KIT SCIENTIFIC REPORTS 7584

Low-Input Intensification of Developing Countries' Agriculture – Opportunities and Barriers

Proceedings of the KIT-Workshop
8th December 2010, Karlsruhe

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KIT Scientific Publishing

LOW-INPUT INTENSIFICATION: WHAT KIND OF RESEARCH SUPPORT IS NEEDED? THE DEVELOPMENT ASSISTANCE PERSPECTIVE

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The livelihoods of 2.6 billion people depend on agricultural production systems (UNEP 2011). There are around 525 million small-scale farms worldwide and 404 million of these have less than two hectares (Nagayets 2005). They also cultivate 60% of the land available (McIntyre, B. D. et al. 2009). The world population will continue to grow and is predicted to reach nine billion by 2050. In 1950, there was 5,600 m^2 of arable land for every person in the world; in 2000 this figure was only 2,300 m^2 and when the world population reaches nine billion, this will be 1,500 m^2. However, land – in terms of the area available (quantity) and its productivity (quality) – is not the only resource that is running short and becoming depleted; the same applies to fresh water, for which demand doubled between 1980 and 2000 alone, and other resources such as phosphate. Natural sources of phosphate will be exhausted in the foreseeable future, although exactly when this will occur is still a matter of debate. Some experts believe this could happen within 50 years; other colleagues argue that the recent and future discovery of new deposits means that reserves could last another 200 years.

Climate change is exacerbating this situation. Regardless of whether this is human-made or not (as some sceptics still believe), it is a fact that the climate is changing. The problem is predicting exactly how these changes will present on a small scale. At the moment only very rough charts are available to show how the changing climate is affecting agriculture. Developing countries in particular need to be alert to production decreasing as a result of increasing temperatures and the subsequent reduction in fresh water availability. In addition, spontaneous weather events, such as storms and heavy rain, as well as very early or very late rainfall or extreme fluctuations in rainfall over time, will also cause difficulties for farmers.

The bottom line is that agriculture must now be intensified due to the world's growing population and changes in eating habits (mainly greater consumption of meat). In the medium term, the assumption that there is enough food for all the people and animals in the world and that the problem is actually one of distribution, is not sustainable. More needs to be produced on the land available. Of course, it would also be useful for people to change their eating habits. However, it would be arrogant to advise people in poor countries who achieve some degree of affluence not to eat more meat, even though the increased demand for meat in the future will come from these regions. If changes can be made here, they will only be

achieved in the long term. For the present, therefore, the focus should be on the industrialised countries.

There is great potential for increasing small-scale agricultural productivity in developing and emerging countries in particular, because production here relies on very few inputs. In many cases, there are insufficient quantities of seeds, fertiliser, pesticides, equipment, livestock and, to some extent, workers. In addition, the capital needed to finance these inputs is not available. One of the most important inputs is knowledge and access to this knowledge. Today there are many new opportunities that were inconceivable just 10 years ago. These have been made possible thanks, above all, to the mobile telephone, which has found its way into every last corner of the world and which could give farmers access to advice. In many countries, however, the advisory services needed to provide this assistance have been neglected or even closed down in the hope that the private sector can supply this support instead. This has often proved to be the wrong conclusion.

Any inputs into these small-scale systems will normally lead to intensification and an increase in productivity. In this context there is therefore much talk of enormous rates of growth, for example as a result of ecological agricultural practices. If investments are made in a marginal system, then almost every type of intensification will lead to increased productivity. It would therefore be important to compare the various approaches in order to evaluate the different increases in productivity and select the optimum system.

'Low-input intensification' is therefore a relative concept. For a production system already functioning with minimal inputs, providing improved seeds and fertiliser is a fairly significant contribution. And even converting the system to ecological agriculture involves, at the very least, a high knowledge input, because such systems generally require the farmer to have extensive know-how. At any rate, it is always essential to consider each individual system in order to be able to determine what is possible or feasible with the resources available (external) and within the production system (internal). Decisions concerning potential changes or improvements can and should only be taken once this process has been completed and in participation with the producer. One possible system is ecological agriculture; another is conservation agriculture, which usually requires herbicides, but also prevents erosion and improves soil quality. Agroforestry systems are a further alternative, but are far too complicated for many farmers. Another popular system is contract farming, where small-scale farmers are provided with inputs and knowledge, which they use to cultivate a particular product (e. g. cotton). This product is then purchased at a predetermined price. With the right conditions, contract farming can be very profitable for small-scale farmers, as demonstrated in India (Felkl 2010) and in other countries.

Every measure should be assessed with sustainability in mind to ensure that the ecological, economic and social dimensions all meet this objective. Intensification must not take place at the expense of the environment or natural resources and in addition it must be financially profitable without causing social damage, such as child labour (this issue is particularly relevant in developing countries).

Not all of the conditions required by intensification processes can be provided by small-scale farmers. For example, if they are producing increased yields, then not only must there be markets for this produce, but farmers must also be able to access these markets and have reliable information about them. This applies to regional as well as national and international markets.

Everything discussed above raises a number of different questions and issues that need to be researched. In a recent publication, several well-known experts formulated 'The top 100 questions of importance to the future of global agriculture' (Pretty et al. 2010), which is certainly worth reading and for the most part corresponds with this author's own experience. One of the basic requirements is that the rural population helps to establish every research agenda. In the past, the big mistake made by those involved in research was assuming that they knew what was best for the people affected and that the issues that needed to be examined could therefore simply be defined from a distance and this research could then be carried out in institutes. They also overlooked the extent of the innovation that already exists within the target group. Efforts must be made to tap into this innovation more effectively and to integrate it into research agendas. In general, more in-depth knowledge and research is needed in the following areas:

- Institutional conditions
  - markets, access to markets and information about markets
  - training
  - dissemination of knowledge, advisory systems
  - service systems, inputs
- Use of electronic media (information and communications technology, ICT)
- Organisation between farmers
  - cooperatives
  - commons
- Financial services
  - loans
  - insurance
  - environmental services
- More efficient use of water and management of different-sized watersheds (in many cases, water is no longer a technical issue, but a political and governance one)
- Improving soil fertility
  - possibilities derived from humus formation
  - *terra preta* to replace or enhance compost
- Fertilisation and fertiliser issues
  - efficient, sustainable use of mineral fertilisers on different types of soil
  - potential substitutes for mineral fertilisers ('peak phosphorus')

- advantages, disadvantages and potential of organic fertilisation

There are particular issues concerning climate change and its impact on agriculture, especially in developing countries. Research needs to focus on two areas: adapting to climate change and the potential for agriculture to reduce greenhouse gas emissions. Agriculture contributes to around 14% of the harmful greenhouse gas emissions worldwide. In addition to carbon dioxide (CO_2) e. g. from machines powered by fossil fuels, these include nitrous oxide (N_2O) from the incorrect use of mineral fertilisers and methane (NH_4) from animals and wet rice paddies. A further 18% of the emissions come from changes in land use, for example deforestation in tropical forests to clear space for future agricultural use, which has well-documented negative consequences.

The main issues are:

1. Adapting to climate change
   > Which plant varieties and animal breeds are useful and under which conditions (robust rather than high-yield?)
   > Who must adapt to what? A question for climate researchers.
   > Which land use systems are suitable for the change in conditions?
2. Reducing greenhouse gases
   > The potential of different production systems to reduce agricultural emissions
     - conservation agriculture
     - biochar
     - bioenergy in place of fossil fuels
     - changes in land use (in both a positive and negative sense)
   > What compensation mechanisms are there/will there be/could there be that are similar to the Clean Development Mechanism (CDM)?

Another general problem is knowing to what extent a production system is advantageous, because different assessments always provide very different results:

> Can organic farming feed the world (Korte 2010)?

> The risks and opportunities of conservation agriculture (CA) in various contexts
  - CA in systems with genetically modified plants
  - can CA also be used without herbicides and is it therefore practicable for organic farming?

> Meat vs. plant-based food
  - as the world population increases, how much meat consumption is reasonable, or possible?

- the majority of the fertiliser used in organic farming today comes from animals. How can this be reconciled with calls for animal production to be reduced because of the high consumption of fodder and production of methane?
- Cost-benefit comparisons and risk assessments that help to select the best approaches

One of the challenges raised time and time again is the conservation of agrobiodiversity, or at the very least slowing down the rate of decline. The following research is necessary:

> What is the potential of gene banks and how secure or sustainable are they?

> How do we aim to conserve agrobiodiversity (of varieties and species) *in situ*; who pays for this?

- *De facto* conservation is increasingly no longer the norm (however, a diverse range of pearl millet varieties in Africa and potato varieties in Peru are still grown and used); what will happen if agriculture is intensified?
- Should rural families actively conserve biodiversity *in situ* and receive payment for doing so? How much would this cost and who would pay?
- Should national or international research institutions be responsible for *in situ* conservation and where will the money come from to fund this?
- What are the costs of conserving essential agrobiodiversity and how is 'essential' agrobiodiversity defined?

In conclusion, this topic raises a great many questions; however, costly research is not needed to answer all of these – often compiling and evaluating the data already available will provide solutions. In the majority of cases, the research and studies must have a strong practical relevance and so it is important that they are not just carried out by scientists, degree candidates and PhD students, but also by colleagues working in the field who have direct access to the target groups. As stated above, only research conducted under practical conditions is worthwhile and only this research will provide the necessary results.

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