Keynote address: Management of Natural Resources – a Challenge to the Agricultural Research System

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1. Introduction

Predictions for the year 2025 include a global population of some 8.5 billion. Among the notable consequences will be greater demands on natural resources employed in the production of food, feed, fibre and forests. The eighties and nineties of the last century witnessed widespread increases in the productivity of natural resources and in production, based upon the knowledge embodied in people, technologies and institutions. But there was also a sense that further expansion in production is threatened by a diminution in the quality of natural resources and that these same quality changes frequently affect the productivity of non-agricultural activities as well. Moreover, there was and still is concern that the capacity of natural resources to play their broader environmental role might be threatened. These circumstances argue for more attention to natural resources management and for the development of sustainable patterns of resource use that con both increase productivity to meet the mounting demands for products and at the same time limit further threats to natural resources and the environment.

Dr. Salah Hafez, than Chairman of the Egyptian Environment Affairs Agency stated in 1992 in an article on environmental issues and policies in Egypt:

> *As far as environmental issues are concerned, no state can set itself in isolation and no human is an island. In fact, we all suffer the severe impacts of continued environmental abuse and crises, and by the same token, greatly hope eventually to gain the rewards and benefits of working towards a world returned to its environmental senses. In Egypt, the issues of environment are related to the natural resources which are depleted or are onnected with a thoughtful development which takes the environmental chacllenge into consideration, realizing the constant and long-term development to meet the needs of the present generation and the future generations to come (Hafez, S., 1992)*

Natural resources (NR) are in a general understanding those products and features of the earth that permit it to support life and satisfy people's needs. In managing natural resources human beings intend to develop or conserve land, water, vegetation, wild animals, mineral resources. Agriculture and forestry are in this sense the two most important disciplines in natural resource management (NRM). Agriculture depends on the sustainability of natural resources and is therefore highly interested to protect it’s resource base. But one has to be aware that agriculture is only able to protect the NR base within it’s technical and economic limitations.

Egyptians as many people around the world are increasingly concerned about natural resources and how they are effected and changed by human activities. In general people are more and more concerned about the sustainability of life on earth. These

concerns resulted during the last decades among others in a paradigm shift in agricultural science in scope with the present and future requirements. In this paper the author intends to reflect on these ongoing changes and to comment on the effects on natural resource management research within the agricultural research system.

2. Paradigm shift

T.S. Kuhn, claimed as early as 1966 that the world of science is undergoing a transition from a science model based on mechanistic thinking and the Cartesian subject-object-dualism toward an ecological and holistic thinking[1]. He saw a paradigm shift emerging.

A paradigm comprises as the author understands it, the totality of principles governing a scientific discipline during a certain period of time concerning methodology and scientific subjects. Up to more or less recently natural resource management was in many countries and in some it still is primarily concerned with the manipulation of ecological systems to achieve a yield of desired products. But it became evident during the last decades that things, that demands are changing. The author believes that contours of a potential change of paradigm have become clearly visible during the past decades. A change of paradigm certainly requires the change of various fundamental principles valid in the field of science under consideration. In our case, this would require that some fundamental principles or criteria valid in the field of NRM and agricultural research undergo a significant change. For instance agroecosystems are presently usually driven to some degree by external subsidies of energy, water and nutrients. Moreover, these systems are purposefully modified by chemical and/or mechanical technology and by selected genetic inputs. The various components of agroecosystems are further modified by social and economic goals. The manipulation had so far more or less to meet the following criteria: (1) economic benefits; (2) technical efficiency; and (3) performance reliability. Although these criteria have not and will not become obsolete, they undergo and have undergone certain changes and have become more and more dominated by other criteria. The following criteria became, as the author sees it, relevant during the last decades, they are:

- the principle of sustainable development
- ecological quality
- consideration of macro scale systems and effects (watershed, basin system etc.)
- changes of natural and socio-economic systems.

There of course are interdependencies between these criteria. Without going into the extensive discussions one realises that there are new elements in the game which altogether may form and in some respect have already formed the basis for a new paradigm in NRM.

As the sustainable development paradigm, which evolved out of the Brundtland report, is built on the premise that neither of the two objectives - economic development and environmental protection - can be ignored and that an acceptable balance must be achieved between the two, science in general and science in NRM in particular has to

[1]Holism is the philosophy that "all things are connected" and that interaction in natural systems are complex. In holism, wholes are more than the mere sum of parts and are the fundamental bases of the real world.

change from the reductionist approach to, what Narain (1998) call's a dialectical approach in (agricultural) research, or even to a holistic approach. And this means of course also from a disciplinary to a multidisciplinary approach in NRM research. Especially since each of the above mentioned two generic objectives constitutes a larger set of more specific objectives and sub-objectives and as societal, cultural, and other objectives cannot be excluded in a holistic approach.

The author strongly believes and experience shows that a sustainable NRM is for instance only possible on a participatory basis. The involvement of all the stakeholders in NRM is therefore very important. If one sees only the farming community as the focal point of an integrated natural resource management, one misses out many increasingly important players in the game. Quite important is the existing and upcoming competition in the field of natural resources (NR) and the present and future interactions of the non agrarian community with the farming community and how this will influence the agrarian use of natural resources as well as food security.

3. Sustainability: a priority issue?

Despite the general world-wide acceptance of the sustainable development paradigm there have been and there still are tensions within collaborative research consortia etc. Scientists and policy makers from developing countries do quite often not see sustainability as being of as high a priority as the scientists from the Advanced Agricultural Research Institutes (ARIs), the International Agricultural Research Centres (IARCs) and the policy makers in the North etc. do.

One of the problems research institutions in many developing countries are facing in natural resource management research (NRMR) is the fact that there is in most cases no general accepted sustainable scenario for their mandate region. While sustaining the natural resource base is high on the agenda of the industrial nations it is not seen necessarily of first priority within the developing world, especially in the resource scarce regions of the Middle East and North Africa (MENA). A consultation meeting in 1999 fore instance showed that concepts in regard to sustainability differ from one country to another, from one expert to another, but one common feature in MENA is that sustainability goes far beyond natural resources. The representatives from eight MENA countries and several international organisations pointed out that sustainability must be viewed in the context of the economic and social development of the countries. In the opinion of these representatives sustainability in MENA can, in the short term, mean targeting a social equilibrium for a rapidly growing population living in a fast-moving economy (Renault, D. et al., 1999).

The consultation revealed clearly that there is seen to be no "sustainable scenario" as such. Instead national strategies of development exist based on long term objectives, which account for current constraints and problems that need to receive proper and immediate solution. During the consultation it was made clear that sustainable development can be foreseen in a future where both the population growth rate has declined and economic development has generated greater opportunities for the whole population.

Given the demographic pressure, the underlying determinant of many national policies in the MENA region and beyond, is social stability. In many important countries of MENA this aspect is seen as of prime importance. Not only because social stability is the foundation for national well-being but also because growth of tourism, which is an important part of national incomes, depends on it. Rural development is seen as conditional on both the free international market to develop efficient farming enterprises and the potential of other sectors to generate jobs and absorb rural migration.

In respect to the sustainability issue IARCs and ARIs (co-operating with National Agricultural Research Systems (NARSs)) have the difficult task to meet their own goals and the differential expectations of the donors as well as their stakeholders. The latter are expecting that their international research partners will assist them to increase and to stabilise production, even under conditions where for sustainability reasons it might be seen necessary to reduce resource use and/or change land use.

4. Overall considerations on Natural Resource Management Research

4.1 Definition and contents of NRM

There is a general understanding that natural resource management (NRM) is primarily concerned with the manipulation of ecological systems to achieve a yield of desired products and that in addition, there is a growing demand for development and management of natural resources that is ecologically sustainable as well as economic. The management of natural resources includes at least the following: (a) discovering, developing, defining and evaluating the goals of NRM at specific sites and the alternative policies (and measures) that will lead toward the goals, (b) getting the stakeholders to adopt the policies (and measures), (c) scrutinising the effectiveness of the policies (and measures) that are adopted, (d) initiating steps to change policies (and measures) when they are judged to be less effective than ought to be.

As not all forms of natural resource management are good, there is a strong interest in establishing criteria of good and bad natural resource management. In this sense, research in NRM can not be primarily descriptive, although detailed descriptions of the management processes may be quite important. Instead, research in NRM has to be predictive. But interest lies not only in predicting what a given management will do in a certain circumstance, but more fundamentally in predicting what would occur if certain activities were adopted. The outcomes of these predictions have to be evaluated and an attempt has to be made to rank management activities in terms of better or worse, and if possible to discern the best. Evidently, this evaluation has to be based on a decision as to whose interests are to be served by the management or, more precisely, how various competing interests are to be weighted. It becomes clear that NRMR has to play an important role in the process of managing NR, all the stakeholders involved in this process expect that researchers will come up with strategic research results, with tools to solve existing and anticipated problems in the management of NR.

4.2 Strategic research results obtainable?

Natural resource management research has particular characteristics which determine the research strategy to be followed. The subject of inquiry is the performance of ecological systems within the different (agro-)ecological regions. The research is generally very site specific and therefore needs to be conducted in most cases with the respective stakeholders and especially with the rural population of the specific research site. A participatory approach has to be followed in most cases. Furthermore the respective social and economic conditions have to be taken into account. The research results obtained are therefore site specific and generally not applicable under different site conditions. Very seldom generic lessons can be drawn directly from single site specific experiments in NRMR.

Strategic research[2] may thus be achieved by drawing generic lessons from many applied research projects. For research institution working at different sites or/and in co-operation with an other research institution, especially non-agrarian disciplines this is both a unique source of advantage in research, and a source of difficulties in organising strategic research. Success requires the formulation of rigorous hypotheses, systematic data collection and documentation, and the use of research methods that will subsequently allow comparative analysis. For this purpose, the use of a relevant theory is essential.

The fundamental linkages between the management of ecological and especially agro ecological systems and the vital biophysical base - climate, soil, hydrology, flora, and fauna - on one hand and the economical, as well as the socio-cultural system on the other hand imply that the research in NRM has to be multidisciplinary. Data collection in NRMR is difficult and must often be sustained over long periods of time in order to achieve generic results. This requires a respective long lasting research relationship between the research partners. Unfortunately such a long lasting research partnership among research institutions is seldom found in NRMR. That's why among other reasons strategic research results are so difficult to achieve in NRMR.

As in and between ecosystems "everything relates to everything" interactions among components and between systems is considered a key concern. Therefore research in NRM has to follow a holistic approach. The holistic, interdisciplinary approach is complementary to an approach involving separation of components for separate treatment in research, with a more narrowly focused disciplinary approach. It is not an "either/or" situation. One can take an overall, holistic descriptive view of natural resource management as a linking mechanism for conservation and sustainable use of ecosystems; and at the same time, one can break the subject down into a discrete set of manageable, disciplinary oriented research topics. In fact, this is necessary in order to make progress in research and to overcome a diversity of problems occurring between disciplines, when a strict inter-/multidisciplinary research execution is followed.

Thus, good problem-focused, interdisciplinary research related to natural resource management should move along the following path:

- It starts as a holistically driven activity at the problem analysis stage. Most real (as opposed to theoretical or hypothetical) natural resources related problems cut

[2] **Strategic research** selects, evaluates, develops, from available knowledge and emerging concepts, tools to solve existing and anticipated applied research problems. It links basic and applied research.

across disciplines in terms of deriving solutions to them. Thus, these links need to be considered in a realistic problem analysis and definition. This is a most important stage in the research process, since agreement upon a defined common problem is a critical element in making progress through research.

- Once the common problem is adequately defined in terms of its different dimensions, the "science" phase of the research commences, generally along traditional disciplinary lines (agro meteorology, soils, hydrology, ecology, agronomy, economics, anthropology, policy research, and so forth), as each scientist addresses his or her research component that can contribute to the resolution of the agreed upon common problem.

- Finally, the results of the complementary components of research are brought together again in an interdisciplinary interpretation of the results and how they relate in solving the initially defined, common problem.

The author, as a participator in and critical observer of many NRM research projects made the observation that most of the research efforts of the agricultural research institutions in NRM, which could be called holistic, lacked the interdisciplinary interpretation of the results obtained. The projects only seldom reached the goals set at the beginning by the participating scientists. The main reasons are seen in an insufficient organisation and co-ordination of interdisciplinary research work. Quite often the participating scientists and/or disciplines do not see or accept the service function they have within the research process, the execution of the research project. It seems very difficult for many scientists to realise that interdisciplinary research is an interactive process of gaining and giving. Furthermore one can observe a widespread unwillingness to share data with other participating scientists and/or disciplines. Scientists tend to hold back data until it was used in their own publication. This is especially the case in the research community of developing countries. This may also be the reason why interdisciplinary research reports fulfilling the requirements of strategic research in NRM are seldom found in Egypt. Quite often during the research process there are more problems between scientists than between scientists and other stakeholders (farmers, extension workers, policy makers etc.).

5. Integration of research on natural resource management into the work of agricultural research institutions

The integration of natural resource management research into a production oriented research institution, e.g. into an agricultural research institution has proven to be a difficult undertaking. This applies to research institutions around the world. The Consultative Group on International Agricultural Research (CGIAR) being a typical example.

The CG system came a long way with much debate to put research in natural resource management on the agenda. Up to the beginning of the nineties it was a common attitude within the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) and the CGIAR System at the whole that the use of manufactured resources (agricultural chemicals and machines) should be developed, while the natural resources should be conserved (TAC, 1988). These

suggests, according to Ravnborg (1992) that it is in manufactured resources that sources of growth should be sought and not in natural resources. Thus, natural resources need not be 'managed' but merely 'conserved' in order to maintain the basis for production, and, not least, the basis for increased use of manufactured resources. Instead of giving higher priority to the majority of areas lying within resource management research as independent research areas, TAC recommended in its 1988 sustainability report, that these aspects should rather by included in the commodity-specific research area. An attitude still quite common in many agricultural research institutions. But at least within the CGIAR it has been recognised since the end of the eighties that there is a need for strategic resource management research within the CGIAR and beyond. This change came about because of the growing pressure both within and outside the CGIARR for change. One reason being the growing global concern about the long-term sustainability of agriculture. The Brundtland Report in 1987 and the preparations for UNCED in 1992 highlighted this issue. Slowly but steadily the CG System got more and more engaged in natural resource management research.

At the International Centres Week in 1990, the CGIAR endorsed the concept of ecoregional activities as a means of integrating resource management with productivity concerns, the "twin pillars of the CGIAR". This concept was subsequently elaborated upon in the paper "An Ecoregional Approach to Research in the CGIAR". The Summary of the paper referred to "expanded research on resource management in the CGIAR" and "major threats to the sustainability of agriculture". In the text of these paper, three key principles for the organisation of ecoregional research were elaborated upon: a systems approach, multidisciplinary teams and co-operation with other institutions.

In 1998 the CGIAR System Review Panel recommended among others the following priority for the CGIAR:

> *A global network for integrated natural resource management that will link productivity research with the environmentally sound management of natural resources. National scientists in developing countries and their international counterparts should work together in preparing and implementing bottom-up, demand-driven projects to manage agricultural ecosystems in a sustainable manner.*

The CGIAR System Review Panel (1998) and the CG System itself noticed that the "emerging natural resource management methods illustrate the paradigm shift that is occurring in agricultural sciences: from classical agronomy to ecological sciences, from analytical research to system dynamics, from top-down to participatory approaches, and from factor-oriented management to integrated natural resource management".

It was than made clear: the CGIAR System is not intending to go into natural resource management research in general. The basic challenge facing the CGIAR was and is still seen in the extension of Green Revolution-type productivity increases within its mandate region and linking it with poverty alleviation and protection of the environment. The CG System is therefore mainly concerned with agro ecosystems and to a far lesser extent with natural ecosystems or with landscape ecology. The Centres are usually only getting involved "in generating and interpreting improved scientific evidence on the extent and magnitude of the impacts of agriculture, forestry and fisheries on the degradation or

enhancement of natural resources and the impact of such degradation or enhancement on agriculture, forestry and fisheries production and food security" (TAC, 1997).

The integrative aspect of natural resource management is understood by TAC as a more holistic approach in research and not as a proposal for gigantic research programmes. The centres themselves see the integration mainly as an incorporation of natural resource management aspects into their research programs and projects.

TAC emphasised that the linkages covered within the INRM framework need to introduced into the CGIAR System not only through Centre activities, but also to a great extent through work in the system wide programmes, essentially those involving implementation of the ecoregional approach.

Looking back critically on the attempts and the process of integrating NRMR into the research work of the CGIAR system the author concludes from his observations that the integration was never fully reached. And this despite TACs efforts to integrate NRMR into the research work of the IARCs, the assistance given by the donor community as well as the efforts made by the individual IARC. The annual reports of the IARCs of the last ten years, especially the lists of publications show that the CG-System has still to go a long way to integrate NRMR into the work of the IARCs. In most cases a full scientific integration of the different projects and disciplines in NRMR has still to be achieved. This applies even more to most of the NARSs. Many NARSs still follow the "plant breeding first" strategy ignoring the fact that this has generally failed in the past and that especially in respect to low-potential areas improvements in crop, livestock and resource management offer the best scope to both increase productivity and to reach a sustainable use of the natural resource base.

The integration of NRMR into the work of the agricultural research institutions is among others quite often hindered by the existing institutional structures. Institutional structures for research that compartmentalise research by discipline and commodity, and incentive systems that fail to include accountability in terms of problem focus, farm-level impacts and off-site effects are increasingly inadequate in the face of the evolving demands on research systems.

No doubt the past three decades have seen substantial investments in NARSs. Efforts were made to strengthening the research capability in NRM. But this has not yet resulted in the institutional capacity that was expected. In many countries a major human and physical infrastructure is now in place, but many NARSs that rapidly developed have suffered erosion of capacity over the past decade due to uncertain funding, lack of articulation with other actors in the NARSs, lack of a broad vision of the future evolution of the research system, lack of transparent long-run strategies and priority-setting mechanisms, and declining quality of human resources. In addition, although the motivation and morale of individual scientists will largely determine the effectiveness of the NARSs, public research institutes generally lack the committed "science environment" needed to spur innovation and discovery. This applies especially for research in NRM.

6. Challenges

Mankind must realise that there is no time to dream of creating more living space or more environment, such as colonizing the moon or building cities beneath the sea; humans must save the remnants of the only environment mankind has, and allow time for, and invest in the regeneration of what mankind has already damaged. Agricultural Science has to play an important role in this efforts.

During the last decades it became evident that things, that demands in NRM, in agricultural sciences are changing: from classical agronomy to ecological sciences, from analytical research to system dynamics, from top-down to participatory approaches, from factor-oriented management to integrated natural resource management.

Over the past four decades, the major emphasis in agricultural research has been on extending Green Revolution-type technologies, emphasising intensification of input use and cropping patterns. The next stage of productivity increase will depend on research to raise the yield frontier, to increase the efficiency of use of inputs, and to sustain the resource base. Many of the gains will come from incremental improvements in a wide array of management practices, rather than from any one technological breakthrough. The research activities of tomorrow will be much more knowledge and skill intensive. All participants in the technology development and transfer system (scientists, extension workers, and farmers) will have to make great efforts to maintain up-to-date skills.

The strategies of agricultural science for the future have to be a significant departure from the generalised "package-of-practices approach" emphasising standardised technologies, higher input use and increased yields, that has been and in some countries still is the driving philosophy of research. Research must respond to new challenges in both high potential areas, where maintaining yields and increasing input use efficiency will be the main concerns, and in low potential areas that must increase productivity, while avoiding degradation of the natural resource base. But research must also show the limits of certain types of land use and demonstrate the necessity to holistic management approaches, especially in NRM.

As holistic management provides ways of more fully understanding a current crisis, its origin, and its relationship to other situation it seems to be the most appropriate tool to manage NR. One has to be aware that holism recognises the absence of walls or barriers among and within ecosystems and that interrelationships are extensive and complete. Furthermore holistic management requires users to anticipate and understand the impact and consequences of their actions throughout whole ecosystems. Agricultural scientists have therefore to adopt quite different approaches to their research work, recognising among others that NRM and agricultural activities are conducted within subsets of local, regional, and world systems.

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