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Research priority setting by a stepped agro-ecological approach: case study for the Sahel of Burkina Faso

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Abstract

The present study proposes a model for the identification of research issues. It includes a set of criteria to weigh the relevance of identified research projects, using an agro-ecological approach by a multidisciplinary team. In this approach, emphasis is placed on the assessment of the impact of the expected results of research projects with regard to productivity and to ecological, economical, and social sustainability. The model comprises seven steps: (1) determination of the main function(s) of a selected agro-ecological zone; (2) determination of the user-needs and indigenous knowledge; (3) determination of the constraints and potentials of the agro-ecological zone; (4) review of existing scientific knowledge and technologies; (5) identification of relevant research issues and their division over strategic and applied research; (6) prioritization and selection of themes and projects; and (7) evaluation of personnel, material and funds. A case study is presented on the sahelian zone of Burkina Faso. Illustration of the model with this degraded area where sustainability is an actual and important issue allows a discussion on the advantages and limitations of this agro-ecological approach for research prioritization.

Keywords: agricultural research, priority setting, agro-ecological characterization, sustainability, Sahel, Burkina Faso

Résumé

L'étude présente une approche pour la prioritisation des thèmes de recherches. Elle comporte un jeu de critères pour l'évaluation de la pertinence des thèmes et projets de recherche sur la base des caractéristiques agroécologiques d'une zone donnée au travers d'une équipe multidisciplinaire. Le model proposé se fonde sur l'évaluation de l'impact des résultats attendus sur les plans de la productivité, de l'écologie et de leur durabilité économique et sociale. La démarche comporte sept étapes: (1) la détermination de la (ou des) vocation(s) de la zone agroécologique concernée; (2) la détermination des besoins des utilisateurs et de leurs connaisances endogènes; (3) la détermination des contraintes et potentialités de la zone agroécologique; (4) la synthèse des connaissances et des technologies disponibles; (5) l'identifica-

tion des thèmes de recherches et leur regroupement en deux catégories: recherche stratégique et recherche appliquée; (6) la prioritisation et la sélection des thèmes et projets de recherche; et (7) l'évaluation des besoins humains, matériels et financiers. Une étude de cas concernant la zone sahélienne du Burkina Faso est présentée. Les résultats obtenus ont permis, dans le contexte de dégradation de cette zone où la durabilité est un important objectif de discuter des avantages et des limites du modèle proposé.

Mots-clés: recherche agricole, prioritisation, caractérisation agro-écologique, durabilité, Sahel, Burkina Faso

Introduction

Priority setting in agricultural research is a necessity in order to allocate the available but scarce financial and human resources (Alston *et al.*, 1995) as efficiently and objectively as possible to the wide range of possible research items in agriculture and related fields. In view of the growing demand for food and fiber by the ever-increasing population, and because of the continuing degradation of the natural resource base, particularly in developing countries, agricultural research and development programmes need to deal separately with productivity and sustainability even if the two are interrelated (Crosson & Anderson, 1993).

As to sustainability, agro-ecology plays a dual role: one in relation to environmental internalities where direct resource depletion or degradation is at stake, and one in relation to environmental externalities, including the effects of technologies on the quality of land elsewhere. Because of these dependencies, multi-scale agro-ecological characterization, (describing the environment including its component-interactions) needs to play an important role in the process of priority setting in research (Goldsworthy *et al.*, 1994; Van Duivenbooden, 1997).

Most of the existing methods for research prioritization are mainly based on economical or agro-economical approaches (Koudokpon *et al.*, 1993; Collion & Kissi, 1994; Kelley & Ryan, 1995); and these methods do not pay enough attention to agro-ecological conditions and do not provide the possibility to explicitly link qualities and specificity of agro-ecological zones with the aim of productivity. Additionally, in the existing methods the aim of sustainability, which is an important issue in the context of the increasing degradation of the earth's natural resources, is not valued against a set of specific criteria (Goldsworthy *et al.*, 1994) and the traditional economic measures of this factor so far have defied any consensus (Anonymous, 1990a).

Research priority setting methods so far have been putting emphasis on smallholder-farmers without giving enough consideration to the diversity of users of natural resources and its effects at other scale levels. Local knowledge as developed by farmers is not clearly considered as an input in the problem-solving process for agricultural production and resources management often because of lack of effective participatory approach.

Lastly, neither the division nor the links between applied and strategic research in

the existing research priority setting are evident while development of strategic research is seen as an absolute necessity for the strengthening of the national agricultural research systems.

The objective of the study is to develop a model for priority setting in agricultural research at country level based on an agro-ecological analysis, taking into account the diversity of users, and focused on sustainability. In this study, special reference is made to bio-physical, socio-economical, and institutional conditions in the sahelian zone of Burkina Faso.

Stepped approach for research priority setting

The proposed method of research priority setting using agro-ecological characterization implies the sequential determination of seven steps (Figure 1) which are discussed below.

Step 1: Determination of the main function(s) of the agro-ecological zone
The main function of an agro-ecological zone (AEZ) is the combination of the natural 'vocation' and the role of the AEZ in the national economy and development plan. This role also can be assigned at regional level for sub-units in the same zone. This 'economical' role, as targetted by policy makers, reflects the level of importance assigned to the area in the framework of national and/or regional development planning. The vocation includes broad, area-specific indications of the prevailing potentials and constraints for certain types of land use activities. A geographical information system (GIS) and related databases are tool for this steps.

Step 2: Determination of user-needs and local knowledge levels
Users, as referred to here, include the 'internal' population of land users and relatives, and the 'external' population at regional, country, and international level living indirectly from the natural resources (e.g. traders, extension workers, tourists, and industrials).

User-needs and local knowledge levels can be determined by means of participatory rural appraisals, and by analysis of existing secondary information. Insight in the traditional knowledge and technology levels makes it possible to: a) define the real constraints to production or sustainability at farmers-level, or for other kinds of resource utilization in relation to the actual level of indigenous technology; b) implement applied research based on the level of technology of the internal users in the area; c) focus strategic research on aspects of modelling, extrapolation in space and in time of phenomena; and d) avoid failures and waste of time and money spent on research themes and projects, of which results will not be used by the internal users.

Step 3: Determination of constraints and potentials of the agro-ecological zone
Land evaluation or simulation modelling provides the possibility to define, either qualitatively or quantitatively, the qualities of the natural resources, the level of ac-

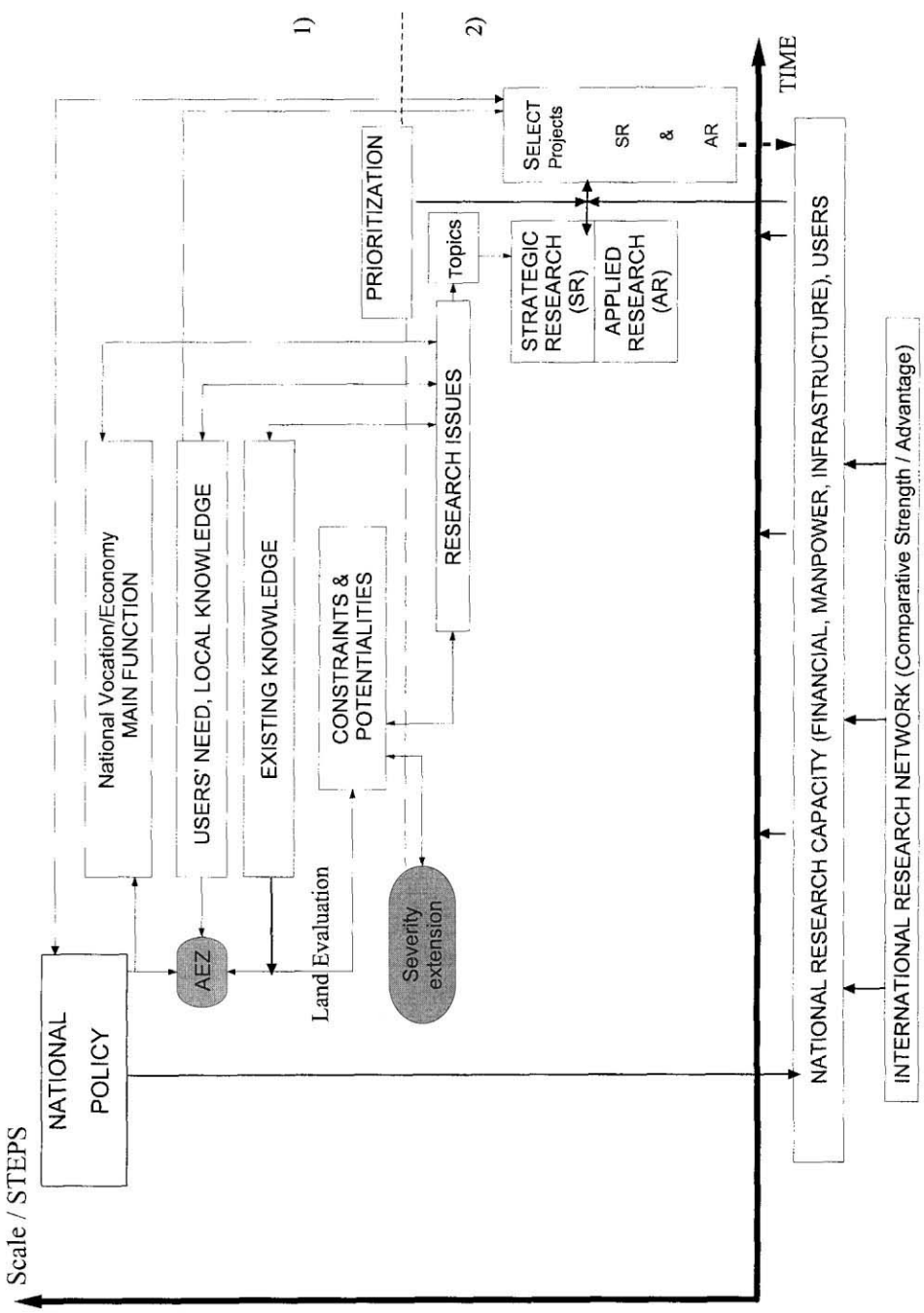

Figure 1. Process of research prioritization in a time-scale framework.
AEZ: Agroecological zone 1) Input data 2) Output data

Figure 1. Etapes de prioritisation des thèmes de recherches.

tual production systems (traditional, semi-modern or modern); and the suitability of the area by a compatibility analysis of agricultural uses, pastoralism, forestry, recreation, etc. The various constraints will be identified in a hierarchic order according to the degree of severity. Spatial evaluation of the main constraints will be done using GIS and related databases.

Step 4: Review of existing scientific knowledge and technology packages
Using the analysis of the needs of the internal users, a review of scientific experiments is conducted to identify alternative technology packages. It should be noted explicitly that existing trends and future problems have to be considered in order to make relevant assessments of the adequacy of the actual knowledge and technology packages in the context of future bio-physical and socio-economical changes. The evolving synthesis is to include scientific knowledge and technology packages at regional, national, and international agricultural research centers levels related to specific agro-ecological zones.

Step 5: Determination of research objectives
The research topics evolve from the previous analyses and steps (Figure 1). A distinction hase now to be made between strategic research and applied research. Strategic research has a focus for a better long-term understanding of the functioning and the behaviour of the agro-ecological zone, including the underlying processes (e.g. development of simulation models and scenarios fitting the aim of sustainable development). Applied research and, for that matter, adaptive research aims with a relative emphasis on sustainable production and productivity increase (e.g. fertilizer experiments).

As a rule-of-thumb, for developing countries, a reasonable division of financial and manpower resources over the two research categories might be in the order of 20-30% for strategic research issues, and some 70–80% for applied research. A good interaction between and alignment of the two should be made.

Step 6: Prioritization of research topics
Prioritization of research themes requires to take into account the identified objectives, and to use a set of objective criteria to weigh the research themes (separately for strategic and applied research). In addition, a hierarchic score is used. In strategic research focus is preliminary of long-term sustainability, while in applied research it is on productivity, i.e. the aims of growth, equity, and short term sustainability.
Subsequently, increased productivity (R) is valued using the formula:

$$R = a \times S / C \qquad (1)$$

where: a = estimated increased revenue due to alleviation of the main constraint ($\$ ha^{-1}$), S = area of the constraint in the AEZ (ha), C = estimated research costs ($).

Next, sustainability is rated by adding three distinguished impacts:
I. Economical impact (I_m), i.e. the effect on the local standard of living, including the estimated effect on farm income and the equity of distribution of this effect.
II. Social impact (I_s), i.e. the effect on local social, cultural values, and political issues, including gender issues, labour availability, distribution of power, land tenure rights, and common law.
III. Ecological impact (I_e), i.e. the estimated effect on ecosystem equilibrum (land degradation: soil structure decline, crusting, erosion, nutrient depletion, and salinization), ecosystems functions (vegetation cover, ground and surface water movement, nutrient flows, etc.), biodiversity (habitat function, and sources of natural products).

For reasons of simplicity, the three individual impacts are considered to be of the same order of magnitude, each having an equal impact on sustainability in an agro-ecological zone. After assessment of the individual impacts I_m, I_s and I_e (each is assigned an impact value between 0 = highest negative impact and x = highest positive impact), classification of the total score ($I=I_m+I_s+I_e$) allows the valuation of the 'sustainability aim' as follows:

Class 1: high priority research project, when I is high
Class 2: moderate priority research project, when I has a medium score
Class 3: zero to low priority research project, when I is low

For example, with x = 5 we can have the following figures: Class 1: $I > 13$; Class 2: $10 < I < 13$; Class 3: $I < 10$

Finally, multipliers are used to take into account the different values of sustainability and productivity in strategic or applied research. A project or research theme will have thus one of the following focus values:

$$F_s = (1{,}5 \times I) + R \text{ for strategic research theme/project} \quad (2)$$
$$F_a = I + (1{,}5 \times R) \text{ for applied research theme/project} \quad (3)$$

where I = sum of impacts, and R = valued productivity.

Step 7: Evaluation of personnel, material and funds
Upon the selection and ranking of the research themes, as described above, the human, material, and financial support have to be determined separately for the two categories of strategic and applied research, and compared with the existing research capacity within the agro-ecological zone taking into account the possibility of joint projects and actions by different institutions in that zone.

Results and discussion

Application of this model to the sahelian zone of Burkina Faso, taking into consideration existing information and the authors' knowledge of the area, results in a number of observations for each of the steps:

The main function assigned by national-level policy makers is animal production

(Anonymous, 1993). It fits well the natural vocation of the area (Anonymous, 1990b; Guillobez, 1985).

Looking at several studies, the internal and external users needs concentrate on putting a halt to desertification, increasing the potential for pastoralism, increasing the productivity of agro-sylvo-pastoralism systems, rehabilitation of the degraded lands, and planning and development of eco-tourism. The local knowledge level is high and specially the pastoralists and agro-pastoralists have appropriate strategies and technics for adaptation of drought (Bovin, 1989; Mortimore, 1989).

The several constraints and potentials of this AEZ are grouped in Table 1. The severity of these constraints range from moderate to very high.

A review of the literature (Thiombiano, non published report) shows that over the past decennia, much applied research has been conducted in the Sahel to tackle these constraints, or to exploit the potentials of the area. Technologies packages have been proposed by national agricultural research system (NARS) and by international research centers, but of both impact is rather low. In the field of strategic research integrated studies have been conducted (Penning De Vries & Djiteye, 1982), but desertification process and sustainability remain still poorly understood (Thiombiano *et al.*, 1996), so that further strategic research in the sahelian zone is needed (Sivakumar & Wills, 1995).

Analysis of the above data for research priority setting on an agro-ecological basis in the Sahel reveals the necessity for strategic and applied research for issues such as desertification, sustainable management of ecosystems, resources inventory and rehabilitation, increasing productivity, alternative energy and eco-tourism. Subsequently, a number of themes/projects can be identified from these issues for both research components (Table 2).

The objective criterea to weigh the several projects are defined in Table 3 by using Equation 1 and 2 for strategic research projects, and Equation 1 and 3 for applied research projects. The related data are obtained from Table 1 (Anonymous (1996a) for the cost of products, and Anonymous (1996b) for the estimated research costs including personnel). In a subsequent evaluation on the sustainability issue, these projects range from high (class 1) with 15 as a value of I, to moderate priority (class 2) with I=11. This implies that these projects should be selected in the framework of research program according to the potential impact of the results in the domain of sustainabili-

Table 1. Main constraints and potentials of the Sahel in Burkina Faso.

Tableau 1. Principales contraintes et potentialités de la zone sahélienne au Burkina Faso.

Main constraints	Area (km^2)	Main potentials
Aridity	61,174	Extensive areas suitable for grazing
Soil erosion	48,938	Good local knowledge of agro-sylvo-pastoral management
Low soil fertility	15,293	Wind and solar energy
Degraded natural vegetation	51,998	Appropriate animal breeds
Increasing stocking rates	36,704	Favourable biotopes for wildlife, plant species, etc.
Shifting dunes	8,220	Availability of deep groundwater reservoirs

Table 2. Example of selected research projects.

Tableau 2. Exemple de projets de recherches identifiés.

Theme	Projects
Applied Research	
1. Land rehabilitation	1.1 Utilization of manure and residus for soil and water conservation
	1.2 Dune fixation to protect natural lakes.
Strategic Research	
2. Desertification process	2.1 Bio-physical desertification processes
	2.2 Socio-economical driving forces of desertification
	2.3 Institutional and political changes in the sahel

ty. In Table 3 are mentioned the focus values Fa for applied research projects 1.1 and 1.2; and Fs for strategic research projects 2.1 and 2.2. Project 1.1 is the first priority for applied research having a higher Fa, and project 2.2 is the first priority for strategic research. An example of evaluation of personnel is given in Table 4. Within the NARS in collaboration with international and advanced centers through the Desert Margin Program, several research projects can be efficiently conducted. Users as pastoralists and agro-pastoralists will be take into account in the process of research.

This case study illustrated the use of the model proposed for research prioritization by an expert team with a great competence on the AEZ concerned. As several authors agreed, the research priority setting is mainly a consensus process (Collion & Kissi, 1994) for which there is no absolute objective set of criteria. In the proposed model, the multi-disciplinarity of the team involved in the process, the simplicity of the weighting or valuation of the aims, GIS and modelling techniques, and the competence of the several experts seem to be the main factors for giving objectivity to the process. The utilization of such an stepped approach gives detailed information and datas sets at different scale levels (country, region), which can be used as a tool to target technologies to the agro-ecoregional zone as developped by NARS and international research centers, and for research priority setting of the Consultative Group for International Agricultural Research (CGIAR) research agenda (Gryseels *et al.*, 1992).

Research priority setting within an agro-ecological zone by the stepped approach proposed seems a relevant process for integration of aims of productivity and sus-

Table 3. Focus values Fa (see Equation 3) and Fs (see Equation 2) of the projects.

Tableau 3. Scores de quelques projets.

Projects	Fa	Fs
1.1	11,485	
1.2	8,646	
2.1		14,903
2.2		14,909

Table 4. Evaluation of personnel and equipment.

Tableau 4. Evaluation du profil des Equipes et du matériel.

Project nr.	Team	Basic equipment
1.1	Agronomist, pedologist hydrologist	Field laboratory
1.2	Amenagist, ecologist, pedologist, hydrologist, pastoralist	Field labour material
2.1	Microbiologist, ecologist, pastoralist, agronomist geographer, pedologist	GIS equipment
2.2	Socio-economist, anthropologist, agro-economist	
2.3	Socio-economist, economist, politics sp.	

tainability. The developed model can allow a real participation of various users, policy makers researchers, extension workers, and non-governmental organizations (NGOs) with possibilities of feed-back to the several intervenants as indicated in the model. In the case study of the Sahel it appears that the project on soil and water rehabilitation and conservation, and the project regarding to the human behaviour regarding natural resources are very relevant for the local and external users (Thiombiano *et al.*, 1996). Consequently, the model proposed can be used for evaluation of research projects/themes to see how the results obtained fit the needs of users, and the main function assigned to the AEZ by the Development Plan of the country or the region.

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