INTERNATIONAL JOURNAL OF AGRICULTURAL SUSTAINABILITY
1473-5903/05/03 0206-11 $20.00/0
Vol. 3, No. 3, 2005

Research and Development Towards Sustainable Agriculture by Resource-Poor Farmers in Sub-Saharan Africa: Some Strategic and Organisational Considerations in Linking Farmer Practical Needs with Policies and Scientific Theories

Willem A. Stoop[1] and Tim Hart[2]

[1]Akkerweg 13A, Driebergen-R., The Netherlands; and [2]Human Sciences Research Council, Pretoria, South Africa

Sustainable agricultural development is presented as a diverse and dynamic process through which it copes with agro-ecological and socio-economic diversity at field level and with ever-changing needs and opportunities of (smallholder) farmers. In support, agricultural research – aimed at locally appropriate and environmentally friendly technologies – should contribute to bridging the currently increasing gaps between scientific theories and government agricultural policies as opposed to the practical field realities that farmers are facing.

These gaps are best illustrated by – what in the West is often presumed to be – a stagnant African agricultural (in reality it is not!) in spite of many ambitious policies and projects by national governments and international donors for several decades. Disappointing adoption rates by resource-poor smallholders of the proposed 'modern' agricultural technologies have often been blamed. However, the actual local systems are primarily based on 'ecological' and 'organic' concepts. Localised intensification through recycling of organic by-products is an integral part of such systems. Consequently, these systems are uniquely adapted to the diverse framer needs resulting from widespread variations in soil, climate and socio-economic conditions. By contrast most international R&D support for the African agricultural sector is aimed implicitly at creating a modern conventional system of farming based on external inputs and along a Western industrial model.

To cope with diverse and complex, location specific problems inherent in development, sustainability and poverty alleviation, requires strong national research and development (R&D) institutions that adopt comprehensive, people-centred approaches as opposed to the technocratic nature of most formal international development assistance. The development debate therefore should be turned around. The 'existing' smallholder farming systems and their needs should be a point of departure, while the various development initiatives and policies should be handled by including the related institutional aspects.

Keywords: diverse conditions, ecological/organic farming, indigenous/local knowledge, pathways of science, people-centred focus, Sub-Saharan Africa

Introduction

Agriculture in both industrialised and developing countries is a unique sector, characterised by complex issues and problems, ranging from macro (economic) policy levels all the way to the micro (smallholder) farming household and field plot levels. Agriculture, being predominantly a (small-scale) family and/or communal enterprise differs in fundamental ways from administrative services and industrial sectors in terms of relative unpredictability, uncertainty and variability in bio-physical (soil and weather) conditions on which the primary production processes rely. In addition there is a huge social diversity in production strategies and objectives among farming households and even among individuals within a household. Contrary to an industrial production process, farming[1] is mostly seasonally determined; it faces relatively high levels of risk, which in many developing countries, are compounded by poor infrastructure and the relative isolation of rural communities. Fluctuating market and trade conditions, as well as political instability further add to farmer uncertainty. Agriculture therefore faces rather unique problems with respect to research and development including the planning, implementation and evaluation processes that are involved as well as the assessments of impacts at various levels.

In early 2002 a comprehensive study (Stoop, 2002) was conducted in the West and Central African region as to 'why' so few of the results from agricultural research where eventually adopted by farmers. The study was conducted at the request of the Technical Advisory Committee (TAC)/interim Science Council (iSC) of the Consultative Group on International Agricultural Research (CGIAR). Among other conclusions the study points out that in general:

- donors, policymakers and scientists have not come to terms with how to cope effectively with the huge diversity in natural resources and consequently production systems of resource-poor farmers, who themselves, are highly diverse in terms of skills, motivations and production objectives; and consequently;
- the complexities involved in transforming agricultural systems tend to be widely underestimated, particularly in Africa where the aim is often to transform a traditional subsistence agriculture into sustainable, permanent and commercially-oriented systems.[2]

These conclusions imply that agricultural and rural development is constrained in many different respects but primarily at national and local levels and that there are important links between these levels. However, policymakers, agricultural scientists and development agents often perceive the realities of the field as chaotic and fail to accept the implications of that situation for the wide introduction of modern technologies through large-scale standardised approaches. A common attitude is to view smallholder farms as merely scaled-down versions of large commercial farms (Waters-Bayer & Bayer, 2004) despite the vast differences between the two, even in developed countries. Not surprisingly, the blanket approaches and the promoted technologies have often turned out to be inappropriate or irrelevant and far from sustainable for the majority of farmers, being resource-poor smallholders.[3]

Obviously there are also serious political and trade constraints at international levels, but these are largely outside the realm of direct action by local decision-makers and producers. The objective of this commentary therefore is two fold. Firstly, it seeks to provide suggestions for coping with the diversity (agro-ecological and socio-economic) of issues at the field intervention level. Secondly, it seeks to contribute to a bridging of the gap between (scientific) theories developed at macro levels by policymakers/scientists, and the practical realities including the living conditions and the agricultural sustainability concerns that farmers encounter at local/micro levels.

The Unique Nature of Agriculture: Implications for Smallholder Farming Practices

Because of the many uncertainties (natural and economic) involved in agriculture, farmers have to continuously adjust and even improvise their practices and the timing of different field operations during the course of the seasons, besides being alert to optimising new production and marketing opportunities. Farmers simply have to be innovative and flexible, and the most dynamic among them will certainly not wait until policymakers and scientists have agreed on appropriate technologies and new policies.[4] This is particularly so for the many resource-poor smallholders in Africa. This group has – over many generations – developed very location and circumstance specific technologies and practices. Under the prevailing resource-poor conditions, these are based mainly on ecological principles. In that way the use of limited local resources (labour and capital) is optimised and the risks of crop failure minimised; at the same time farmers tend to be well aware of the need to maintain the sustainability of the natural resource base for future use. However, under certain unfortunate circumstances this local knowledge and related practices become ineffective or are undermined. Corruption and armed conflicts are two major conditions that destabilise local communities even leading to localised concentrations of refugees, having potentially more devastating and immediate effects on agricultural systems than *climate change* or increased pressures from growing rural populations.

The *diversity* in farming practices encountered across Africa is an integral element of agriculture in general. For most African agricultural activities, its significance for policy formulation and particularly for agricultural research and development towards more productive and intensified (yet sustainable) production systems is gradually being recognised (Eicher, 1999;

IAC, 2004). Yet, the wider scope and the implications of the diversity issue for policy formulation, as well as for research and development strategies and their subsequent field implementation, tend to be bypassed. A general trend is to simplify complex situations to a few manageable standard systems that can be conveniently studied and modelled (the reductionist approach). This was also done by the IAC study (2004) that proposes to focus future research on just four major production systems and a limited number of supposedly major production constraints for the whole of Sub-Saharan Africa.

In an excellent paper, Toulmin and Guèye (2003) provide a wide-ranging assessment of the ongoing changes in West African agriculture and of the numerous alternatives that evolved locally as a result of farmers responding to changing agro-ecological, social, economic, organisational and political conditions. Subsequently, different patterns towards intensification, occasionally extensification and diversification in agricultural production systems and sources of revenue (including the increasingly important 'non-farm' revenues) are revealed. In South Africa the existence of Social Grants and greater employment opportunities for skilled and semi-skilled members of farming households enable them to engage in agriculture at different times and in a number of different ways. As such agriculture is just one of several different livelihoods that rural households engage in. Belières *et al.* (2002) noted the flexibility of diverse small family farms in West Africa in responding readily to changing market and policy conditions, whereas the large-scale, mechanised commercial farms often faced exceedingly serious financial problems, having lost flexibility because of large prior capital investments.

Such features are not restricted to developing countries alone. For instance, in an analysis of Dutch dairy farming, Van der Ploeg (2003) showed that individual farmers follow very diverse strategies in coping with changing economic conditions. As a result he identified a wide range of solutions that differed remarkably from the prevailing intensification and scaling-up models developed by agricultural scientists. Since, Dutch government agricultural policy decisions tend to be largely based on the outcome of these models, it is not surprising that many Dutch farmers have reservations about the propositions by policymakers and scientists.

Increasingly, policymakers and agricultural scientists tend to present agriculture as an industrial sector that operates largely through standardised technologies that are implemented routinely and supposedly most efficiently at large scales. As Chambers *et al*. (1989) pointed out, however, industrial agriculture differs greatly from the resource-poor types that are being practised all over the world and particularly by smallholders. As such, the diversity of individual farmers and their diverse strategies, in economic as well as sociological and technical terms, is largely ignored. This is particularly alarming when it comes to international development assistance. For the agricultural and rural livelihood systems of smallholders in Sub-Saharan Africa, Toulmin and Guèye (2003) describe situations that differed profoundly from the development theories as presented by international agricultural scientists, most of whom implicitly rely on the industrial model (for an example see Bindraban & Rabbinge, 2005). While these theories largely guide the strategies and funding decisions of major international donor agencies, as well as the policy decisions of national governments, they are out of context. This is manifested for instance by the South African Government's Land Reform for Agricultural Development (LRAD) subprogramme which was strongly influenced by the World Bank (Aliber & Mokoena, 2003). It focuses on large-scale export-oriented agriculture requiring intensive, and often unsustainable, external inputs. Most beneficiaries involved in these projects have subsequently achieved very little and in worst case scenarios they have gone bankrupt or had their hopes dashed (Aliber & Mokoena, 2003; Hart, 2003).

From the above it follows that despite the connectedness between macro and micro levels the gaps between macro-level theories and policies, and field-level farming are huge in both the developed and developing worlds. These gaps originate largely from a common, but flawed, comparison with industrial production processes where *diversity* and *variability* are of much less significance. By contrast *agricultural R&D*, particularly when dealing with smallholders, must handle the diversity issue strategically. As discussed in the following section the current major approaches still fall considerably short of this requirement.

Major Strategies in Dealing with Agricultural Development

In view of the complexity and multifaceted nature of agriculture, it is not surprising that, over the years, widely different ideas and strategies have evolved about the required research and development to support this sector. In broad terms one could distinguish between three extremes:

- a science and technology-/policy-centred strategy (IAC, 2004), which – in spite of all the 'demand' rhetoric – tends to operate in a top-down and largely reductionist fashion, being initiated mainly by formal public-sector institutions operating at the macro/meso level;
- a people-centred strategy (Reij & Waters-Bayer, 2001; Waters-Bayer & van Veldhuizen, 2004), that is rooted at the (micro) level of local communities and consequently operates in a more bottom-up fashion; and
- a demand-/problem-led strategy that has evolved mostly over the last decade under the influence of increased privatisation of public sector research and extension services.

The first strategy finds its origin in the linear 'research – technology transfer – development' model under which scientists operate out of experiment stations and laboratories. Starting in the late 1970s, disappointing impacts led to the 'Farming Systems Research (FSR)' approach that was structured around 'on-farm' experimentation with various degrees of farmer participation. This approach remained, however, highly technology-biased with the human aspects receiving relatively little attention, the FSR teams being composed of mostly agronomists and economists. Only rarely were sociologists and anthropologists included. Unfortunately, donors started to look upon this 'research' approach as a means to accelerate technology adoption and rural development, for which it was inappropriate. Presently, something similar is happening through the Challenge Program for Sub-Saharan Africa with its Integrated Agricultural Research for Development[5] approach (FARA, 2004).

By comparison the 'people-centred strategy' is fundamentally different in that local people largely have the initiative and external people/agencies play facilitating roles in guiding the locally identified needs and demands for various services. Consequently, this strategy is much more appropriate to cope with diversity issues in both agro-ecological and socio-economic terms; it also helps to create an awareness about how agricultural practices are intrinsically intertwined with local culture and customs. This latter relationship is often overlooked, thereby reducing the likelihood of adoption. Moreover, a greater awareness about the diversity in human nature, motives and individuality, be it farmers, scientists or technicians, is fundamental to understanding variations in yield levels between farms and in appreciating the frequently biased nature of scientific outputs as well as the questionable quality of much rural survey data. Unfortunately, this people-centred strategy is often incorrectly employed thereby undermining its effectiveness as numerous critics have pointed out (cf. Cooke & Kathari, 2001; Nelson & Wright, 1997; Pottier *et al*., 2003; Shepherd, 1998).

In the case of the 'demand-led strategy', neoliberals somehow assume that it will resolve many of the priority-setting and targeting problems commonly faced by R&D services. This trend was set in motion by the World Bank and was subsequently followed by many developing country governments (Gardner & Lewis, 1995). It focuses on privatising R&D services and institutions, assuming that the costs will be paid for by the client (Torkelsson & Anandajayasekeram, 2000) – generally the resource-poor smallholder farmers and rural families. Whether such a strategy can provide the correct signals to address complex and multifaceted, mostly local, issues of sustainability and poverty, remains doubtful. Major undesirable side effects on income distribution and the natural environment will go unnoticed, because the focus will be increasingly on short-term, single-issue, problem-solution while bypassing the more complex agro-ecological, socio-economic and institutional issues.

Obviously, each of these three strategies has particular weaknesses, that can be attributed largely to the dominant (Western) agricultural research and development paradigms, as well as to macro level political and economic interests. The net result has been that considerable national and international financial resources have, and are being, spent on flawed, politically motivated programs and projects with entirely unrealistic expectations. The next sections will explore what might be required to remedy this situation.

Sustainable Agriculture as a Location Specific, Agro-Ecological Phenomenon: Field Examples from Rainfed Farming in the West African Savannah Zone

Some background considerations

The productivity of any ecosystem has an upper limit, which if exceeded can result in its degradation and collapse, thereby reducing the future availability of resources for human survival (Reijntjes *et al.*, 1993). This emphasises the need to manage agricultural and natural resources in ways such that the ever changing human needs can be satisfied, requiring that the quality and quantity of the natural resource base is consistently improved or at least maintained. Pretty (1996) has pointed out that this implies the integrated use of a wide range of practices, technologies and resources. This would include, for instance, the use of by-products and wastes from one component of the farming system as inputs to another. From his work with smallholder farmers he identified four important principles:

- externally prescribed technologies do not persevere;
- externally introduced organisations do not persevere;
- expensive technologies, requiring expensive inputs, do not persevere; and
- sustainability is not equivalent to permanence, rather it is dynamic in nature.

These principles suggest that sustainable technologies need to be compatible with the farmers' environment – natural, socio-cultural, economic, infrastructure and institutions (Torkelsson & Anandajayasekeram, 2000). This means that the technologies/practices need to be understood within the local context. Participatory research in Sub-Saharan Africa (Reij & Waters-Bayer, 2001) illustrates that farmers are continuously developing and improving their practices, based on the knowledge and resources at their disposal. Many of these site-specific innovations are sustainable while the ones that are not will be adjusted or rejected over time, which is in line with Pretty's fourth principle (see above).

Because of poverty and therefore the inability to afford expensive external inputs, it becomes imperative that smallholders develop low external input options while maximising the efficient use of their local resources. Therefore indigenous farming systems and the associated farmer knowledge have a strong empirical and ecological basis through which the functional integration of different locally available resources and farming skills, which vary from site to site, is achieved (Reijntjes *et al.*, 1993). To exploit the assets of these indigenous systems researchers need to work together with farmers. However, at the same time and in particular the biological scientists require a profound knowledge about the ecological aspects of farming under low levels of external inputs, rather than being preoccupied – as is often the case – by developing and introducing 'modern', high-yielding technologies. In this context it is useful to analyse some of the key characteristics of rainfed agriculture as practised by smallholders in the West African savannah.

Strategies and major ecological elements in West African rainfed (smallholder) farming

The early ICRISAT program in Burkina Faso – which was initiated in 1975 – made considerable efforts through agronomic and anthropological studies to position the overall research activities in a local smallholder context (Stoop *et al.*, 1982). Based on combinations of on-station and on-farm studies a number of crucial farmer strategies for crop management were identified:

- Early planting (with the first rains in late May/early June) in spite of subsequent early drought risks, being the only option to prolong the cropping season under rainfed conditions.
- Close matching between crops and different land/soil types (with respect to soil moisture regimes and soil fertility) that occur in fairly regular patterns in the gently rolling landscapes as linked to common toposequences (e.g. the most drought tolerant crops, such as millet, fonio and cowpeas on the dry uplands and upper slopes, sorghum and maize on moist to wet lower slopes and lowlands, rice on wet/inundated lowlands (Stoop, 1987; Van Staveren & Stoop, 1985).
- Frequent use of intercrop combinations often on adjacent and transition land types (maize with rice on lowlands and lower slopes; millet with cowpea on uplands; sorghum with millet on lower slopes; maize with millet on uplands in higher rainfall areas).

- Fine-tuning of the above systems through a large selection of local varieties with different growth/maturity cycles (and grain quality characteristics) and therefore adaptation to different planting periods (ranging from very early to late in case of a delayed onset of the monsoon rains).

The above strategies are largely ecological in nature and contribute to stabilising production and spreading the labour requirements and risks of both droughts and floods over a short (3–4 months) and rather unpredictable rainy season.

As population pressures increase there will be progressive increases in the demand for land and with it a need to increase production levels that will only be possible if soil fertility levels are improved, or at least maintained. Also for this aspect there exists a body of local knowledge. For generations manure, crop residues and other household waste products have been applied to the high yielding plots that surround the family compounds (Prudencio, 1993). Over the years, the production and use of locally produced organic fertilisers has greatly evolved from informal arrangements between farmers and pastoralists about the grazing of their animal herds on crop residues and fallow fields to deliberate collection, production and sale of manure in local markets (Vierich & Stoop, 1990). Progressively composting practices aimed at more distant fields have also increased, while the transportation and application issues involved were resolved locally (Clottey *et al*., 2005).

In recent years, the significance of ecological/organic systems and their scope for intensification has been highlighted anew by the 'system of rice intensification' (SRI). This system was initially developed during the 80s by smallholders in Madagascar and has since been adopted increasingly by (small) rice farmers in South and South-east Asia (http://ciifad.cornell.edu/sri/listservs/index.html#rice). Likewise, farmers have introduced important location specific improvements without or through minimal use of external inputs such as mineral fertilisers, pesticides and herbicides to improve soil structure, waterholding capacity, erosion control and pest management (Hart, 2005; Mazzucato & Niemeijer, 2000; Reij & Thiombiano, 2003; Reijntjes *et al.*, 1993; Tiffen *et al.*, 1994).

Strategic implications for research and development

Many local farming systems mimic nature, thereby ensuring that optimal use is made of natural resources (land, nutrients, groundwater, radiation and rainfall), and underscoring the importance of ecological insights – such as elaborated above – in progressively developing technological improvements in existing systems. As climate and nature change, and population density increases, farmers have to adjust their practices to ensure continued sustainability and increased productivity from their fields. Smallholder systems – as already mentioned – rely on a wide and quite sophisticated range of options permitting them to adjust to the vagaries of farming. These (local) options have evolved and been tested over generations and have permitted the population to survive often under harsh environments. In research being conducted in South Africa one of the authors noticed how farmers involved in a vegetable garden project resorted to local practices and 'traditional' crops when they experienced drought conditions after their irrigation pump was stolen.

Agricultural R&D (national and international) should seek to capitalise on this knowledge and subsequently contribute by widening the range of technological options available to farmers to achieve the dual objectives of increased productivity and sustainability. Given the huge diversity (and variability) in the agro-ecological and social conditions of farming even at micro field levels, the need for a wide range of options (which implies a need for increased flexibility by scientists) is a condition *sine qua-non*. Moreover, as the pressure on farmers progressively increases to intensify and commercialise their production, they will increasingly have to adjust their farm management strategies. This applies in particular to the timing of field operations for planting and weeding, but also the professional applications (the informed use) of agro-chemicals, as well as adjusted crop rotations, intercropping or companion planting methods.

In this context, a close collaboration between farmers and researchers is required, which, however, demands a number of rather fundamental changes in the training of agricultural specialists, as well as in the current procedures and organisation of agricultural research, including the institutional arrangements, as will be explored in the next section.

Critical Issues for Agricultural R&D Institutions: Towards a New Generation of Agricultural Scientists

In both developed and developing countries the agricultural sector is currently under considerable pressure, and with it the research and extension services. While in the former, overproduction and environmental issues are major concerns, these are fundamentally different in developing countries. For the latter the agricultural sector generally constitutes the backbone of the national economy and often directly touches on the wellbeing of a majority of the population. Certainly for most African countries it is therefore vital to maintain a functional and operational research and development/extension capacity, following realistic approaches given the prevailing financial constraints. This must be considered a prime responsibility of respective national governments. Apart from a facilitating role and the creation of an enabling policy environment stimulating a competitive private sector and reliable market system, this must also involve direct funding support to national institutions including operational costs. Only then, can the continuity of long-term programmes of vital national interest such as food security, sustainability and quality of natural resources (air, water and soil) be ensured. This leads to three major requirements for national R&D institutions:

- a holistic strategy to cope with the 'diversity' issue;
- an institutional structure and programmes that permit effective linkages between major stakeholders operating at different levels (from macro policy to micro field implementation), and through a range of consultative and participatory approaches; and
- a well-trained professional staff that combines a comprehensive vision with interdisciplinary skills and a sound technical expertise.

The third issue is of particular significance, being related to introducing the use of more comprehensive and more people-centred strategies by agricultural R&D institutions. Apart from the need to cope with 'diversity', a second crucial requirement for a comprehensive approach is the establishment of linkages between the various stakeholders in the agricultural development process. Firstly, these links would have to translate into a favourable national policy environment concerning the creation of infrastructures, marketing facilities and occasionally even the use of subsidies as described by Dorward *et al*. (2004). Secondly, the links must be rooted largely at local levels to ensure responsiveness to real farming circumstances and the needs of rural communities. This underscores once again the need for people-centred strategies and for institutional structures that ensure the essential linkages between micro/field level practical farming and the macro (policy and research programme formulation) level in achieving a sustainable agriculture.

Especially for many of the science and technology proponents, this implies some rather fundamental changes in perspective, if they want their contributions to become more relevant in a livelihood context. More than before, they will have to accommodate a people's factor (including the institutional aspects) and an ecological perspective into their activities. Unfortunately, technical scientists have rarely received any formal training in the former, while their knowledge about the latter is at best superficial. Yet these are crucial elements in any long-term agricultural development process.

Consequently, the professional staff must be well equipped to recognise and to handle the social diversity issues by having been taught some professional skills to communicate and dialogue effectively with various stakeholders apart from their specialist technical training. This would include a degree of familiarity with various (field) methodologies and approaches, including a critical appreciation for their limitations and relative precision of the results/outcomes and thereby the relative validity of conclusions. The basis of such skills has to be laid, however, through university education.

University training in agricultural sciences generally includes the use of statistical methods. Less emphasis is paid (unfortunately) to the precision (and the associated costs) with which various parameters can be measured and the ensuing limitations and limited relevance of various types of data. This should include the limitations and risks involved in the common extrapolation and up-scaling process to wider geographic areas and farmer communities. A widespread (and costly) misconception in general understanding of statistical theory is that more data leads automatically to greater accuracy. However, in the absence of a broad,

general understanding of a complex system (such as a livelihood system), accuracy of isolated parameters is of very limited value. The interpretation of such data is open to multiple biases and therefore of little significance, as Toulmin and Guèye (2003) pointed out in their study on the evolutions in West African agriculture.

Conspicuously absent from the technical (including agricultural sciences) university curricula are elements related to the humanities, notably anthropology, psychology and communication/facilitation/interviewing skills. This is an extraordinary shortcoming in view of the need for 'development-oriented' scientists to collaborate with a wide range of stakeholders – in the first place farmers, but also the commercial and political parties – involved in the development process. An awareness of the various pitfalls in human communication during interviews and data collection processes is crucial in view of the serious consequences for the relevance and accuracy of the collected information. In fact, the vast group of technical scientists – in spite of the high-powered rhetoric about participatory approaches and need for partnerships – is, in fact, very poorly equipped to handle this subject at the field implementation level. No doubt this will be a fundamental reason behind the disappointing impacts of many large-scale technology transfer and development efforts conducted in the past and certainly in Africa (Stoop, 2004).

For obvious reasons agricultural training and research is increasingly focussed on – what is being called – 'modern science' with the aim to develop commercially attractive 'modern new technologies'. Consequently, other forms of fundamental technical research into (micro) biological, physiological and ecological processes – that constitute the basis of any agricultural production process – tend to be neglected. Yet this knowledge is crucial in addressing issues such as the protection of the natural environment, resource-use efficiency, health and food quality. These issues are relevant to the long-term sustainability of agriculture in general and should not be considered an exclusive concern of alternative (biodynamic, ecological or organic) forms of farming (Röling, 2006).

In summary it is in the domain of the human and ecological sciences that universities have an obligation to prepare their agricultural graduates better (or at least to a minimum) to cope with socio-psychological elements and facilitation skills and the wider concerns about the environment. These elements are of critical importance in getting behind the real nature of complex problems and to distinguish between fact and fiction of the rhetoric widely used by various stakeholders.[6] But this increased intellectual baggage of individual scientists is by itself no guarantee for more successful and sustainable agricultural development in the absence of appropriate institutional structures. It is these institutions that must effectuate the linkages through which micro/local level knowledge is capitalised upon in the up-scaling process towards policy and research programme formulation. In that respect the 'Convergence of sciences' research programme of Wageningen University makes an important contribution (Van Huis *et al.*, in press).

Concluding Remarks

When dealing with complex situations – like agricultural development – comprehensive strategies and approaches are obviously required to permit the introduction of change, thereby establishing new types of order. In that respect, a sustainable agriculture and livelihood perspective is not a matter of either–or, but must rely on elements of all three – earlier mentioned – strategies. It needs to be multifaceted and multidisciplinary in dealing with the entire range from macro- to micro-level issues, including the links between levels and the respective stakeholders (Peat, 2002). These links between stakeholders operating at different levels are a matter of institutions. These must have explicit mandates to ensure that the micro/field level realities are effectively exploited in formulating policies and research programmes that are rooted in the realities – their short and long term needs – of current farming. Yet, this national institutional emphasis is still largely absent, as it is in each of the three major agricultural development strategies discussed earlier. This perspective is, however, also fundamentally different from the futuristic ideas of a modern, conventional agriculture as are being pursued by several major international (Western) donor and development agencies.

In the media African agriculture is often characterised as 'primitive' and its farmers as 'ignorant' mainly because they are non-mechanised and have frequently rejected the improved varieties and agricultural chemicals proposed by external

experts. However, many local strategies and practices are highly ingenious in managing the limited natural resources and harsh climates like in the West African semi-arid savannah and Sahelian zones. Many of these practices are far more resilient and adaptable to changing conditions than the standardised, modern 'technological packages' that are being promoted as the solution in the fight against hunger and poverty (Sachs, 2005). Generally, these proposed 'modern' technological packages (an improved variety and mineral fertiliser) are very limited in scope, while still involving relatively high costs for smallholder farmers, thereby increasing the overall risk (in both production and economic terms). Likewise, irrigation has been suggested as a simple solution, disregarding the advanced technical know-how involved as well as its dependence on suitable land and a reliable source of high quality water. Instead of resolving the plight of smallholders many proposed 'modern' technologies therefore increase the costs as well as the economic and food security risks. These are not attractive prospects for any resource-poor farmer.

Apart from the current 'battle against hunger and poverty' politicians and scientists (national and international) frequently claim that a growing world population can only be fed adequately in the future through what is being called 'modern, conventional agriculture'. Yet, the proposed technological solutions, partly based on the outputs of biotechnology and genetic engeneering research, are out of reach for the vast majority of rural poor for financial reasons, while frequently being poorly adapted in ecological terms. As such many of the Western development assistance programmes are illustrative of the gap that exists between theory-driven policymakers and scientists on the one hand and the realities of farming at the field level (both in terms of its diversity and dynamics) on the other.

The saying 'think globally, act locally' therefore remains highly relevant today. While obviously international and coordinated research and development interventions are important, viable national and local initiatives are crucial in achieving impacts (a sustainable and raised production) at grass-roots levels. In handling complex and diverse (agro-ecological and socio-economic) situations typical for smallholder farming, strong national research and development institutions effectively using people-centred approaches are a prerequisite. Together with producer organisations, locally adapted innovation and dissemination to neighbouring communities could be achieved most effectively. Coherent national policy environments (particularly for land rights, infrastructures and markets, occasionally even involving the use of subsidies) would be an essential condition for success, in particular for African countries where smallholders largely dominate the agricultural sector. It is exciting that the ongoing 'Convergence of Sciences' programme at Wageningen University brings together many of the issues raised in this paper through a number of doctoral research studies (Van Huis *et al.*, in press).

Acknowledgements

Thanks are due to Ann Waters-Bayer, Wolfgang Bayer and Niels Röling for making valuable comments and suggestions on earlier drafts of this paper.

Correspondence

Any correspondence should be directed to Willem A. Stoop, Independent Consultant, Akkerweg 13A, 3972AA Driebergen-R., The Netherlands (nadamo@planet.nl).

Notes

1. The term 'farming' is used in a wide sense to refer to the activities of all people who produce and/or harvest from plants, animals and aquatic resources. 'Farmers' include peasant/family smallholders, pastoralists, forest dwellers and artisanal fisherfolk among others.
2. Ambitious development goals and objectives are written mostly in administrative and scientific jargon remote from and largely hiding field realities where the production changes are to occur. Similarly, many locally sustainable practices go unrecognised and their potential ignored.
3. Resource-poor smalholders/farmers are those who have weak or very restricted continued (sustainable) access to conventional agricultural inputs such as agrochemicals, technology, mechanisation, irrigation, land and finances which are generally a prerequisite for most modern agricultural technologies.
4. In a compilation of independent studies carried out in parts of South Africa researchers and extension officials identified local innovations at each site they visited (de Villiers *et al.*, 2005). Innovations involved natural resource management, social networks and technology improvement and

development. Most farmers felt that without these innovations they would no longer be involved in agricultural activities, while researchers noticed a number of ways in which they could collaborate with farmers to improve some of the innovations.

5. Mistakenly, an essential holistic perspective (including multiple scales and interdisciplinarity) is being translated into a 'new science' and a 'theoretic approach' for which the required professional human resources are non-existent. Together with a plethora of coordinating bodies and of bureaucratic regulations non-workable and ineffective approaches are being proposed. Agricultural research and development processes are being stifled by administrative procedures and inherent delays in the disbursement of funds.
6. At one stage it was very fashionable among government officials, extension agents and farmers in West Africa to urge scientists to conduct on-farm experimentation at operational scales (*en vraie grandeur*); presently a similar trend occurs as the testing of *best-bet practices*. In either case farmers are primarily participating for personal motives of status and short-term benefits (seeds and agricultural chemicals for free or on easy credit conditions) rather than an interest towards agricultural innovation for which the above approaches are largely inappropriate.

References

Aliber, M. and Mokoena, R. (2003) The land question in contemporary South Africa. In J. Daniel, A. Habib and R. Southall (eds) *State of the Nation: South Africa 2003–2004*. Cape Town: HSRC Press.

Bélières, J-F., Bosc, P-M., Faure, G., Fournier, S. and Losch, B. (2002) What future for West Africa's family farms in a world market economy? *IIED*, 113.

Bindraban, P. and Rabbinge, R. (2005) Development perspectives for agriculture in Africa – Technology on the shelf is inadequate. Wageningen: WUR, North-South Discussion Paper. On WWW at http://www.north-south.nl (Accessed April 2006).

Chambers, R., Pacey, A. and Thrupp, L.A. (eds) (1989) *Farmer First: Farmer Innovation and Agricultural Research.* London: Intermediate Technology Publications.

Cooke, B. and Kathari, U. (2001) *Participation: The New Tyranny?* London: Zed Books.

Clottey, V.A., Agyare, W.A., Schreurs, M., Maatman, A., Abdulai, H. and Dinku, R.K. (2005) Composting to ensure food security: Learning by doing. Paper presented at *National Conference on Participatory Agricultural Research and Development*, 9–13 May 2005, Tamale, Ghana.

de Villiers, J., Oettle, L. and Salomon, M. (2005) *Catalogue of Farmer Innovations: Inception Phase 2004.* Durban: WHAM Communications.

Dorward, A., Fan, S., Kydd, J., Lofgren, H., Morrison, J., Poulton, C., Rao, N., Smith, L., Tchale, H., Thorat, S., Urey, I. and Wobst, P. (2004) Rethinking agricultural policies for pro-poor growth. *ODI Natural Resource Perspectives*, No. 94.

Eicher, C.K. (1999) Institutions and the African farmer. CIMMYT Economics Program, Mexico.

FARA (2004) Building sustainable livelihoods through integrated agricultural research for development. *Securing the Future for Africa's Children.* On WWW at http://www.fara-africa.org (Accessed March 2005).

Gardner, K. and Lewis, D. (1995) *Anthropology, Development and the Post-Modern Challenge.* London: Pluto Press.

Hart, T. (2003) Land reform: What have we learned? *South African Journal of Agricultural Extension*. 32: 15–27. South African Society of Agricultural Extension, Pretoria.

Hart, T. (2005) Local Innovations Using Traditional Vegetables To Improve Soil Quality. *IK Notes*, 79. On WWW at http://www.worldbank.org/afr/ik/default.htm. Accessed April 2005.

IAC (InterAcademy Council) (2004) *Realizing the Promises and Potential of African Agriculture. Science and Technology Strategies for Improving Agricultural Productivity and Food Security in Africa.* Amsterdam, The Netherlands: IAC.

Mazzucato, V. and Niemeijer, D. (2000) *Rethinking Soil and Water Conservation in a Changing Society: A Case Study in Eastern Burkina Faso.* Wageningen: Wageningen University.

Nelson, N. and Wright, S. (1997) *Power and Participatory Development: Theory and Practice.* London: Intermediate Technology Publishers.

Peat, F.D. (2002) *From Certainty to Uncertainty. The Story of Science and Ideas in the Twentieth Century.* Washington DC: Joseph Henry Press.

Pottier, J., Bicker, A. and Sillitoe, P. (2003) *Negotiating Local Knowledge: Power and Identity in Development.* London: Pluto Press.

Pretty, J.N. (1996) Participatory learning for integrated farming. *Integrated Farming in Human Development – Proceedings of a Workshop* (pp. 1–21). On WWW at http://www.husdyr.kvl.dk/htm/php/tune96/2Pretty.html. Accessed 27. 3. 01.

Prudencio, C.Y. (1993) Ring management of soils and crops in the West African semi-arid tropics: The case of the Mossi farming system in Burkina Faso. *Agric Ecosystem Environment* 47 (3), 237–264.

Reij, C. and Waters-Bayer, A. (eds) (2001) *Farmer Innovation in Africa. A Source of Inspiration for Agricultural Development.* London: Earthscan Publications.

Reij, C. and Thiombiano, T. (2003) Développement rural et environnement au Burkina Faso: La réhabilitation de la capacité productive des terroirs sur la partie nord du Plateau Central entre 1980 et 2001. Rapport de synthèse. GTZ – Patecore, Ambassade Royal des Pays Bas, USAID, Ouagadougou.

Reijntjes, C., Haverkort, B. and Waters-Bayer, A. (1993) *Farming for the Future: An Introduction to Low-External-Input and Sustainable Agriculture.* London: Macmillan Press Ltd.

Röling, N. (2006) Organic agriculture and world food security: A reaction to the challenge by Fresco, Van

Kasteren and Rabbinge; Presentation KLV debate, Wageningen UR, 23 March 2006.
Sachs, J.D. (2005) *The End of Poverty. How We Can Make it Happen in Our Lifetime*. London: Penguin Books Ltd.
Shepherd, A. (1998) *Sustainable Rural Development.* London: Macmillan Press Ltd.
Stoop, W.A., Pattanayak, C.M., Matlon, P.J. and Root, W.S. (1982) A strategy to raise the productivity of subsistence farming systems in the West African semi-arid tropics. ICRISAT; pp. 519–526 in *Proc Intern Symp on Sorghum*, 2–7 November 1981, Patancheru, A.P., India.
Stoop, W.A. (1987) Variations in soil properties along three toposequences in Burkina Faso and implications for the development of improved cropping systems. *Agric Ecosystems & Environment* 19; 241–264.
Stoop, W.A. (2002) A study and comprehensive analysis of the causes for low adoption rates of agricultural research results in West and Central Africa: possible solutions leading to greater future impacts. The Mali and Guinea case studies. (77 pp.) Interim Science Council/CGIAR, FAO, Rome.
Stoop, W.A. (2004) R and D for the resource-poor farmers in Africa: Reality or rhetoric? In *Proceedings of Symposium 2003 on the Sahel 'Sustainable Agriculture: Lessons and Opportunities'* (pp. 153–160). 1–4 December 2003, Bamako, Mali. INSAH, IER and Syngenta Foundation for Sustainable Agriculture, Basel, Switzerland.
Tiffen, M., Mortimore, M. and Gichuki, F. (1994) *More People, Less Erosion. Environmental Recovery of Kenya.* Chichester, UK: John Wiley & Sons.
Torkelsson, A.B. and Anandajayasekeram, P. (2000) *Indigenous Knowledge and Sustainable Agriculture.* Paper presented at the *16th International Symposium of the Association of Farming Systems Research and Extension*, Santiago, Chile.
Toulmin, C. and Guèye, B. (2003) Transformations in West African agriculture and the role of family farms. Issue Paper No 123. London: IIED.
Van der Ploeg, J.D. (2003) *The Virtual Farmer. Past, Present and Future of the Dutch peasantry.* Assen, The Netherlands: Royal van Gorcum.
Van Huis, A., Jiggins, J., Kossou, D., Leeuwis, C., Röling, N., Sakyi-Dawson, O., Struik, P.C. and Tossou, R.C. (in press). Agricultural research to reduce rural poverty; Can convergence of sciences support innovation by resource-poor farmers in Benin and Ghana? Introductory article, *International Journal of Agricultural Sustainability* (Special Issue).
Van Staveren, J.Th. and. Stoop, W.A. (1985) Adaptation to toposequence land types in West Africa of different sorghum genotypes in comparison with local cultivars of sorghum, millet and maize. *Field Crops Research*, 11, 13–35.
Vierich, H.I.D. and Stoop, W.A. (1990) Changes in West African savanna agriculture in response to growing populations and continuing low rainfall. *Agric Ecosystems & Environment*, 31, 115–132.
Waters-Bayer, A. and Bayer, W. (2004) Research to alleviate poverty in the face of industrialisation of livestock production. In E. Owen, T. Smith, M.A. Steele, S. Anderson, A.J. Duncan, M. Herrero, J.D. Leaver, C.K. Reynolds, J.I. Richards and J.C. Ku-Vera (eds) *Responding to the Livestock Revolution: The Role of Globalisation and Implications for Poverty Alleviation* (pp. 191–207). Nottingham: Nottingham University Press/British Society of Animal Science.
Waters-Bayer, A. and van Veldhuizen, L. (2004) Promoting local innovation: Enhancing IK dynamics and links with scientific knowledge. *IK Notes No 76.* On WWW at http://www.worldbank.org/afr/ik/default.htm. Accessed January 2004.