem?

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* The views expressed in this paper do not necessarily represent the official views of FAO nor IICA; they are the personal observations and responsibility of the author.

MODERN PRODUCTION AND MARKETING

One of the basic goals of agricultural development is the more effective and efficient use of resources to increase the supply of agricultural products, and to offer them to consumers at a lower relative price and in better quality. Usually this is accomplished by applying more of the relatively less limited or less costly factors of production, such as technology and capital, to productive land, which ultimately is limited and by using less labor, which eventually becomes expensive.

However, the application of an ever-increasing amount of technology, including management, and capital to the most productive land, while using less labor, becomes more and more complex. The chances for errors and mistakes are, simultaneously, more frequent and more expensive. One might make the comparison with the driving of an oxcart compared to an expensive truck equipped with a 4-speed transmission, 4-wheel drive, and perhaps with a refrigerated body. With a modern agriculture, everything must be done correctly, on time, and so planned and executed that mistakes are kept at a minimum because they are very costly.

It is not sufficient only to select a better grass or legume for the improved pasture, but the seed must be planted on suitable land and on a seedbed adquately prepared, including the proper use of fertilizers and herbicides. But all of this isn't enough without the proper management and maintenance of the pasture, if returns are to maximized and the additional expenditures of capital and technology are to be justified.

Modern agriculture is complex, highly technical, and extremely commercialized (a high proportion of the inputs of production are purchased rather than produced on the farm, and most of the products are sold rather than consumed at the farm). Therefore, it is not possible for the research needs of a modern livestock industry to be served adequately by investigations conducted by individual research technicians trained only in animal husbandry and working alone. The research demands of an effective, efficient, highly commercialized livestock industry can best be met by the cooperative or coordinated investigations of a team of research workers. Granted, an animal nutritionist can measure the physical response and determine the cost of various rations and probably calculate which of the several rations used in his experiment was most profitable. But if he wants to interpolate, and to use his results as the basis for predicting the profitability of other ration combinations, with different costs of ingredients and different prices for the animal products, then he should solicite the active cooperation of an economist trained in linear programming or computer programming. Of course the nutritionist could easily become competent in the mathematical maneuvers but the economic analysis should be done with the help of an economist.

We accept the above statement as if it were axiomatic, yet how frequently are research projects submitted for approval with neither a review, nor even a consultation, by technicians from other fields that should be actively cooperating in the research. If research workers are not required by administrative regulations, to obtain the cooperation or coordination of their projects

with other technicians, they usually will not do so. I speak from personal experience obtained in three different cultures.

INTERDISCIPLINARY RESEARCH: PROBLEMS IN THE TROPICAL LIVESTOCK INDUSTRY

Several problems are described that indicate the need for interdisciplinary research in various aspects of the livestock industry of Latin America, with emphasis on tropical areas. It is obvious, and probably quite natural, that most of these suggestions focus on research that favors the cooperation of the animal or pasture technician with a land-use specialist or a farm management man or a production economist. Of course, the problems given below are only several examples out of a multitude that could be described.

Emphasis is given to the tropical areas because the problems in the temperate zones of Latin America are more similar to those in equivalent climatic regions where the livestock industry is now quite well developed. Unfortunately, the tropical climates offer few chances for such transfers of research results. However, where the socio-economic conditions are radically different, then such factors as management and marketing still provide a real challenge in the transfer of research results from a developed region to one less developed, even with similar physical-biological conditions.

1. The Role of Modern Livestock Production in the Humid Tropics

As one flies at low altitude over a tropical jungle, or a tropical savanna, or a coffee area such as the highlands of Central Costa Rica, he may well ponder the question: What is the role of modern livestock production in the tropics, especially in the humid tropics?

a) Is it only to utilize the lands not suitable for cultivated crops or valuable tree crops?

b) Or is it best justified as a place to produce year-around pasture to "grow out" the beef animals born and weaned in areas that have a long dry season?

c) Can beef and/or dairy compete economically with cash crops (annuals such as rice, yuca or certain vegetables; or perennials such as bananas, cocoa, or rubber) on the best (alluvial) lands of the humid tropics?

Indeed, this series of questions offers opportunity for, or even demands, interdisciplinary investigation. Either through well-planned, long-range experiments, or at a "utilitarian" level of demonstration farms, or a survey of commercial farms, obviously the first interest is in the physical-biological feasibility and techniques of the livestock production under the conditions being studied. This is the realm of the plant and animal scientists, along with the appropriate veterinarians, entomologists and pathologists, to mention only a few.

Once the physical-biological production techniques and results are established, then the economists have a fertile field to study, to analyze, and to compare from a socio-economic viewpoint. The input-output (cost-benefit) relationships should be established not only for existing technical and economic conditions (costs of inputs, prices of products) but also under assumed changes for the future (changes in technology, in marketing, in demand, in competition, etc.).

The questions were asked about the humid tropics because we do not have complete information to answer any of them, except in limited situations. Present research results, plus field observations, indicate that there is a very encouraging future for livestock in the humid tropics but, as in the case of crops, a high level of management, technology, and investment is required for success, and for successful competition with certain crops, I doubt, for example, that either dairy or beef production can compete on the best alluvial soils with well organized banana production, if the marketing is also well organized, unless the milk or meat is being produced very intensively and for a special market. However, on heavier soils with slightly impeded drainage, or in areas where crops cannot be marketed so readily, it appears that well-managed livestock production is competing successfully.

In many situations we agricultural economists do not have adequate information, and we need to work with the livestock specialists to get reliable-and useful-data for economic analyses. Occasionally, as I read the results of research by animal husbandrymen, I think that their work would have benefited from team efforts, too.

2. <u>Management of Livestock Farms in the Tropics</u>

It becomes entirely clear that the level of management of most livestock farms in the tropics is very low from a glance at the statistics of production per animal or per unit area of land, death losses, calving percentages, conception rates, age to reach 400 kgs. etc. It is also easy to conclude from a visit to most livestock-producing areas that there are a few well-mananged, modern, efficient, productive beef and dairy farms. Usually these are surrounded by others sill practicing primitive methods.

Nevertheless, before launching a livestock promotion campaign, do we really have adequate research results upon which to select suitable management systems for the production of meat or dairy in:

a) The wet/dry tropics, with a long dry season?
b) The humid tropics, where grass stays green all the year?
c) The tropical highlands, above 1500 meters, for example?

It is apparent that a substantial body of knowledge has been accumulated in the tropics, and probably even more has been adapted from temperate regions, with variable success. However, most of this information seems to center around the management of animals (sanitation, feeding, breeding) and pastures (natural and improved). We seem to have

pathetically little information about the management of the livestock farm, especially under tropical conditions in the less developed countries. Of course, this alarming shortage is explained by the extreme dearth of farm management specialists in Latin America, and even of economists with training and experience in agriculture.

However, on the basis of limited farm management research, it appears that tropical livestock production, both beef and dairy, will probably reach the "point of diminishing profits", that is to say, the most profitable intensity of management, at a level of production that is lower than in temperate regions*. This indicates that fewer inputs of production should be used and lower production rates achieved per animal. As we develop a tropical livestock industry, this gap between the tropical and temperate regions will narrow.

That forecast for tropical livestock production is based more upon superficial field observations and non-systematic interviews with producers than upon research results. Certainly we need farm management studies on livestock operations under a much wider range of conditions than are now available. And to make these studies, the farm management and livestock investigators must cooperate actively and closely or else the results are likely to be useless, or even dangerous. This kind of cooperation in research is very important in Latin America where the agricultural economists have had very limited experience on livestock farms, and the animal husbandry specialists usually have had little or no training in economics.

Research in the management of livestock farms must clearly identify systems of management of the land, the animals, and the plants (pasture and forage) that are physically-bioligically-ecologically-economically sound in the long term, as well as those that may be profitable in the short term while some marketing situation may give a temporary economic adavantage to a particular area. For this kind of research, interdisciplinary teamwork is essential.

3. Size of Livestock Enterprise in the Tropics

Experience in several developed countries, largely located in temperate climates, indicates that the expensive and complex production inputs, as well as the highly trained management, required for both production and marketing of livestock and livestock products, is most profitable if organized into rather large production units. Under various conditions this means for optimum efficiency and profits, a dairy herd selling fresh milk should have about 50 to 70 milking cows while a beef

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* Aguirre, J. A. The Economics of Milk and Beef Production in the Humid Tropics: A case study, San Carlos County, Costa Rica. Unpublished Ph.D thesis, Cornell University. 1969.

herd on the ranges of the semi-arid climates should have at least 300 brood cows. The optimum size has increased greatly in the past 25 years as new and costly technology, including a surprising degree of mechanization, has been introduced into an ever more-competitive economy. Adequate economic studies, based upon sufficient physical-biological-ecological knowledge, have been made to form a solid foundation upon which to base the recommendations that public institutions, as well as private companies serving the industry, should be expected to make to guide the production and marketing operations of the livestock industry.

But we really do not have adequate research results upon which to make sound recommendations about the optimum size of a beef or dairy herd under the rather difficult tropical conditions in the less developed countries*. For instance, can a small herd of 10 dairy cows or 50 beef cows compete successfully under tropical conditions, as more technical advances are being introduced into a more commercialized industry? I doubt it; it appears that the small enterprise will be at an economic disadvantage, even if effective cooperatives can be organized. However, this observation is based upon fragmentary research results from studies made in only a few areas and under a rather limited range of conditions.

Nevertheless, the agricultural development planners, especially those with responsibilities in agrarian reform and colonization, need to know both the minimum and optimum size of a livestock enterprise in essentially every country of Latin America. Although the well-trained agricultural economists can make this kind of economic studies, it is highly desirable and far more satisfactory if such studies are conducted with the active cooperation of the livestock specialists.

4. Mechanization of the Tropical Livestock Industry

For those of us who can remember farming as it was before the use of gasoline and electricity on the farms, on the rural roads and in the marketing channels, it is rather difficult to visualize modern milking parlors (some portable), the refrigerated trucks, the specialized tractors and farm vehicles and implements, jeeps as partial substitutes for the cowboys'horses, etc. But the mechanical age has arrived, and is here to remain.

However, to what degree and under what ecological-economic conditions should the dairy and beef farms of Latin America be mechanized? This question is more important when one considers the so-called "surplus" labor that, at least in theory, is supposed to be available. But is year around labor actually available in livestock producing areas, and are enough of the workers adequately trained to work with livestock, especially with agricultural chemicals and other modern practices? In some areas, the

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* For more details about the agricultural development problems of the tropics see Plath, C. V. El Desarrollo del Potencial Agrícola en los Trôpicos Húmedos de la América Central. Turrialba, Vol. 19, Nº 1, Trimestre Enero-Mayo, 1969, pp. 21-29. (not yet available in English).

answer is negative, a fact that encourages mechanization. Another serious challenge to mechanization is the high price of machinery and the often prohibitively-high cost of maintenance due to the shortage of mechanics and repair parts. Of course these problems are being resolved, faster and more satisfactorily in some areas than others, but it still remains a physical and economic challenge to those who are pioneering the mechanization of the livestock industry; pioneering in the sense of introducing such big socio-economic changes, rather than the invention of new machines or mechanical processes.

Research on the feasibility of mechanization requires the cooperation of the livestock investigators with farm management specialists and, in the case of the modification of machines currently available, with the agricultural engineers.

5. Introduced Species for the Tropical Livestock Industry

Modern, intensive agriculture seems to be based quite largely upon exogenous species of plants and animals, or at least upon the carefully selected varieties or strains of indigenous species. Although changes in managment practices usually can increase the production of native species of both plants and animals, nevertheless it is the introduced species, or at least genetic crosses of them with the "criollos", that form the bases for the most productive and profitable plants and animals.

Even though we acknowledge the value of introduced species, and realize that the introduction, selection, and testing is a never-ending project for plant and animal geneticists and management specialists, nevertheless an additional problem exists: Under what socio-economic conditions can these proven species be recommended? The ecological conditions, and the management practices, may be well understood, but is it wise to recommend introduced or hybrid species of grasses or legumes or animals on small farms where both pasture-animal management and capital is deficient? Normally, the introduced species require more careful, intensive, and selective management, which usually requires additional purchased inputs (fertilizers, insecticides, vaccines, etc.), than is necessary for the native species under the common production practices. Under these circumstances, is it realistic to recommend the introduced species to operators of small farms who have very little capital or credit, and who have had neither training in the new management techniques nor access to adequate technical guidance? I doubt it!

However, we are beginning to see the results of experiments in the application of modern agricultural technology to small farms through cooperative group action*. Some of these socio-economic experiments are hopefully successful although others seem to be failures, at least when

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* Los Programas de Fomento de Cultivos Alimenticios en Centro América: Reconocimiento de Experiencias. Myren, Delbert T. y Sebald G. Manger C. Programa Cooperativo Centroamericamo para el Mejoramiento de Cultivos Alimenticios. XIII Reunión Anual, San José, Costa Rica, 1967. CIMMYT, México.

the outside assistance is removed. As a broad generalization, one might observe that where realistic and experienced social scientists cooperate closely with the physical-biological scientists, the chances for success of these experiments in the application of modern technology to small farms seem to be greatly increased. The amount of funds available per farm seems to be less important, above a modest minimum, than the realistic, interdisciplinary planning and execution of the project.

The use of introduced species of either plants or animals seems to be more questionable when they have not been adequately tested and demonstrated under the conditions of the selected farms. This is even more critical for small farms for the reasons mentioned above.

6. Economic Motivation for Livestock Development

We have gained enough experience through economic studies and carefully-made field observations to state quite boldly that the possibility for greater profits is a strong motivation for farmers in all parts of the world, almost regardless of the political-economic system of the government. It is, therefore, essential that those who are trying to promote the livestock industry should be ever mindful of the power and possibilities of economic motivation; and also to the fact that without the promise of good profits almost no farmer is willing to take the risk of trying new technology, nor of spending additional funds and effort on something that has a low probability of physical and economic success. Both the livestock producers, and the marketing men who handle their products, are human; they are motivated by profits!

Once again it is easier to get agreement on a general principle than on its specific applications. Within the framework of the development of the livestock industry, what practices and technology, or species of plants or animals, are profitable? Under what physical and socio-economic conditions are they profitable? Or is it more desirable, or even necessary, to give a higher priority to the use of scarce funds for social goals rather than emphasis on the economic aspects? For instance, is the colonization of small livestock farms, or agrarian reform in general, a more urgent objective than the economic efficiency and maximum profits in the production of livestock products?

More specifically in the livestock industry, is it profitable to fertilize pastures, or to irrigate them? If so, under what conditions of ecology, land, economy, and management? When is it desirable, and profitable, to establish artificial insemination of beef cattle, or to feed concentrates to them, in the tropics?

Obviously we have a few answers, or partial answers, to most of these questions. Equally obvious is the fact that on these economic questions, which are dependent not only upon physical-biological factors but also upon human reactions and social institutions, it is dangerous to make assumptions or recommendations based solely upon research and experience in temperate zones and developed countries.

SYNOPSIS

A considerable body of information has been accumulated in Latin America to serve as a basis for the agricultural development that is definitely in progress. However, as we get down to the specific recommendations for selected areas or farms, we are often shocked by the shortage of detailed information. Some agricultural developers are shocked into frustation and despair; others into challenges and action.

Within the livestock industry of Latin America we observe some good research, part of it completed but more of it now in progress. Some of this research is even established on the basis of interdisciplinary cooperation, but not enough of it.

Modern agriculture is too technical, too complex, and too commercialized to be served adequately by research conducted by scientists only from within any selected branch of agriculture. A modern livestock industry requires accept this as a basic truth, but many times we observe, for example, a research project in animal nutrition being carried out without the active cooperation of, perhaps, an organic chemist or an agricultural economist or a veterinarian. Frequently the proposal for a research project is not even reviewed by these supporting scientists, to obtain their suggestions about methodology and possible cooperation.

A few ideas for interdisciplinary research are presented for consideration as representing important gaps in the knowledge needed to develop the livestock industry of Latin America.

1. The role of modern livestock production in the humid tropics: Is it only to utilize lands not suitable for cultivated crops or valuable tree crops, or to fatten beef animals grown in areas with a long dry season? Can beef and/or dairy compete with cash crops (annual and perennial) on the best lands of the humid tropics?

2. Do we have adequate information to decide what are the best farm management systems to produce beef or milk in the wet/dry tropics; in the humid tropics; in the tropical highlands? The most profitable system in the short term may not be physically-biologically-ecologically sound in the long term.

3. Can a small herd (10 dairy cows or 50 beef animals) compete successfully under tropical conditions, using modern production methods? Colonization (agrarian reform) planners need the answers.

4. Should dairy or beef farms be mechanized in Latin America, considering the so-called "surplus" labor and the problems of machinery prices and maintenance costs?

5. Is it realistic to recommend introduced species of grasses or legumes and livestock on small farms where both pasture-animal management and capital is deficient? The problem is more critical when the new species have not been fully demonstrated under the conditions of the selected small farms.

6. Economic motivation is important in the dissemination of modern technology. Is it profitable to fertilize pastures, or to irrigate them; under what conditions (ecological, economic, land, management, etc.)? Under what conditions is artificial insemination of beef cows profitable?

Already there are some answers or partial answers to part of these questions in various areas of Latin America. Some good research, even a few interdisciplinary projects, is being conducted. However, the "unknowns" are numerous and dangerous; dangerous because modern commercial technology does not allow a wide margin for errors. The transfer of practices and methods from dissimilar areas and conditions, without adequate testing and modifying, is always risky.

Inter-American Institute of Agricultural Sciences of the OAS
and
Food and Agriculture Organization of the United Nations FAO

Panel on Post Graduate Education and Associated Research for the Support of Livestock Development in Latin America

Working paper No. D-7 Dr. E. M. Hutton, CSIRO, Australia

Title: ESTABLISHING RESEARCH PRIORITIES FOR LATIN AMERICA: PASTURE AND FORAGE ASPECTS

INTRODUCTION

World demand for beef is increasing steadily as population growth accelerates and the standard of living in many countries rises. Also in developing countries there is an increaing demand for milk and dairy products. The aim in Latin American countries should be to make both beef and dairy production as economic as possible by adjusting property size to the type of animal industry and applying all the modern pasture and forage techniques available. To take advantage of pasture improvement it is necessary to confine sowing and fertilizing of tropical legumes and grasses to the better rainfall coastal and sub-coastal areas unless cheap irrigation water is available.

Beef production is best established on relatively large properties of 500 hectares or more. This would at times require amalgamation of smaller properties to ensure efficient low cost production of beef. Dairying, a more intensive form of animal production, is economic on smaller properties of about 100 hectares. Irrigated pastures are a distinct advantage in dairying and reduce the need to buy in concentrates. The economics of dairying is assisted by having beef as a by-product.

Priorities in pasture and forage crop research are similar whether the concern is beef or dairy production. However, for beef production, emphasis needs to be on the interactions involved with legume-based pastures fertilized mainly with superphosphate. For dairying, the research should cover not only the role of legumes in pastures and as forages but also the place of grass and gramineous forage crops heavily fertilized with nitrogen, phosphorus, and potassium. During the primary stages of increasing productivity of the beef and dairying industries of Latin America through improved pastures and forages, research priorities include:

1. Introduction and testing of legumes and grasses successful in other countries,

2. Collection and testing of the indigenous legumes and grasses of Central and South America,

3. Study of the plant nutrient deficiences in the soils of the main areas suitable for growth of improved pastures and forages,

4. Selection and propagation of effective Rhizobium strains for the various legumes and study of seed inoculation methods and nodulation in field plantings,

5. Regional evaluation in small trials over a wide range of conditions of the relatively few legumes and grasses found promising in the preliminary introduction and assessment work,

6. Study of the factors affecting seed production of promising legumes and grasses including application of fertilizers, harvesting and seed cleaning and storage to maintain viability,

7. Large scale grazing trials in a few key areas to measure the productivity of the few widely adapted legumes and grasses,

8. Chemical analysis of pasture samples cut regularly during the season from the small scale evaluation trials or large scale grazing trials,

9. Studies on increasing the output of animal products per hectare by integration of pastures and forages and supplementary feeding of conserved crops or of minerals.

10. Investigation of the economic returns from the different practices and of methods of providing cheap fertilizers and seeds.

I. Preliminary assessment of introductions and indigenous species

This includes research priorities 1 and 2 already mentioned. Published work describes a number of legumes and grasses found promising in various countries. Seed of all these should be introduced into the different Latin American countries even though some of the species may be indigenous there.

All the important pasture and forage plants in tropical Australia originate from introductions. Latin America has been of particular value as a source of legumes and Africa as a source of grasses. The main tropical pasture legumes used in Australia include Townsville lucerne (Stylosanthes humilis), Stylo (Stylosanthes guyanensis), Centro (Centrosema pubescens) Siratro (bred from Phaseolus atropurpureus), Peru Leucaena (L. Leucocephala), Greenleaf and Silverleaf Desmodiums (D. intortum and D. uncinatum), Miles Lotononis (L. bainesii), Glycine (G. wightii, formerly G. javanica). Puero (Pueraria phaseoloides), and Calopo (Calopogonium mucunoides) are useful pioneer legumes in wet tropical conditions. The most important leguminous crops include Rongai Dolichos (D. lablab) and cowpeas (Vigna sinensis) used as forage and mung beans (Phaseolus mungo) and soybeans (G. max) used for grain.

The best pasture grasses in tropical Australia include buffel (Cenchrus ciliaris), Rhodes (Chloris gayana), para (Brachiaria mutica), signal (B. decumbens), pangola (Digitaria decumbens), molasses (Melinis minutiflora), guinea (Panicum maximum), green panic (P. maximum var trichoglume), paspalum (P. dilatatum), Kikuyu (Pennisetum clandestinum), Setaria (S. sphacelata),

and Urochloa (*U. mosambicensis*). The main forage grasses are elephant (*P. purpureum*), *Sorghum almum* and a range of hybrid sorghums, and bulrush millet (*P. typhoides*).

Simultaneously with the introduction of promising pasture and forage cultivars into Latin America there should be a study of the indigenous legumes and grasses of Central and South America. These areas contain a wealth of potentially valuable species and varieties in such genera as *Stylosanthes*, *Phaseolus*, *Desmodium*, *Leucaena*, *Vigna*, *Centrosema*, *Chloris*, and *Paspalum*. Ecotypes of interesting species need to be collected from a number of different habitats to give a range of variability. Botanical work is a necessary part of the investigation aimed at the selection of indigenous species for preliminary assessment of their agronomic potential.

The first stage in the assessment of introductions and interesting indigenous species is to grow them in rows in a few nurseries established in areas representative of the climate and soils of the region. Introductions should be fumigated with carbon disulphide and these and selected indigenous species are raised in peat cups or pellets and transplanted 20-40 cm apart within 5 m rows. The rows are 1-2 m apart, depending on the vigour and growth habit of the species. For example, the rows of vigorous prostrate legumes would need to be 2 m apart. The main objective of the nursery stage is to select for further trial the promising species and ecotypes from observation of the type, amount, and seasonal pattern of growth, their perenniality, seed production, and tolerance to factors like cold, drought, insects, and diseases. If sufficient seed of a species is available replicate rows should be planted. A standard grass or legume planted at regular intervals throughout the nursery is needed as a reference for the new grass or legume species. In the initial nursery phase the rows are left uncut although portions of the rows of the standard variety are cut and weighed to assist in the assessment of yielding ability. Grass rows need to be regularly fertilized with a mixture containing nitrogen, phosphorus, and potassium and legume rows with superphosphate. Seed of the legumes should be inoculated with the appropriate rhizobium before sowing and on poor soils legume rows should be fertilized with molybdenized superphosphate.

The nurseries can be used for more intensive evaluation of special groups of grasses or legumes by growing each species in replicate rows and subjecting them to a cutting regime and weighing the dry matter produced. After assessment of the different species, the main purpose of the nurseries is to provide seed for regional testing over a range of conditions of promising types in small replicated plots under periodic grazing. The species nurseries are a valuable starting point for pasture and forage improvement in Latin America.

II. Plant nutrient deficiencies in soils of the areas suitable for pastures

Coincident with the assessment of introductions and indigenous species it is vital to determine any plant nutrient deficiencies in the soils where pastures or forages are to be grown. This important aspect is frequently overlooked but unless the soil deficiencies are known and corrected, development of pastures and forages on a large scale is doomed to failure except on the relatively small areas of rich alluvia or basaltic soils. Appearance of

a soil is often deceptive and red, brown, or black soils which look fertile can be deficient in essential elements like phosphorus, sulphur, or molybdenum. For establishment, high productivity, and persistence, legumes and grasses must receive, on many soils, regular annual applications of fertilizer which supplies the essential elements that are unavailable. Proper fertilization gives herbage of high feeding value which results in quick growing animals, high calving rates, and high quality carcases.

On most soils legume based pastures usually need only superphosphate containing phosphorus, sulphur, and calcium with perhaps the periodic addition of small amounts of molybdenum. Unit for unit, sulphur is as important as phosphorus, particularly in legume nutrition. The great arc of solodic and podsolic soils in the tropical coastal and sub-coastal areas of northern and north-eastern Australia has been shown to be deficient in phosphorus, sulphur, and molybdenum as well as nitrogen, usually supplied by legumes. Where soils are very sandy, potassium is often deficient. Copper, zinc, and boron are other elements which are sometimes deficient for growth of legumes and grasses. When nitrogen fertilized grass or forage is the basis for production substantial amounts of superphosphate and potash as well as nitrogen have to be used if deficiencies of phosphorus and potassium are to be avoided. Other deficiencies including minor element ones are liable to occur with this practice.

Nutrient deficiencies of a region are determined from pot trials in a glasshouse followed by field tests. For each pot trial soil to a depth of 15cm is collected at random within one of the soil types. The chemical nutrients and water used in the pot experiments must be pure, otherwise results are unreliable. The test plants are usually legumes and *Phaseolus lathyroides* with its upright growth and sensitivity has proved particularly useful.

The subtractive layout requiring only a moderate number of pots is used when limited information on a relatively large number of deficiencies is required. In this the control contains all essential elements and treatments are obtained by omitting one element, or one combination of elements, at a time. With pot experiments it is more usual to first do a phosphate rate trial and then a factorial trial of 64 pots involving 7 elements and using a half replication. This approach is warranted because phosphorus has a central role in pasture and forage growth and is frequently deficient in soils. In the phosphate rate trial, a basal nutrient containing adequate calcium, sulphur, potassium, copper, zinc, molybdenum, and boron is added to all pots and then six levels of phosphorus from nil to 1500-2000 kg per ha are applied using three or four replications. The factorial experiment provides valuable information on the interactions between nutrients which are added at two levels, nil and adequate after a non-limiting basal dressing of phosphate is given to all pots. In the factorial there is no external replication, the control is a nil treatment, and a typical experiment would contain all the elements used in the basal nutrient of the phosphate rate trial.

Following the pot trials regional factorial experiments are done in the field using a minimum plot size of 4 m x 5 m. Factorials are often unreplicated because of the large number of plots involved. Replication reduces experimental error but is not necessary when large differences are obtained.

If the pot trials have shown a gross deficiency in a nutrient its lower level in the factorial should not be nil but at a level to give some growth. A heavy sowing rate is used for the field plots to reduce invasion from one plot to another. In legume experiments a companion grass is sown at a light rate to prevent ingress of weeds and observe the effect of the legume-nutrient reaction on the grass.

III. Provision of effective rhizobium for the legumes

Apart from rainfall, a high level of dry matter and protein production in legumes is mainly dependent on the supply of essential nutrients and efficient nodulation. Effective Rhizobium strains are now available for most legumes, including the tropicals, and peat cultures of these can be bought commercially in Australia. Imported peat cultures could be used for wide scale inoculation of legumes or as a starting point in any Latin American country for propagation of effective Rhizobium for the different legumes grown.

The setting up of Rhizobium research in Latin American countries is warranted because of the importance of legumes in the economic production of nitrogen for both pasture and grazing animal. This would need as a basis the maintenance of a collection of effective Rhizobium including not only imported strains but strains isolated from the nodules of indigenous legumes. Important aspects on nodulation which could be studied include methods of seed inoculation and why Rhizobium strains effective in the glasshouse are not always effective in the field. However research is not worthwhile unless it leads to a commercial supply of effective Rhizobium for large scale pasture and forage development.

At the Cunningham Laboratory, the Rhizobium collection has been assembled mainly from strains isolated from nodules collected from indigenous legumes growing throughout the tropical world. Effectiveness of the strains is tested by the Leonard bottle-jar technique in the glasshouse. Strains are stored by absorbing them on unglazed porcelain beads which are then placed on slagwool pads in small McCartney bottles half-filled with silica gel desiccant. To develop a culture only one bead is needed from a bottle. Seed is usually inoculated with peat cultures applied as a dust or as a slurry in water. Inoculation of seed is also achieved by pelleting it with a mixture containing the Rhizobium, and adhesive, and a suitable nutrient compound. Lime pelleting using ground calcium carbonate has been successful with temperate legumes like alfalfa but inhibits nodulation of tropicals.

The work at the Cunningham Laboratory has shown that it is beneficial to inoculate the seed of most tropical legumes. Some, like Miles Lotononis, require a highly specialized Rhizobium. The legumes vary in nodulating ability and Townsville lucerne and Siratro are two which nodulate freely even with the native soil Rhizobium. Legumes which nodulate slowly and sometimes with difficulty include Glycine, Greenleaf Desmodium, and Rongai Dolichos. Application of Molybdenized superphosphate enables most selected legumes, except Glycine, to nodulate and grow well in plots in the large areas of poor acid soil in the coastal and sub-coastal areas of tropical Australia. This is due to their ability to extract calcium from soils of low calcium status and to their tolerance to excess aluminium and manganese. These findings are of importance to pasture development in a number of tropical areas.

IV. Regional evaluation of the promising legumes and grasses under periodic grazing

Where personnel and facilities are limited or quick results are required regional evaluation could be based on imported seed of well tried and successful legumes and grasses from overseas. This would not remove the necessity for concurrent nursery assessment of a flow of introductions and native species. There is still plenty of opportunity for Latin America to contribute new pasture and forage plants to world agriculture, particularly from its indigenous species.

Only the relatively few promising legumes and grasses are planted in the series of samll plot trials in the areas where pasture and forage improvement are contemplated. Forage species are kept separate in these trials as they are usually tall growing and bulky and are often short lived. A suitable plot size is 6 m x 6 m and there should be 4 or 5 replications of each species. Adequate soil preparation and a relatively heavy seeding rate of about 6 Kg per ha are necessary for good establishment.

Pasture legumes are sown with a light seeding of a common compatible grass such as Nandi Setaria. The grass prevents weed invasion and its growth reflects the degree of nitrogen fixation by the legume. In many areas the survey of soil deficiencies would show that the legume-grass plots required .28 kg molybdenum per ha and annual applications of 250-500 kg of superphosphate per ha. Where rainfall is high and soils light textured, a basal application per ha of 8 kg of copper sulphate and 125 kg of potassium chloride may be needed. Forage legumes are usually grown alone and if large seeded need to be soen at about 15 kg per ha. Fertilizer applications for these are the same as for the legume-grass plots.

Grasses are planted with a common legume such as Greenleaf Desmodium to determine their compatibility with legumes. As the legume may not provide enough nitrogen for the grass to indicate its growth potential, the grasses are also grown alone and given annual applications per ha of 250 kg of nitrogen, 250 kg of superphosphate, and 125 kg of potassium chloride. This denotes their nitrogen response and separates out the different grass types including the forages. If larger grass plots of 10 m x 10 m are used and half sown with legume and the rest given applied nitrogen, reactions of the grass to the different ecological conditions and forms of nitrogen are obtained in the one plot.

Sampling of plots for yield and botanical composition could be commenced in the establishment year, but is more meaningful in the second and subsequent years. Once established plots are sampled and grazed periodically when sufficient herbage is on offer. Grazing by cattle should be completed within a week and not be too heavy and should leave the sward in an active condition. Depending on the rainfall and rate of growth of the pasture or forage, about four samplings and grazings are done at monthly or six-weekly intervals over the season. If plots are uniform one sample per plot is sufficient, if variable two samples per plot are necessary. A convenient sample is obtained with a 1 m x 1 m quadrat, the material being cut with hand shears or a motor driven scythette. Soon after cutting the green herbage from the mixed swards is hand separated into legume, grass, and weed. The material from the mixed and pure grass swards is dried at 60-70ºC for 24 hours in a forced-draught dehydrator and

then removed and weighed as soon as it is cool. If samples are analysed for nitrogen, yields per ha of both dry matter and protein can be calculated for the various legumes and grasses. A rapid measurement of the dry matter yield of plots without cutting is now possible with the Electronic Capacitance Meter (Custom Scientific Electronics Pty. Ltd., Brisbane). This is particularly useful for pure stands, but can be used in mixed by estimating the percentages of legume and grass.

Regional evaluation over a range of conditions sorts out the few persistent legumes and grasses with wide adaptability, but gives no measure of the animal production possible from them. However, these legumes and grasses can be used with confidence in large scale grazing trials and also in extensive sowings of commercial pastures. It is better to complete proper grazing trials with the promising species before they are used commercially but this is not always possible. The regional plots will show definite trends in the various species in the second year but three or more years are needed to obtain definite information on their growth habit and persistence and with legumes their compatibility with grasses. Continuous observation is required on all species to determine their reaction to climatic stresses, insects and diseases, and whether they are well eaten by the animal. Grasses that are poorly grazed should be particularly noted. Chemical analysis of the plot samples for nitrogen and other major elements is important to ensure that sufficient fertilizer has been applied.

V. Factors affecting seed production of the promising legumes and grasses

When the legumes and grasses developed overseas are used for research programmes and commercial plantings in a Latin American country, it may be more economic to import the seed. However, seed production of promising species should be investigated as local conditions could be suitable for a seed industry and it may be desired to market an indigenous species. A supply of cheap irrigation water assures high seed yields as crops can be watered whenever they need it; also seed crops can be grown in the dry season when atmospheric conditions favour seed setting.

Grass seed crops are best grown in rows as this allows weed control and applications of fertilizers containing nitrogen, phosphorus, and potassium which stimulate seed production. The importance of different proportions of these elements on grass seed production needs further work but it is known that correct use of nitrogenous fertilizers results in high seed yields. Direct harvesting of grass seed with "all crop" headers saves time and labour but sheaving and stooking followed by threshing usually increases yields.

Legume seed crops require different harvesting techniques. Rolling crops of twining legumes just before flower initiation reduces the vegetative cover and gives even flowering with the pods well clear for direct heading. With these legumes mowing and windrowing and allowing the seed to mature in the swathe and then picking up and threshing with an "all crop" harvester usually gives the highest yields. In the erect Townsville lucerne the mature pods drop so suction and also blower harvesters have been developed to pick the seed up from the ground. Hard seed can be a problem in legumes and mechanical scarification is sometimes needed.

Seed viability of a number of grass species falls off rapidly under poor storage conditions, but that of legumes is much less affected. To maintain seed viability for long periods seed should be stored in chambers at 10ºC and 35 per cent relative humidity. Where these facilities are not available drying seed to five to six per cent moisture content and storing in air-tight drums will retain its viability for several years.

There are a number of unsolved problems associated with seed yield and quality in the various species. Seed setting due to its affect on yield needs particular attention. Trueness to type and freedom from weeds are necessary attributes of commercial seed and can only be controlled by a suitable certification scheme.

VI. Large scale grazing trials

Large scale grazing trials are essential to determine the level of animal production possible in a region by using the most promising legumes and grasses, adequate fertilizer as shown from studies of plant nutrient deficiencies in the soils, and different forms of management. Only a few of these trials should be attempted in key areas as they are expensive and require up to 120 ha and extensive fencing and facilities as well as a number of cattle. They need to be operative a minimum of five years and need a lot of technical effort and labour to obtain all the relevant information from them.

Three beasts should be used per paddock so that paddock size usually varies from 1.2 - 7.3 ha depending on the grazing pressure and the rainfall. A typical experiment may incorporate six pasture mixtures all with equal phosphorus, potassium, sulphur, and molybdenum fertilizers using one or three stocking rates and having two replicates. Such an experiment would normally use weaners (live weight 180-190 kg) or yearling cattle (live weight 270-340 kg) which should be uniform and of similar age. Continuous or rotational grazing could be used. The value of the different pasture mixtures and the management they require are indicated by the overall live weight gains of the cattle after they have been on the experiment for 12 months. The steers are slaughtered and a new lot of weaners of yearlings are put on the experiment for the next twelve months.

When a particular pasture mixture has been proven for a region it should be used in a large scale experiment to study the effect of management and fertilizer rate on the calving rate of cows and weight changes of the cow-calf combination. This experiment has a similar lay-out to the previous one but is commenced with in-calf heifers. As the efficiency of the beef industry is dependent on the breeding cow and its calving rate as well as the liveweight changes of the weaners this type of experiment is very important.

Where dairy cattle are involved the same type of layout can be used as in the beef production experiments. However, it is advisable to rotationally graze and shut up paddocks at the height of the growing season for conservation of the herbage as hay or silage. The conserved fodder is then fed back in the dry season and a constant weight of concentrate fed to each cow if it is thought desirable. There is considerable scope to introduce nitrogen fertilizer treatments and gramineous and legume forage crops into dairy pasture experiments. The effect on milk production of well fertilized and irrigated

forage crops grown in the off season for pastures warrants investigation where high production per ha is desired.

In large scale grazing trials the changes in botanical composition and the trends in dry matter and protein production and in levels of phosphorus, sulphur, potassium, and calcium need regular study to give an appreciation of the important interrelationships in the pasture-animal system. Observations on changes in soil organic matter and nitrogen and other factors help to define the role of the soil in the pasture ecosystem. The total dry matter produced during the year in continuously grazed trials can be estimated from the material cut within portable exclosures. However relatively large numbers are needed to cover the variation in the pasture so this technique is time consuming. Where grazing is continuous it is usual to measure the amount of material on offer to the animals during the growing season by cutting up to 20 strips 6 m x .6 m from a 1.2 ha paddock with a rotary mower fitted with a collector. Rotationally grazed paddocks are sampled in the same way. Subsamples are taken for estimation of moisture and chemical analysis.

Large scale grazing trials are playing an increasingly important part in the research programme of the C.S.I.R.O. Division of Tropical Pastures. At Rodd's Bay, Queensland, the carrying capacity of native spear grass was trebled and beef production increased five-fold by oversowing with Townsville lucerne and topdressing annually with 125 kg per ha of molybdenized superphosphate. Extensive experiments near Townsville in Queensland with Townsville lucerne-spear grass pastures involve Droughtmaster cows (Shorthorn x Brahman) and their weaners. In these annual applications of superphosphate increased calving percentages of the cows almost 40 per cent and carcase quality of the steer progeny which reached 454 Kg at 29 months of age. It has been shown that superphosphate almost doubles the dry matter of Townsville lucerne, and increases its protein content by a third and its phosphorus level over 2 1/2 times.

On poor sandy Wallum soils at Beerwah near Brisbane, a mixed pasture of Pangola grass, Greenleaf Desmodium, Miles Lotononis, and white clover gave annual liveweight gains in steers of 449 kg per ha when grazed at a beast per .4 ha. and fertilized annually with 250 kg of superphosphate and 125 kg of potassium chloride per ha. A heavy initial application of these fertilizers together with lime and minor elements was used at the start of this experiment. At the Narayen Experiment Station near Mandubbera, Queensland, the best pasture mixture in a large grazing experiment is buffel grass, Siratro, and ordinary alfalfa. In spite of a recent drought it has maintained liveweight in the steers grazing it.

All the major grazing experiments in Queensland have clearly shown that the combination of improved legume-based pastures, superphosphate, and tropical cattle will markedly increase productivity and result in efficient low cost beef production. Persistent perennial legumes contribute high feeding value and stability to the pasture system. Tropical legumes are more digestible than grasses at most growth stages, the digestibility of tropical grasses falling off rapidly with maturity. High live weight gains from legumes results from their high animal intake of digestible energy and protein due to denser packing and shorter retention time in the rumen. If the legume-grass herbage being eaten has more

than 10-12 per cent protein, the excess nitrogen passes into the liver as ammonia and is voided in the urine as urea, a good proportion of which is utilized by the grass.

Breeds of cattle with a high proportion of Brahman and Afrikander genes are able to utilize tropical pasture better than English breeds. The Bos indicus genes confer tick resistance and increased ability to digest nitrogen and dry matter at high temperatures. In addition loss of nitrogen as urea in the urine is much less in the Brahman and Afrikander crosses.

VII. Chemical analysis of pasture samples

Pasture samples taken regularly from both the regional evaluation and large scale grazing trials should be analyzed for nitrogen, phosphorus, sulphur, potassium, and calcium. Analysis for other elements including molybdenum, manganese, copper, and zinc are needed at times. Rapid methods are now available for the analysis of all the major elements except sulphur. A knowledge of the mineral composition of the herbage denotes whether the pasture is being adequately fertilized. A favourable mineral balance is necessary for quick growth of the grazing animal.

At the Cunningham Laboratory critical values (percentages) of phosphorus and potassium necessary in the leaves of the main legumes for normal growth have been determined just before flowering. Critical phosphorus value for Townsville lucerne and Miles Lotononis is .17 per cent, for Greenleaf Desmodium .22 per cent, and for Siratro .24 per cent. Critical value for potassium appears to be around 1 per cent for most legumes. When phosphorus and potassium are at the critical levels in a nodulated legume and the nitrogen is less than 2.8-3.0 per cent it can be inferred that the soil is deficient in molybdenum.

VIII. Increasing animal production by integration of pastures and forages and fodder conservation

The easiest system is a continuously grazed pasture properly fertilized and managed without thought of supplementation of the animal. However dry matter production of pasture is cyclic with a peak at the height of the wet season and often an inadequate level for the animal in the middle of the dry season. Liveweight gains reflect these differences. Studies are needed to examine whether hay or silage made from pasture at the end of the wet season or irrigated forages prevent cattle liveweight loss in the dry season. Hay is difficult to make in the tropics and many of the legumes and grasses make poor silage. Feeding value of the hay and silage is not high, and supplementation of pastures with urea-molasses-phosphate mixtures is probably a better practice. The best results are obtained from feeding grain of summer crops such as sorghum and the mung bean Phaseolus mungo which is high in protein and carbohydrate. Mung bean is a very adaptable pulse crop and should be more widely grown. A large range of varieties is available in India.

It must be kept in mind that the newer legume based pastures when well fertilized and managed are tending to maintain liveweight gain throughout the year in spite of the dry season. Beef production founded solely on perennial pastures should be the aim of all pasture scientists.

IX. Economics of different practices and provision of cheap fertilizers and seed

Economic studies of the various practices involved in beef and dairy production in Latin America are a necessary adjunct to pasture and forage research programmes. A lot of effort could be lost in promoting research results which eventually prove uneconomic. As stressed previously, research emphasis should be placed on making the legume based pasture system as efficient and economic as possible. Cultivating, sowing, and irrigating short term crops is expensive, particularly when grown in the dry season. Gramineous and leguminous seed crops such as sorghum and mung bean grown during the wet season have, however, distinct promise as a source of relatively cheap supplementary feed.

The provision of cheap pasture and forage seed and fertilizer, particularly superphosphate, is vital to the future of the cattle industry in Latin America. A number of countries may find it necessary to build superphosphate works and subsidize production of this important fertilizer.

X. Conclusions

Latin America countries have considerable potential for increased beef production for home and overseas markets through the development of improved tropical pastures. Production of dairy products for home consumption could also be markedly increased. To make the cattle industries efficient it is necessary to encourage large scale production and back it with the lines of pasture research outlined in this paper. These aspects should be given priority at this stage as they are the essential ones to give cattle production a sound basis. Studies of the soil deficiencies in plant nutrients and the reactions of promising introductions and indigenous species to fertilizer applications in the various environments are fundamental to pasture development.

Detailed research on plant nutrition, physiology of pasture and forage plants, plant breeding and genetics, animal nutrition, plant chemistry, plant pathology, and entomology could well be left to a later stage. For example, it is inadvisable to commence work on plant breeding and genetics until the aims in the improvement of pasture plants have been clearly defined from experience in growing them for a number of years in different environments. However, Latin America has a unique opportunity to classify, assemble, and evaluate its very valuable array of indigenous legumes and grasses. A co-operative centre strategically placed in Latin America for this important work would be a progressive move of considerable interest to all the tropical world.

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RECOMENDATIONS PROPOSED AT THIS PANEL

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1. The Panel stresses collaboration between agronomic, animal, veterinary medical, and socio-economic scientists in post-graduate training and research programs.

2. That the research and training institutes establish cooperative agreements with existing universities, and that all degrees be granted by the universities.

3. Graduate schools should specialize in those areas in which they have attained a level of excellence or have the staff and facilities. Repetition of areas of specialization should be avoided.

4. The use of research as a teaching tool is recognized as paramount but it should not loose sight of the fact that in agriculture a useful purpose is necessary. Therefore graduate schools should formally and ideologically be connected with carrying results to producers. The same is recommended with undergraduate efforts and practical or high school agricultural levels.

5. It must be recognized that post graduate education can be at its best only when coordinated with research projects which are stable not only from the financial point of view, but with the necessary personnel established on a long term basis to carry it out.

6. Animal industry activities at IICA or other post graduate educational institutions should be reinforced in an effort to stimulate the personnel, in the following manner:

   a) Strengthen scientific interchange between developed and developing countries, by means of symposiums, visiting professors, courses and post graduate study programs.

   b) Sabbatical leaves to centers where the leadership in the desired specific fields exists.

   c) Salaries comensurate with the level of importance of the mission, so as to leave the scientist absolute freedom to dedicate his time to the job at hand.

   d) Provide adequate equipment to permit the development of the education at the level required for modern technology.

   e) Facilitate assistance to scientific congresses.

7. In general, it is considered convenient that the majority of Latin American institutions make their programs more specific. Recommended priority would be assigned to livestock production with special reference to the proper utilization of pastures.

8. The centers which develop these activities should follow these structural guidelines:

   a) The different sections of these centers should be in close physical proximity, even though they be organized administratively into different divisions or departments.

   b) Research and teaching should co-exist in the same institution.

9. Considering the scarcity of human and material resources, the establishment of new centers should be avoided. Instead, some of the existing institutions which have already demonstrated proficiency and adequate potential should be strengthened.

10. For Latin America the post graduate level should emphasize the development of should judgement as well as the acquisition of scientific knowledge. Time spent on well-run experiment stations or well-run private farms should be encouraged as part of the training.

11. Post graduate training should bring the student up to the frontiers of science and the most advanced practices on a universal basis. Local training should not eliminate the need for training abroad.

12. Emphasize the need to improve the education and research in animal sciences at all levels in future educational programs in Latin America being planned at Inter American Institutions in cooperation with International Organizations.

13. Agencies dedicated to technical assistance to research and post graduate training efforts should simplify procedures and eliminate the number of intermediary administrators. Help should reach by direct channels, those existing leaders who have proven their capabilities even with limited facilities. This help should at no time surpass 30% of the total budget of the program being assisted.

14. That national and international support be solicited for the improvement of at least three centers of excellence for research and post-graduate training to represent the major ecological areas of pasture and animal production in Latin America. Sattelite Stations should be established concurrently to cover specific necessities of local regions. Programs should begin at the M.S. degree level, with the goal to advance to granting the Ph.D. degree as soon as acceptable high standards have been reached.

15. That the organizations and foundations that are strengthening existing schools and research centers, do so in specific fields rather than on a blanket basis, by means of stable, long term programs.

16. That guidelines on minimum standards be developed and published in regard to facilities and staff needed for post graduate training. This should be done by the Directors of the Graduate Schools of Latin America in contact with the Council of Graduate Schools of the United States.

17. That a revision of contractual arrangements concerning fellowships be made, so that the returning fellows are not obligated to work for their sponsoring organization beyond a maximum of three years.

18. That funding organizations for fellowships abroad be encouraged to include family support. Lack of such support eliminates many capable prospective students, as they do not chose to leave their families behind during prolonged periods of study abroad.

ERRATUM

Page	A-1- 3	Line	34	"Master of Science"	Instead of:		Master of Science
"	A-1- 4	"	37	List of courses 6	"	"	(6)
"	A-1- 5	"	4	Food Sanitation	"	"	Veterinary Sanitation
"	A-1- 9	"	10	Table 1 1960 Overall per/inhab.	"	"	Overall per/i
"	A-1-10	"	13		"	"	Value
"	A-3- 1	"	15	geographical	"	"	grographical
"	A-3- 1	"	27	living	"	"	life
"	A-3- 3	"	3	are	"	"	is
"	A-3- 3	"	32	around on the rouge	"	"	in enclosed field or the likes
"	A-3- 7	"	23	bureaucratic	"	"	beaurocratic
"	A-3- 7	"	45	Sao	"	"	Soa
"	A-4- 4	"	2	Basic Training	"	"	Basical Training
"	D-2- 4	"	11	Dominican Rep.	"	"	Rep. Dominican
"	D-2-22	"	18	cow	"	"	cows
"	D-2-23	"	38	adaptation	"	"	adaption
"	D-6- 2	"	20	adequately	"	"	adquately
"	D-6- 7	"	18	management	"	"	managment