Evolving from Farming Systems Research to a more Holistic Approach: Experiences in the Andean Region[1]

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Abstract

The Altiplano is a plateau covering an extension of approximately 180,000 km^2, which is located between Peru and Bolivia at an altitude of 3,800 masl. Over five million inhabitants live in this geographical area, with 60% of them living in rural areas. Regrettably, this is one of the poorer areas of both countries. The main agricultural systems are a mixed crop-livestock production systems and extensive livestock in the most depressed areas. Subsistence farming, where crop and animals play different roles as a source of food, traction, bank, insurance, and accumulation of foodstuffs, among others mark these systems.

Due to a limited market access, a lack of appropriate technologies, and an increased population growth, the deterioration of natural resources -mainly soil and water- and the loss of fauna and palatable species of the native grasses is evident. This degradation threatens the capacity to sustain the human population in the medium term and threatens to perpetuate the rural poverty.

In the search of technological options for the small farmers of the Altiplano, different activities within special projects were implemented to evaluate agricultural and crop-livestock systems at the farm level. The projects also encompassed, as an objective, the consolidation of a research methodology oriented to rural development.

These projects were framed into a holistic approach with an emphasis on fieldwork with farmers in applied and basic agricultural research problems. The first steps were diagnosis and characterization of the rural communities and their families emphasizing the use of technologies from the experimental station, with the idea that they would produce almost immediate results.

The apparent technology adoption by the users was favored due to additional means of support in inputs and infrastructure. However, upon evaluating the progress of the activities, it was evident that the nature of the works in progress as seen holistically was very complex and needed greater analysis and synthesis. Therefore, both biophysical and socioeconomic studies were emphasized in order to produce a synergism between both approaches. These conjoined studies allow a better understanding of the problems of technology adoption by peasant collaborators and facilitated the creation of mathematical models to simulate and generate scenarios and hypotheses regarding the operation of production systems.

The use of participatory methods allowed that the research was oriented to produce results that solved problems as prioritized by the farmers as opposed to the imposition of technologies based only on results from experimental stations. Contests among farmers such as in “seed fairs” promoted a more fluid dialogue between farmers and scientists, and contributed to an exchange and mutual assessment of experiences which seeking joint solutions. However, since this approach limits the extrapolation and adaptability of results and may influence the objectivity of the explanation for particular phenomena, a systems analysis approach was utilized to fill in this gap. The use of simulation models allowed the ex-post and ex-ante analysis of the systems. Its acceptance by researchers facilitated the simulation of treatments or technological alternatives before implementing them in the farms. It was a valuable tool for professionals who were inclined to give special importance to ancestral practices of production management. Also the capacity of the models to handle variables that are not of easy measurement, but can be simulated contributed to explain the rationale of the farmers. The results of the evaluations were positive, indicating the validity of the implementation of both approaches, and more importantly, in the validation of technology alternatives of broad acceptance. Nevertheless, surplus production obtained without a market orientation becomes a problem that needs to be addressed. Likewise, problems on land tenure, equity, property right, product transformation needs to be addressed to understand the dynamics of evolving agricultural production systems. Consequently, the strength of appropriate technologies and strategies and the contribution of policies and capacity building that link research and development must focus on the utilization and conservation of natural resources, market-oriented agricultural production systems, and post-production processes with an adequate policy for trade and regional integration.

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Introduction

The farming systems research approach (FSR) constituted an important step forward in agricultural research in developing countries. In Latin America, it started in the 1970s and the adoption, adaptation, and evolution of this approach have been highly variable across the continent. It is possible to encounter research groups that are implementing the methods used by some of the pioneers in the 70s while other groups are moving to "more holistic" approaches.

This paper aim at describing the experiences developed in the Andean region from the perspective of a few members of a group that initiated the work as a FSR team. Highlights of the evolution during the last ten years are presented. Some of the steps are covered in more detail for variable reasons where probably the most important is the time used to analyzed the experiences and lessons learned.

The paper is divided in three parts. In the first one, an overview of the FSR approach is presented. The authors felt it was important to present some details since the methods and experiences from this phase constituted the basis and the theoretical framework to move to a different paradigm.

Two cases where members of the original FSR team are or have been involved and where the so called "more holistic approaches" are tested are then presented. In one of the cases the focus is on sustainable NRM through an innovative method of empowering farmer/resource-user and communities. Emphasis is given to efficient learning, monitoring and evaluation of the learning process, the effect learning has on the decision-making and its impact. The other case deals with the experiences on how to involve the private sector in investing in the rural agricultural sector. The two experiences are part of the portfolio of complementary methods being test by the NRM scientists from CIP, CONDESAN, and other partner institutions.

A short part on concluding remarks is presented to share some of the lessons learned, concerns, and challenges with the reader.

Implementing the FSR approach in the Altiplano

The Altiplano is a special ecoregion within South America. Some of the areas are well endowed with natural resources. However, it is also a region with high climatic and economic risks. In addition, due to historical, cultural and political reasons it has a quality of life, which is well below its true potential. Poverty, a very slow rate of development, an increasing high population growth rate, unequal distribution of wealth, and natural resources degradation characterize the region. Over the last years, government policies have promoted the development of large urban centers and as a result, most of the population is now found in major cities. It is estimated that by the year 2025 over 75 % of the population will be urban (IICA, 1994, Winograd, M. 1995). While poverty is common in the outskirts of the cities, the poorest of the poor are found in rural areas, most of them being small farmers.

Smallholders constitute the majority of farmers. They comprise over 80 % of the Altiplano farm population practicing a highly diversified agriculture to cope with both climatic and economic risk. Within these diversified farming systems, crop-livestock production systems play a critical role, as they provide valuable products to allow in a short period a sustainable agricultural system, but well within agricultural subsistence farming. Therefore, these farmers need options with a clear problem solving focus to improve their livelihood while preventing natural resource deterioration. During decades the approach has usually been to improve the system by increasing the productivity. However such an approach did not necessarily improve the overall system. Figure 1 shows a simplification of the poverty cycle in relation to the natural resources in the region. The scheme indicates that a clear intervention on exogenous factors to reduce the effects on migration, malnutrition, poor education and poor health is needed. Therefore, a holistic approach encompassing the integration of other disciplines, various sectors of the economy, and policy studies was needed.

Agricultural researchers have been applying their knowledge by using the scientific method in search for answers to factors limiting agricultural production. The scientific method is and will be a valuable process that utilizes knowledge to generate new knowledge (Cañas and Lavados, 1989) therefore its sole application is not sufficient to solve technological problems (Figure 2). Nevertheless, without new knowledge it will be difficult to overcome the situation of agricultural production systems at different level production and scales.

Problem solving requires adaptation of knowledge to overcome limiting factors. The successful use of technology to solve major limitations to agricultural production relies upon an adequate acquaintance with the problems within a specified context (i.e. environment) and a good application of available knowledge. When this interface is used to solve agricultural problems of small farmers with their active participation, we say that we are applying a holistic methodology on Systems Analysis Research for Rural Development (SAR&RD).

The application of the FSR approach in the Altiplano was oriented to solve the food security problem and produce, whenever possible, surplus for the market. The details are presented elsewhere (PISA 1993; Quiroz, 1994; Quiroz et al., 1999 - THIS IS THE PAPER BY FAO-COLLINSON). Common problems in the implementation of the approach are also discussed by Dent, 1993 and Thornton, 1991.

One of the lessons learned from the application of farming system research in Latin America (1970's), is that farmers do not adopt complete technological packages, but rather adopt components of them (Quiroz, 1994). Unfortunately, the message has not reached key research and development decision-makers, since most of the limited agricultural extension and development projects in the region tend to enforce technological packages to small farmers. Changes in productivity of a small farm from a low level to its potential level might be pictured as an ascending spiral (Quiroz et al., 1999) with the actual production level located at the lower end and the potential at the upper end (Figure 3). The number of turns required to go from the actual to the potential level differs among production systems. Results are not expected in a short term.

Technological alternatives will be incorporated on each turn depending on its profitability (increase cash flow).

It can be envisioned that a complete turn of a cycle requires the application of several methodological steps (Figure 4). Figure 3 and 4 jointly describe the methodology integrating methods used at different hierarchical levels, as well as the institutions necessary to complete each turn. The classical scheme of farming system research includes diagnosis, experimentation, validation, and diffusion (Zandstra, et al. 1981; PISA, 1992). These steps are commonly applied by most of the research teams following that methodology. The diffusion phase represents, in many cases, the most difficult step. Usually constraints by land tenure, size of operation, access to credit, market orientation, education and health attempt to adopt a particular technological alternative. A brief description of each step considering the generation of technological alternatives for a specific agricultural product with comparative advantage in a specific market are described by Quiroz et al., 1999.

Several technological alternatives were developed and integrated, such that each farmer could use a combination of them according to their resources (capital and land) to improve productivity and therefore their income. The income is mainly from five components: crops, animal production, processing, labor off the farm, and external support. Therefore the focus was to improve crop and animal productivity. A few of the results obtained with the application of the FSR approach in the Altiplano are summarized in table 1. A study on farmer's valuation of the technologies was reported in PISA, 1993.

Methodologically, the team contributed to the application of the FSR approach with the introduction of process-based simulation models and decision support systems. A step-wise description of the Andean experience in systems analysis is presented in Quiroz et al., 1999. Simulation models were used to select treatments for on-farm experiments, perform ex-ante evaluations of technology options, conduct simulated experiments whenever biophysical or economic limitations existed, understand the rational of farmer's on specific production decisions, and assess the sustainability of practices and options. Several examples are given elsewhere (Arce et al., 1994; León-Velarde & Quiroz, 1994 & 1999).

In order to complete the cycle of the FSR methodology (Figure 4), production programs must be implemented. Without the implementation of these programs the population benefited with the outcomes of the FSR is limited to a small number of farmers, confined mainly to those participating in the process. This is directly related to the diffusion of the good technologies and practices that even in the best of the cases reaches a very low percentage of the population. This is exemplified in Figure 5. Regardless of the high diffusion rate of potato seed production in rustic greenhouses, among participating farmers, the impact on the total population is limited. Note that the time required to reach the total population is in the long term. The use of fertilizer and plastic represented a problem in order to improve the diffusion rate when the project action was retired (SEIMPA, 1995).

The possibility of initiating and maintaining effective production programs in the Andes, through conventional forms, is very low. Local and national governments have neither the level of financial support required nor the infrastructure to implement them. Innovative methods to attract the private sector and cost-effective mechanisms to increase the adoption rate of good technological practices are demanded. In addition to solving the productivity problem other important issues must be included in the new paradigm: the protection of the natural resource base, the competitiveness in the market, and the generation of rural employment.

Empowering natural resources users through learning

Poor farmers in the Sierra of Peru not only face food security problems as they used to, but are now required to compete in the market while conserving the natural resource base. The situation is aggravated by the impoverishment caused by the socio-political problems that existed in Peru, particularly in the Southern Sierra.

After the pacification of the country, the government of Peru needed to give an effective response to the rural population, particularly in the areas more affected by the guerrillas. Beside an aggressive plan to incorporate the region to the rest of the country and to the national economy, a project on sustainable natural resources management was designed and implemented.

In the design phase, the International Fund for Agricultural Development (IFAD) and the Ministry of Agriculture, a team combining different experiences was brought together. Successful experiences in NRM (Pachamamma Raymi, Pachammaman Urupa) and FSR (PISA, PRODASA) were combined in this phase.

The project combines several innovative features aiming at empowering rural farmers/resource-users through effective learning. It is highly participatory with very low transaction costs. It involves farmers, group of farmers, group of women, communities and group of communities.

In the onset of the project the communities, divided into small groups of seven to ten, were asked to present the dynamics of the natural resources base in their communities. They were asked to make maps of the situation 20 years before, the present situation, and their expectations 20 years in the future. There were two incentives to participate, the involvement of the community in the project and a cash price of US$ 1,000 for the community that best presented its case, as judged by a jury selected from and by the communities. In order to participate, the communities had to open an account in a local bank. In this way the communities were incorporated into the financial system.

Technological innovations are demand driven. Together with the identification of the need, farmers who have already solved the "problem" might be contracted out by the community with their own funds or with a loan from the project. Individual farmers might apply any practice thought useful. The learning process is tested through a contest at the communal level. The excellence is awarded in cash to the best three farmers register in the contest. The contest is then performed among the communities to judge the collective impact. Specific contests designed for schools aim at developing a culture of excellence in agricultural production and NRM.

Farmers are willing to test different options to win the contests. One would think that this might not be a sustainable way to produce impact, but the reality is different. According to a recent evaluation (unpublished) the majority of the farmers stated that "even when we loose we win". Farmers that loose in a contest analyze the practices of the winners and implement them into their farm with modifications for future contests. This method has proven to be an excellent way to quickly sieve technological options and to adopt best practices at a very large scale.

In only two years dramatic changes has taken place. Farmers are convinced they can change their future through farming; they have changed the way they get prepared to compete. A few of them carefully plan not only how to win but what they are going to do with the cash they expect to win.

The expected impact at the regional level is analyzed using systems analysis tools. The first ex-ante assessment of the impact of the project was done during the design phase. An example of the analysis was described by Quiroz et al., 1994. Even though a strict monitoring and evaluation have not been performed yet, a small sample seems to indicate that the expectations were at least met.

Attracting the Private sector to invest in rural production

The opportunity to expand the area of mixed systems, improving in turn the operation sizes, can only be achieved if concrete steps are taken. The following paragraphs summarize what the consortium for the sustainable development of the Andean Region (CONDESAN) is implementing in several benchmark areas. The main objective is to help the governments solving their problem of equity and management of natural resources while focusing on technical and economic efficiency.

Given the circumstances, the large challenges of the rural sector will be the incorporation of lands underutilized to generate new jobs, handling adequately the natural resources and achieving adequate levels of thus guaranteeing food security. Regarding the mixed systems, the discussion should be focused on their economic competitiveness with other forms of generation of employment (tourism, rural, agricultural sector-industry, construction of roads etc) and of the management of natural resources (forests to protect water sources, capture of CO_2, construction of terraces, etc). It would be easy to convince the governments, if by invested dollar, the mixed systems are more efficient than the other alternatives. This implies quantifying a tradeoff between generation of employment and value of the environmental externalities.

CONDESAN strategy is based on the premises that there is available land that is under utilized and of low-cost. This is particularly true in areas in Colombia, and Ecuador.

There are capitalists and landowners that want to enter in strategic alliances to ensure the possession of the land and/or production of raw materials

Under the current scenario:

- A few small producers who can finance an establishment of mixed systems in an adequate scale that guarantees an equivalent wage with the rest of the society.

- Even though the value of the land has been reduced, the lack of work causes that it is impossible that the producer accumulates capital to purchase land and thus expand its operation size.

- With the levels of unemployment the cost of the capital has increased in cash for the small producer.

- The state is neither willing nor has the availability of capital to finance all the establishment of the mixed systems, even if it is demonstrated that this is one of the better alternatives of investment.

With this scenario, the most viable solution is to enter in commercial alliances with entrepreneurs and/or large producers, who are in turn supported by the state with levels of investment on the order of 30%. These alliances should initially be administered by the private sector and subsequently to have an evolution toward an administration of the producers with more business capacity.

There is a consensus on the need for making the change through the strategic alliances. The reasons for his consensus is based on premises alluding to better administration, vertical integration of the production chain, agreements of prices in critical moments. An absolute necessity is to have objective criteria in order to prioritize the investment, in such a way that fulfills the expectations of the partners.

To illustrate the work CONDESAN is doing we include a summary of an on-going case study: Livestock Fund for development in town of Pensilvania, Colombia[3].

Initial conditions:

- Low-producing farms on hillsides- 2.5 Kg of milk/day, 0.8 AU/ha
- Cows with low milk production potential
- High rainfall, high erosion
- Technology validated in similar ecological conditions
- No funds to buy grass & legume seeds nor improved cows
- Short term profitability not enough to pay loans
- No matching funds to have access to a Government Guarantee funds

Challenges for CONDESAN

[3] CONDESAN 1999. Fondo Ganadero para el desarrollo pecuario de Pensilvania. Una nueva alternativa para mejorar la capacidad de vida, impulsando las siembras de pasturas asociadas. Publicación CONDESAN/Fundación Darío Maya. Informe annual de CONDESAN, 1999. 10 p.

- Design a project that would be attractive to farmers and other actors
- Foment the creation of a farmers association and a livestock fund
- Create a strategic alliance including the local government and the private sector based on actual revenues for all the partners
- Help negotiating the financial support
- Create the financial mechanisms that would stimulate participation

Project highlights

- Designed to increase milk production from 300 to 1200 Kg of milk/cow-year
- Increase stocking rate from 0.8 to 1.5 AU/ha
- Increase parturition rate from less than 55 to 70%
- Provide farmers with up to 1000 improved cows (up to 8 cows/household)
- Benefit 250 farmers
- Investment required : $887,000 (80 % from a loan and 20 % by the private sector)
- Revenue in NPV: a)farmers-$709,000; b)Livestock Fund-$349,000 (private sector)
- Negative cash flow during the first 4 years: $221,000. Two thirds covered by farmers with the profits and one third by the livestock fund.

Each member of the alliance plays a complementary role. The foundation Darío Maya was tasked with the responsibility of creating the farmers association and to manage the fund. The local government through the municipal extension agency has the obligation of giving technical assistance to farmers in the different stages of the project, including the marketing of the final product. The federation of coffee growers was asked to organize the community and to become the main private sector partner providing the initial funds needed to create the Livestock Fund. The Banco Cafetero was the financial source for the loan and CONDESAN provides funds and backstopping and facilitates the process. Farmers sign an agreement of co-responsibility to pay the loan and to share 50% of the profits with the Livestock Fund.

A few lessons learned in the process

- Strategic alliances with private sector require government funds in the order of 30% of the total amount required. In order to achieve this, the project must be focus to include the governmental priorities such as generation of rural employment or the protection of the environment.
- The fund should be initially managed by the private sector and then transferred to farmers. The process should include the training of farmers in managerial skills.
- The operational size of the participating farm is critical. The size should be as efficient as possible to minimize fixed costs.
- Fast implementation should be privileged. In order to do so, the product selected should be one that would be of high demand from the private sector partners. Partners from the private sector strongly linked to local and international markets would facilitate a fast implementation of the project.
- The geographical coverage should be selected in such a way that it would include as many small farmers as economically viable. It is required that the alliance can be

effective in a great scope of action without reducing significantly its profitability. This factor is necessary so that the alliance can select areas with biological potential, that guarantees the productivity and in turn to be able to include an adequate number of small farmers, working in areas where a large impact on environmental externalities is expected.

- It is of outmost importance to generate income in the shortest term possible. This is the most attractive bait for the private sector and ensures future investment thus benefiting a larger rural population. Products with periods of less than 18 months have a clear advantage.
- A very important part of the economic and social benefit is related to the evolution that the existing alliances can have. It is expected that the alliances by product should increasingly evolve toward niches of poor population with environmental impact. The government is willing to invest in order to achieve this change, whenever the ex-ante analyses, shows the alternatives produce a large total benefit (economic and social). Some products are more suitable than others, but in most cases, the evolution depends on the capacity of convocation and leadership of the entrepreneurs and managing partners.
- Timely investment: the long-term products that are those which currently have better profitability, present cyclic prices through the time in both the national and international markets. It has been seen that starting in 1990 these prices are highly correlated. The profitability of the investment and the cash flows are very related with the time the activity is initiated and as a result it should be regarded as a key element in order to identify the niches of investment that the Andean countries would have. For example; the prices of livestock are the lower in the last 40 years and this suggests that the region is at a stage of liquidation of inventories that would be compensated for in the future by good prices, even for domestic consumption. The optimal moment of investment is a complex analysis that requires long-term information and studies of cycles of production and prices. Entering in these businesses without knowing in depth these fluctuations might make the difference between a successful project and a disaster. For many of the products analyzed the time to invest is not right at this moment.
- Alternative financing sources: the large export companies have access to credits in dollars. It would be impractical to allocate resources to them through the internal system when the only endorsement of the government would make it possible to attract new capitals to the sector.
- Maintaining/creating rural employment: Investment necessary for generating a permanent employment is a major issue. Unemployment is one of the principal problems that we are facing in rural areas and this indicator is valid for identifying the niches where the investment of the government is more effective. There are good opportunities to invest in farms that are in the hands of small producers that with minor management changes could increase profitability.
- Equivalent income of the producers that enter in the alliance: The shadow prices for the farmers' adjusted for the costs of the basic services would be an indicator that would show the regional niches where the investment should be oriented. The shadow price of the wage is one of the most decisive factors in the profitability of the alliances. The critic economic situation in the Andean countries is making that farmers enter in alliances where they contribute with labor for 12 months, without

receiving a payment in cash by this service, thinking only about the income at the harvest.

Concluding remarks

In conclusion, it is evident that the biophysical and socioeconomic conditions are changing rapidly. However, technical intervention and accumulated knowledge based on system analysis research for rural development can be used in specific sites. Appropriate methods and procedures can be used in a wide range as decision support tools to improve production and productivity without natural resources deterioration.

Practitioners of SAR&RD methodology are increasingly being pressed to deliver technological options for overcoming small farmers' problems. Farmers demand for solutions require short-term answers, a high degree of specificity (differential environmental, market, and social constraints), and with a minimal environmental impact. Researchers are, on the other hand, limited by decreasing financial resources. Under these circumstances, models and simulation techniques may become very useful in improving efficiency and promoting a sustainable agricultural development among resource-poor farmers, particularly those living in fragile environments. Fortunately, computer technology is becoming more accessible, both in price and performance, and new professionals are better trained in its use.

Within the context mentioned above the main issues dealing with productivity, poverty and natural resources must be considered within a global research and development agenda in relation to support livelihoods in the crop-livestock production systems. An emphasis and understanding of the dynamics of evolving production systems is necessary to strengthen appropriate technologies and strategies with a clear contribution of policies and capacity building focussing on: utilization and conservation of production resources; market-oriented production systems, post-production processes, and policy for trade and regional integration.

Figures

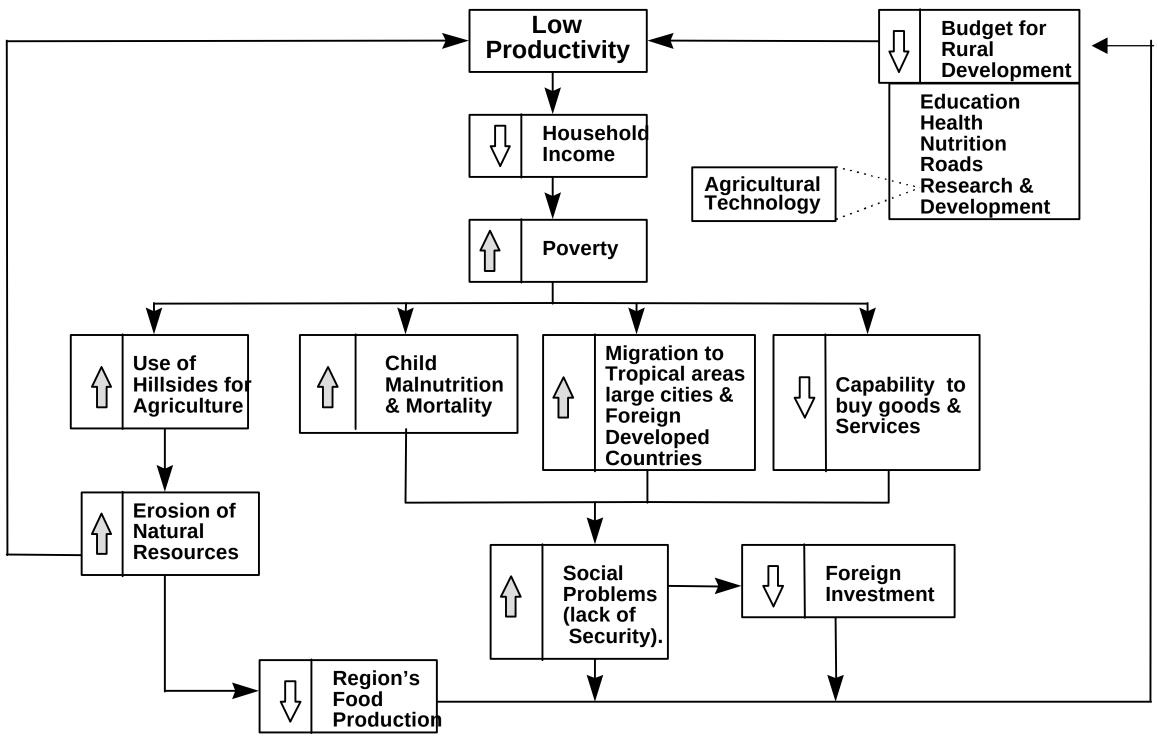

Figure 1. The vicious cycle of deterioration of natural resources, low agricultural productivity, poverty and violence. (Adapted by R. Quiroz from PISA and PRODASA, 1993.)

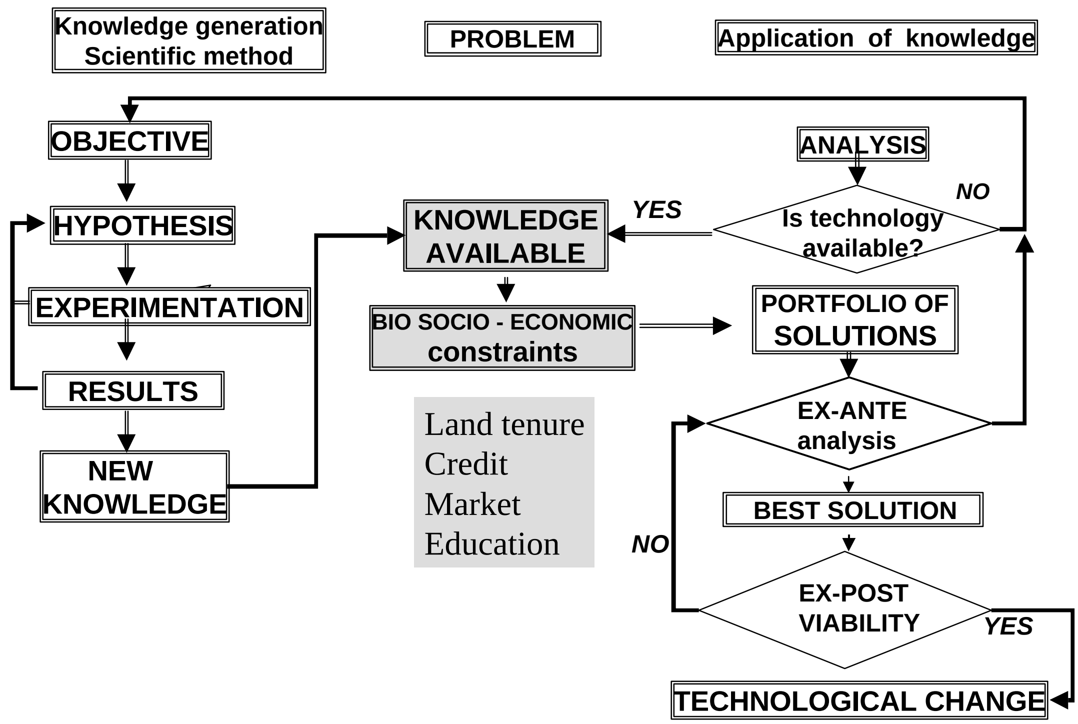

Figure 2. Schematic representations of linking scientific method with knowledge generation and its use in systems analysis research for rural development (SAR&RD) methodology, considering the main limitations and constrains (adapted from Cañas and Lavados, 1989).

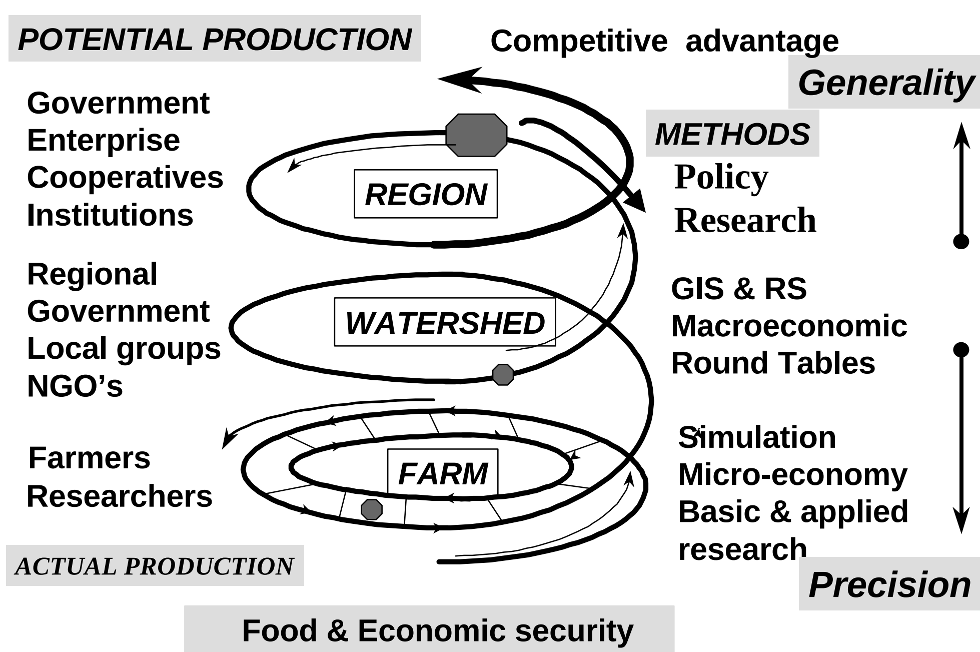

Figure 3. Systems hierarchies and research methods utilized by the system analysis research and rural development. At the level of the agricultural scientist a high level of precision is demanded, which apparently decreases in each turn, but the demand for better and correct policy is highly desirable to obtain an equity and natural resource conservation. The role of institutions and policy makers increases on each turn. A balance of integrated planning and responsible decision-makers in each turn is necessary. (Adapted from Leon-Velarde and Quiroz, 1994)

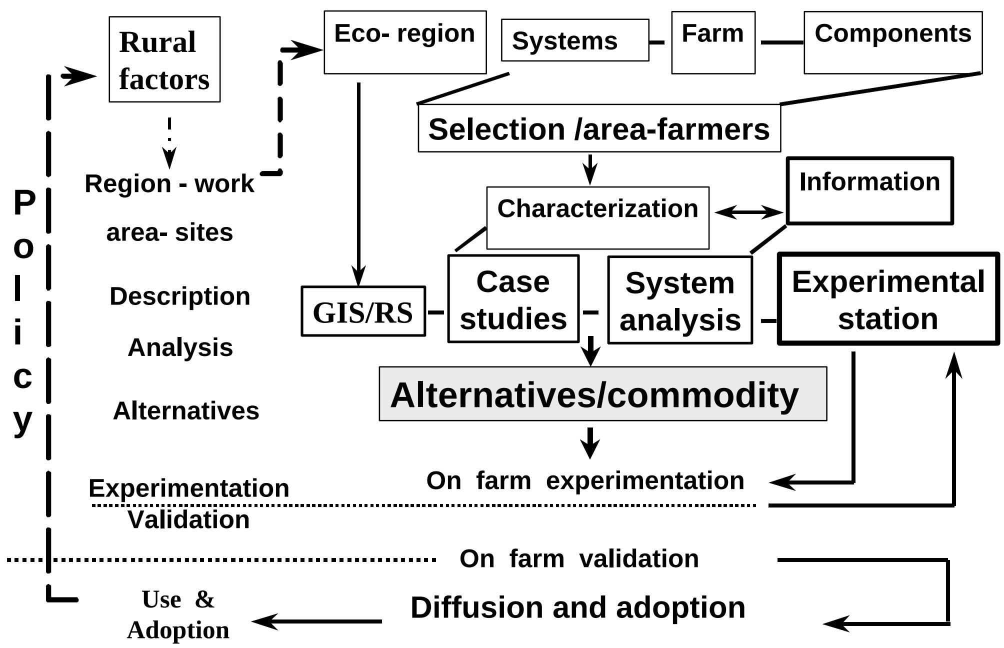

Figure 4. Schematic flow diagram of Farming System Research (FSR) in relation to System Research Analysis and Rural Development (SAR&RD). (Adapted from PISA, 1992 and PRODASA, 1995).

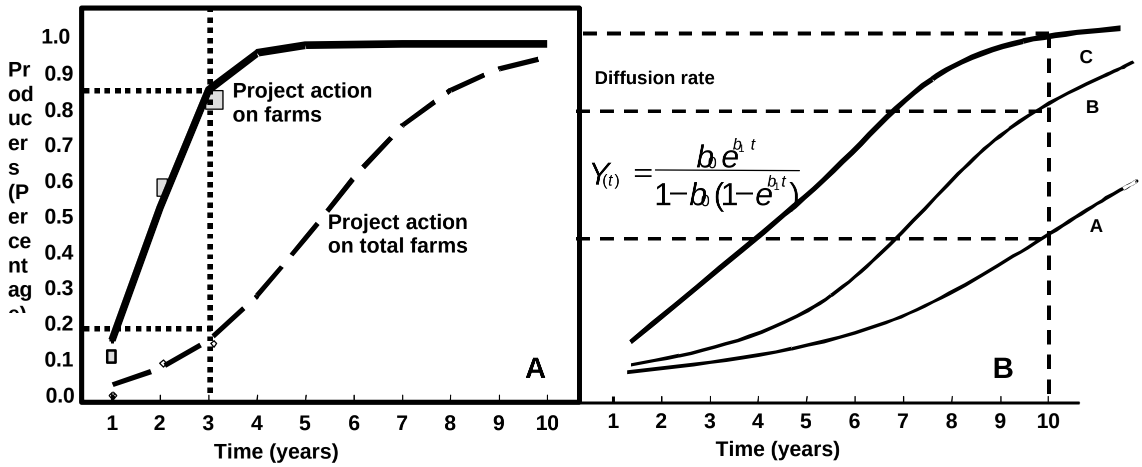

Figure 5. Rate of technology diffusion. (A) Case of rustic greenhouse to produce seed potato; during the first three years 88% of the target was reached, which represents 18 % of the total population. (B) Shows the possibility to increase the rate of adoption by using a participatory method among farmers; the use of farmer collaborators and contests among farmers contributes to an increase in the adoption rate.

Tables

Table 1. Main results obtained in alternatives of production when considering appropriate technological alternatives without deterioration of natural resources in the Altiplano.

Technological alternative	Result	Impact on traditional use
Use of aquatic forage; llachu-totora	0.584 $g.day^{-1}$	142 %
Forage budgeting; use of perennial and temporal forage base	Forage availability; silage and hay. Increase milk production	Forage increment; 38-96% 45-75 %
Climatic risk minimization; use of shelter	Increase gain weight; reduce age first mating	53 %; 18-20 months
Crops/greenhouses	Contribution to family diet Increase vegetable production	Potato 2.8 $kg.m^2$ Mixture /food-market 58 %
Alpaca management production system; fiber-interchange of sires (break down consanguinity)	Increase fiber production. Birth weight Increase income; gross margin ($1,980)	12-15 % 18 % 55 – 104 %
Use of model simulation	Dual-purpose Risk analysis	Evaluation of scenarios; ex-ante and ex-post analysis
Use of manure decomposition/mud	Increase water retention Increase nutrient availability	14 % on potato and quinoa production Reduce use of fertilizer by 30 %
Use of credit / revolving funds	Credit scheme used by NAR'S	86 – 92 % of credit recovery

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