Farmers' experiments and innovations and their contribution to Cuba's agricultural innovation system

Friedrich Leitgeb and Christian R. Vogl

Working Group Knowledge Systems and Innovations, Division of Organic Farming, Department of Sustainable Agriculture Systems, University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria. friedrich.leitgeb@boku.ac.at, christian.vogl@boku.ac.at

Abstract: *Farmers' capacity to experiment and innovate is a crucial element for participatory processes of research and for participatory technology development. Furthermore, innovations are the driving force for agricultural development. The innovation system perspective includes the contributions made by all the actors involved to knowledge development, dissemination and use. This paper examines the role of farmers' experiments and innovations and of participatory and formal research in Cuba's agricultural innovation system (AIS). It also identifies meetings for knowledge sharing and describes the strategies of diffusion of farmers' contributions to the AIS. The research methods included 34 semi-structured interviews with agricultural experts of the agricultural formal and informal research sector and 31 free lists to assess the institutional influence on farmers' experiments and innovations.The results suggest that the integration of farmers' experiments and innovations constitutes an upcoming promising approach improving knowledge and technology development within the AIS. Moreover, the governments' commitment to social participation in knowledge development provides the basic prerequisite for the integration of farmers' experiments and innovation into the Cuban AIS. The historically conditioned vertical structure of knowledge development and diffusion is gradually changing towards more horizontal ways of knowledge sharing. Various meetings for knowledge exchange between farmers and between them and government officials have favored mutual learning, which contributes to the institutionalization of farmers' knowledge.*

Keywords: *innovation, farmers' experiments, knowledge transfer, participatory research*

Introduction

Increasingly scientists throughout the world are starting to acknowledge farmers' capacity to experiment and innovate, stressing the importance of participatory approaches for agricultural research and development (e.g. Haverkort, 1991; Thrupp, 1996; Reece and Sumberg, 2003; Sumberg et al., 2003; Gonsalves et al., 2005; Sumberg, 2005; Hoffmann et al., 2007; Hellin et al., 2008). Agricultural innovations are widely recognized to be driving forces of rural development. Farmers play a key role in development processes, either as developers of innovations or else as end-users (Chambers et al., 1998; Fischer, 2001; Reij and Waters-Bayer; 2001; Leitgeb et al., 2008; Sanz, 2008).

A complex framework of underlying conditions (e.g. political, administrative, economic) determines the very nature of farmers' experiments and innovations. Thus, e.g. decision makers hold crucial power shaping favoring conditions to support farmers' experimental activities and to facilitate the spread of informal research results through social networks (Kummer and Vogl, 2009).

We hypothesize that farmers' experiments and innovations constitute a valuable contribution to knowledge and technology development. If the efficiency of agricultural innovation systems (AIS) is to be improved, agricultural policy, scientific research and the formal advisory system must provide a friendly environment for the integration of farmers' experiments and innovations. This paper aims to examine Cuban farmers' role in knowledge and technology development and their contribution to the AIS.

Agricultural Innovation Systems

There are different commonly used definitions of "innovation", depending on the discipline involved. For instance, Spielman (2008) defines an innovation as "doing something new by using existing or novel knowledge in new ways". In the agricultural context and at farm level, an innovation is "something new that started within the lifetime of a farmer" (GebreMichael, 2001). An innovation often implies an interactive and social process.

The *innovation system* approach reflects the interactive and social character of an innovation and provides an understanding of the dynamic processes involved. An innovation system includes all stakeholders at governmental and non-governmental levels, their interactions and contributions to the development and the diffusion and application of knowledge and/or technology. An AIS may include multinational and national agribusinesses, as well as small, medium and large-sized ones, individual stakeholders, cooperatives, farmers' organizations or other community-based groups on a market level, national and international research institutes, extension services, government marketing agencies, higher education institutions and NGOs. The diversity of actors involved in an AIS interact on the basis of market and non-market relations (Malerba, 2002).

The smallest units of an AIS are farmers, farm workers, farm households and rural communities (Spielman, 2006). It is these units that put innovations and knowledge into practice and that, consequently, determine whether and innovation is developed enough to suit local conditions or whether it requires further adaptation to such conditions (Douthwaite et al., 2001).

Knowledge and its development, diffusion and use play a key role in innovation systems. Knowledge is more than the simple accumulation of information. It is characterized by its applicability and usability (García Pleyán, 2006). Every type of knowledge is specific to a certain production sector. Thus, the agricultural sector relies on a site specific knowledge base (Malerba, 2002). Innovation and knowledge are complementary concepts – the development of an innovation leads, in turn, to the development of new knowledge. Those farmers' activities that eventually lead to innovations and to the development of new knowledge can be categorized as "farmers' experiments."

The term "farmers' experiments" designates the "research conducted by farmers for the discovery or generation of information" (Wortmann et al., 2005, p. 244). Farmers experiment to test the validity of a hypothesis or to try something new (Reijnties et al., 1992). Throughout the long history of agriculture, farmers have developed lots of technologies and built up specific knowledge bases for their respective local environments (Reijnties et al., 1992). Thus, informal research by farmers can be a major source of agricultural innovations (Hippel, 1988; Biggs, 1990; Reijnties et al., 1992).

Innovation is the core element of an AIS, interconnecting knowledge development, diffusion and use. In other words, an innovation is the vehicle that transfers new knowledge from one actor in the AIS to another. Knowledge sharing meetings (Ingram, 2008) play a key role in terms of diffusion. The end-users of innovations manage a specific amount of new knowledge, whether embedded in a technology or not, and integrate it into their existing local knowledge base. This integration gives rise to a new, hybrid and evolving form of knowledge that can potentially lead to further innovation.

The agricultural sector in Cuba

The Cuban Revolution, coming to office in 1959, favored production systems using a high proportion of foreign inputs and top-down knowledge transfer, until the collapse of the Eastern European socialist block in 1989, which led to major changes. The upcoming crisis triggered a shift towards a more sustainable agricultural production based on the use of few external inputs and agro-ecological practices.

Today, Cuban farmers and farm workers are organized in 3,500 cooperatives spread all over the island (Vázquez Moreno, 2008). Apart from the state-owned production units, which hold 35.8% of the agricultural area, three main types of cooperative production can be distinguished: 1) Credit and Service Cooperatives (Cooperativa de Créditos y Servicios, CCSs) with 12.4% of the agricultural area;

2) Agricultural Production Cooperatives (Cooperativa de Producción Agropecuaria, CPAs) with 8.8% of the land, and 3) Basic Units for Cooperative Production (Unidad Básica de Producción Cooperativa, UBPCs), with 37%. Independent farmers share the rest of the land. However, the mentioned share of agricultural area significantly differs from the actual cultivated area. In 2007 more than 54% of the potentially cultivable area was unproductive fallow land (O.N.E., 2008).

Methods

Field research in Cuba was conducted within the methodological framework of a research project on "Organic Farmers' Experiments"[1]. The data collection was carried out in 2007 and 2008 for 5 months each year. During this period, 34 expert interviews were conducted with representatives of research institutions, the agricultural administration, farmers' organizations and international development agencies. The selection of the interview partners was based on purposeful sampling and combined with snowball sampling. Recommendations of local counterparts from research institutes helped selecting the appropriated interviewees. The selection criterion for interviewees was the prominence of their role and expertise in the fields of farmers' experiments and innovations, agricultural extension and organic farming. A semi-structured interview guide was used that covered such topics as the institutions' mission and objectives, their own information and knowledge systems, the interviewees' perception of farmers' experiments and innovations and sustainable agriculture and organic farming in Cuba. In addition, 31 free lists (Bernard, 2002) were collected to identify the institutions influencing farmers' experiments and innovations. The interviews lasted between 45 minutes and 2 hours, depending on time availability of the interviewer and on the willingness of the interviewee to share information. Furthermore, secondary data was analyzed, such as those provided by newspaper and magazine articles, brochures, proceedings of events and other relevant media publications.

All but one of the interviews were recorded with a digital voice recorder, transcribed with Express Scribe software and, finally, coded and analysed with Atlas.ti. The interview data was analyzed according to a content analysis, based on a combination of deductive and inductive coding (Miles and Huberman, 1994; Bernard, 2002).

Participant observation completed the set of methods to gain additional insights into farmers' participation in scientific and semi-scientific conferences, innovation award forums, innovation fairs, farmers' and scientists' workshops, seminars and farmers' meetings. During all events, selected relevant phases were digitally recorded and protocols were elaborated and analyzed in the same way described for the interviews.

Formal research in Cuba

The formal agricultural research system dates back to the early days of the Revolution, having been influenced by its most important trading partner at the time, i.e. the Soviet Union. For decades, Cuba followed the model of green revolution and hierarchical structures in agricultural production, research and extension services. In 2001, there were between 100 and 150 agricultural researchers in Cuba, against an average of 70 in the rest of the Caribbean region (Roseboom, 2001). The formal agricultural research sector comprises institutes of the Ministry of Agriculture (MINAG), the Ministry of Higher Education (MES) and the Ministry of Science, Technology and the Environment (CITMA). The MINAG head office has a directorate of science and technology that coordinates agricultural research activities on a national level. The CITMA, when appropriate, approves research programs and projects. Furthermore, the MINAG supervises 17 research stations, which do research on the main agricultural production sectors, such as rice or tobacco, and 38 experiment stations distributed throughout the island according to production zones. In addition, the MES has research institutions

[1] The research project, which lasted two years, was carried out in Austria, Cuba and Israel by three PhD students. The study was aimed at generating empirical knowledge on the processes whereby organic farmers experiment and innovate and how they generate new and sustainable knowledge.

distributed all over the country that contribute to knowledge and innovation development (Funes et al., 2002).

Key actors in knowledge diffusion

MINAG's municipal offices, state-owned agricultural enterprises, and local staff members of the National Small Farmers' Association (ANAP) are the main providers of technical assistance. Other important contact points for agricultural advice are the Plant Health Research Institute (INISAV) and the Center for the Reproduction of Entomophages and Entomopathogens (CREE). Each municipality counts on several extensionists who assist individual farmers and cooperatives. In addition, there are research stations spread all over the country, often in remote areas, located near the farmers. The topics addressed by all these actors mainly include pest and disease control, seed and soil management and, to a lesser extent, irrigation, processing and marketing.

The ANAP is the most important institution of knowledge diffusion among farmers who are members of CCSs and CPAs. It runs offices in all municipalities, and, therefore, has access to every farming unit. The ANAP has an educational and training centre in the province of Havana as well as 117 training rooms distributed all over the country.

Urban agriculture seemed to be an effective way to overcome the economic and food crisis. This perception led to the foundation of the National Committee on Urban Agriculture (GNAU) in 1994. Every province and municipality runs its own branch office for the organization and administration of the urban agriculture movement. These offices also provide extension service. Many extensionists live near the production units, so they share similar knowledge and viewpoints with the farmers. As a result, establishing rapport with them takes place in a natural way, which eventually helps improve the efficiency of their work.

The INISAV deals with crop protection, having research institutes in each province and 69 experiment stations all over the country. Each experiment station employs about ten extensionists who provide farmers and cooperatives with extension and capacity-building services, make field visits an organize workshops, seminars and courses. Audiovisual materials, such as short videos, computer presentations and leafelets help improve the efficiency of knowledge diffusion. However, it is oral knowledge that prevails, since also extension agents face shortage of resources, which restrains extension services. Given such restraint, mass media are a cost-effective means to reach a wide range of farmers. The information provided by TV, radio or newspapers is accessible even to farmers living in remote areas. TV and radio stations broadcast agricultural information nationwide, and local radio stations diffuse agricultural information from local research institutes or experiment stations. Some experiment stations of the INISAV even have their own radio programs. A remarkable example of knowledge diffusion through documentaries is the Program for Local Agricultural Innovation (PIAL), a project implemented by the INCA.

Local and national newspapers and farmers' organizations' magazines publish summaries of agricultural events or articles on the latest and relevant agricultural topics. Whereas the national newspaper is available even in remote areas and, therefore, widely used as a source of information, the magazines of farmers' organizations are of rather limited circulation, and, therefore little reach.

Extensionists play a key role in Cuba's AIS. Therefore keeping them up to date through further education and capacity building helps improving the efficiency of knowledge transfer. The Cuban Association of Agricultural and Forest Technicians (ACTAF) provides education and training to extensionists and other professionals. With offices in each province and more than 20,000 members all over the country, it is one of the most important technical associations in the agricultural sector. The ACTAF lays stress on knowledge sharing, frequently organizes workshops on cooperative basis, conferences and seminars and publishes books and a magazine on organic farming.

Another important organization is the Cuban Association of Animal Production (ACPA), also with about 20,000 members. The ACPA emphasizes knowledge sharing, and, thus, facilitates access to agricultural information and provides capacity building, education and extension services.

An example of horizontal diffusion of knowledge is the Farmer-to-Farmer Agroecological Movement (MACAC), implemented by the ANAP, which created it in 1997. Every municipal office of the ANAP employs a representative of the MACAC, who coordinates and supervises all activities related to the movement. The main pillars of the MACAC are the participants who play the roles of "facilitators" and "promoters". Facilitators usually have a higher education standard – and therefore specialized knowledge – than average farmers, so they often promote the introduction of agro-ecological innovations. They assist farmers and stay with them during the experimental stage of adoption of agro-ecological practices. However, facilitators are not typical extensionists, since they usually live in rural areas and most of them are farmers themselves. As for promoters, they are research-minded farmers who stand out for being enthusiastic experimenters and eloquent communicators.

The MACAC provides an organizational framework for the diffusion and horizontal spread of farmers' agroecological experiments and innovations. It plays a key role in facilitating knowledge sharing among farmers, providing agricultural training and education and offering extension services. Although the ANAP is the leading provider of farmer-to-farmer extension in Cuba, there are other institutions that also organize knowledge sharing meetings (INCA, ACTAF, ACPA, etc.).

Participatory Research in Cuba

More and more, representatives of the academic agricultural education sector invite farmers to participate, especially in the elaboration of MSc and PhD theses. The high density of educational institutions and the easy access to them all over the country favor the interaction between farmers and scientists or students, who often live in rural neighbourhoods and, therefore, share a similar background with the farmers. Thus, most of the research relationships are characterized by trust and mutual understanding. Farmers' participation mainly includes technology assessment or feasibility evaluation of innovations introduced from outside e.g. new varieties, organic fertilizers, erosion control methods, etc.

Agricultural research institutions, farmers' organizations and development agencies encourage farmers' experiments and innovations. Probably, the most successful example of participatory research in Cuba was the Participatory Crop Improvement Project (*Fitomejoramiento Participativo*, FP) launched by the INCA in 1999. INCA's scientists offered seeds to farmers and encouraged their experiments to assess the suitability of different varieties for specific farming conditions. In 2007 the FP project became part of the PIAL, thereby expanding the original concept. Now, the project staff members encourage farmers to experiment on any topics of interest.

Another example is the INISAV, which has emphasized farmers' participation in its research projects for more than ten years. Many of the research projects have included an on-farm research component with different levels of farmers' participation, depending on the researchers' and farmers' willingness to collaborate. Participatory research projects focused, above all, on agroecological strategies for plant protection. However, farmers' participation concentrates on technology assessment on their own farms.

The National Institute for Basic Research on Tropical Agriculture (INIFAT) is the leading entity in Cuba conducting research on urban agriculture. The institute collaborates with urban producers and rural farmers. Its staff members seek, to some extent, linking all research projects to farmers. Like the INISAV, the INIFAT focuses on farmers' involvement in technology assessment.

Although the Cuban government encourages bottom-up approaches concerning knowledge and technology development, some scientists remain skeptical about farmers' participation in research and development, as well as about farmers' own innovations. According to some interviewees, these scientists frequently underestimate farmers' achievements in knowledge and technology development, sometimes even hampering the widespread diffusion of farmers' innovations.

Farmers' experiments and innovations in Cuba

The collapse of the socialist block in 1989 had a drastic impact on the Cuban economy and society and led to an economic and food crisis. It was during the period after such collapse that Cuban farmers had to become innovative. Cuba's government started to support new and sustainable technologies (e.g. biological pest control, organic fertilizer production) and reorganized the agricultural structure (e.g. farm diversification, downsizing of large farms, offering of land in usufruct). Apart from the farmers' and the governments' approaches to optimize rural farming, city inhabitants also became more and more actively engaged in agricultural production – the arise of urban agriculture.

Farmers' experiments and innovations turned out to be an indispensable element of all the aforementioned approaches aiming to overcome the crisis. Cuban farmers and city dwellers who engaged in agriculture had to experiment to maintain and increase the agricultural output.

Even today, farmers' experiments and innovations prove important to Cuba's agriculture. Most Cuban farmers are involved in activities that can be denominated "farmers' experiments". However, there are big differences between experiments in terms of complexity, intensity and chronology. Farmers' experimental methods strongly depend on both the farmers' personal background and the kind and closeness of their relationships with scientists or extensionists. Those farmers who are willing to introduce their experiments to a public audience generally use more sophisticated methods for conducting and evaluating them. These farmers often rely on the support from extensionists or scientists to elaborate a report and prepare a presentation. Although some outstanding farmers conduct highly complex experiments by using scientific or semi-scientific methods, most of the experiments are simple and easily manageable. Farmers usually choose a pragmatic approach to experimentation and even adapt or adjust the methods during the experimental process in order to reach applicable results. It is particularly research-minded farmers (who are enthusiastic experimenters) that actively engage in testing and are constantly experimenting, whereas rather passive farmers avoid worrying about experimenting or else their experiments date back long time.

The outcomes of farmers' experiments primarily serve the purpose of improving a given current situation. Most farmers' experiments and innovations bear upon the local context.

Cuban farmers frequently recycle both agricultural and non-agricultural resources, seeking alternative uses and recombining old stuff with new materials. Farmers' initiatives to face the shortage of resources are well integrated into rural culture. The term "to invent" (*inventar*) is an established expression in Cuban society, representing key concept in the daily struggle to cope with the difficulties of the crisis. The term "to invent" refers to the concept of improving farm and family welfare. During the peak of the crisis, Cuban inventions helped the citizens to weather that challenging situation, and even today they are an integral part of everyday life.

Institutionalizing farmers' experiments and innovations

Cuba's agricultural sector is highly regulated and institutionalized. Consequently, the agricultural institutions also influence farmers' experiments and innovations. The aim of the free-list exercise was to assess the institutional influence on farmer's experiments and innovations. The interviewees mentioned 63 different institutions – or generic terms for institutions – that are known to influence farmers' experiments and innovations. The most frequently mentioned institutions were the ANAP and the INCA. The ANAP represents private farmers belonging to CCSs and CPAs and runs the MACAC, with farmers' experiments as an essential element of the whole movement. The ANAP is the spokes-organization for farmers' interests, before the government and, at the same time, is the government's communicator of relevant information.

The high level of the INCA as a government body is an indicator of the success and importance of the PIAL. Undoubtedly, these two institutions determine the debate about farmers' experiments and

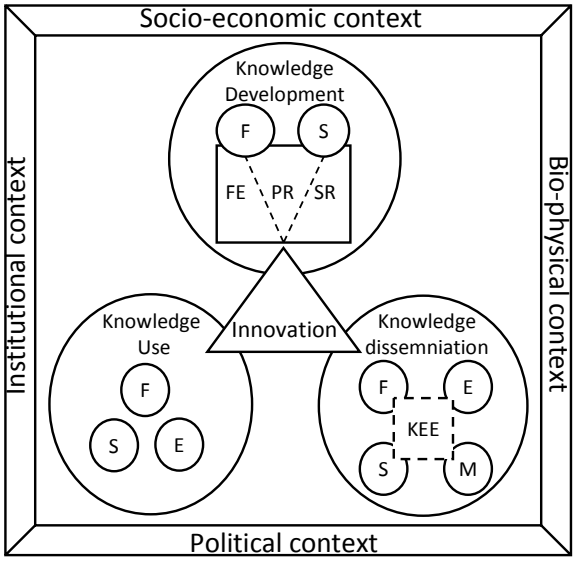
innovations in Cuba. However, it is all the aforementioned institutions – whether governmental or not – that, to some extent, influence farmers' experimental processes and innovations.

Owing to the efforts of some research institutions, with INCA leading the way, the general attitude of scientists and extensionists towards traditional technology transfer gradually shifted to more participatory approaches.

Farmers' participation in national and international conferences is a promising approach to institutionalizing farmers' experiments and innovations. The main purpose of inviting farmers to conferences is to improve knowledge sharing between them and scientists. Conferences with farmers' participation are organized on a regular basis by several institutions. The ANAP and the ACTAF organized conferences where farmers' presentations – mostly based on their experiments and innovations – made up over 80% of the total. Their participation includes poster presentations or even talks. The organizing committees compile farmers' experiments and innovations and publish print or digital versions of the proceedings.

The Forum of Science and Technology (FCT) is the most impressive movement in Cuba. It awards prizes in 13 different sectors, including food and agriculture. All Cuban citizens can participate and present their innovations to a wider audience. All institutions of the agricultural sector (e.g. INCA, ANAP, ACTAF, etc.) organize their own forums. The forum starts at local level and ends at national level. The ANAP is in charge of the organization of the forum of the private farmer sector. The promotion by the MACAC has given rise to a high degree of farmers' agroecological experiments and innovations presented at the forum. The municipal statistics offices collect all awarded contributions, which the CITMA recently started to compile on a central database.

The diverse initiatives launched by Cuban organizations to integrate farmer's experiments and innovations into the AIS reveals the government's commitment to farmers' participation in knowledge development and diffusion (fig.1). The encouraging environment for the integration of farmers' experiments and innovations accounts for their high degree of acceptance by parts of the scientific community.



Key: F = Farmers; S= Scientists; E = Extensionists; M = Media; FE = Farmers' Experiments; PR = Participatory Research; SR = Scientific Research; KEE = Knowledge Exchange Encounter

Figure 1. Cuba's agricultural innovation system (source: own graph).

Conclusion

One of the main characteristics of the AIS approach is its focus on the stakeholders and the linkages between them. Opportunities for interaction and open discussion favor knowledge diffusion and sharing. Cooperative meetings, workshops, conferences and the FCT itself are crucial platforms for knowledge exchange. These platforms facilitate the communication of farmers' experiments and innovations to the public. As these events start on a local level and sometimes even include the international level, they help improve the spread of innovations and new agricultural knowledge. Thus, the Cuban example demonstrates how farmers' experiments and innovations can be integrated into an AIS so that their innovative capacity is recognized and, at the same time the applicability of their innovations can be improved.

Cuba's administrative and institutional structure provides several platforms for farmers to exchange and spread knowledge, though on occasion the lack of flexibility of such platforms lowers the diffusion of innovations. According to the interviewees, the potential end users of agricultural innovations are often unaware of the results achieved by formal and informal research. The interviewees said that the diffusion depends on local initiatives and mainly remains a farmers' domain. Thus, personal communication networks are crucial to knowledge sharing and innovation spread.

Although farmers' participation in agricultural research and development is promising, top-down approaches are still common. Providing a favoring environment for farmers' active participation will help them develop their full potential in AISs. Policies have the capability of lying out such favorable environment. Thus, political commitment to research, education and social participation in agricultural development is an effective way to upgrade an AIS. However, policies can just build the general framework for the integration of farmers' experiments, since such integration often depends on local decision makers, who directly interact with farmers. Therefore, agricultural decision makers should actively involve farmers in knowledge and technology development.

The Cuban example highlights farmers' contribution to knowledge and technology development and reflects the expanded social participation in the AIS. However, the full acceptance of farmers' contribution and the willingness to increase their participation are lacking among certain scientists. Nevertheless, the innovative capacity of individuals and groups is a powerful element of AIS and a further contribution to the systems' resilience. Providing favoring conditions for farmers' experiments increases the adaptive capacity of farmers. The complexity of the elements of an AIS and their interaction determine the capacity to respond to external changes. The heterogeneity of the different actors and their interactions are key to the resilience of an AIS. Different stakeholders have different skills and knowledge, whose exchange helps building up resilience.

Farmers are permanently experimenting and innovating, with or without scientists' acceptance, and thereby contribute to agricultural development and knowledge generation. The Cuban example illustrates how an increase in farmers' participation helps build up a socially-based knowledge base and how it can lead to agricultural development. Farmers' experiments and innovations contribute to agricultural development, whether integrated into formal research or conducted on their own. Through these experiments and innovations, farmers improve farm management and thereby help generate sustainable livelihoods.

The involvement of farmers in knowledge and technology development facilitates the establishment of a knowledge society in which farmers are not just seen as end users of technology but as an active part of the AIS. Cuba's AIS exemplifies how a higher degree of farmers' participation increases the applicability of innovations, thus improving AIS's efficiency. Scientists should be open to – and accept – farmers' indigenous trend to experiment and innovate, taking advantage of their valuable contribution. Better awareness of farmers' capacity to contribute to knowledge and technology development is key to improving AISs.

Acknowledgement: The authors want to express their thanks to the Austrian Science Foundation (FWF) for financing the project "Organic Farmers' Experiments", including its funding of field research in Cuba. This research would not have been possible without the intensive support from our Cuban colleagues Fernando Funes Monzote and Humberto Rios. The field work in Cuba was done thanks to a student visa under an official agreement between the University of Natural Resources and Applied Life Sciences (BOKU), the Experimental Station of Pasture and Forages "Indio Hatuey" (EEPFIH) and the National Institute of Agricultural Sciences (INCA). We do also thank Elena Sanz Soro, May Ling Chan, Eduardo Freire, Susanne Kummer and Racheli Ninio for the inspiring discussion about the subject of our paper.

References

Bernard, H. R. (2002) *Research methods in anthropology - Qualitative and quantitative approaches*. Walnut Creek, USA: Altamira Press.

Biggs, S. D. (1990) A multiple source of innovation model of agricultural research and technology promotion. *World Development* 18(11):1481-1499.

Chambers, R., Pacey, A. and L. A. Thrupp, (1998) Farmer First. Farmer Innovation and Agricultural Research. London, UK: Intermediate Technology Publications.

Douthwaite, B., Keatinge, J.D.H. and J.R. Park (2001) Why promising technologies fail: the neglected role of user innovation during adoption. *Research Policy* 30(5):819-836.

Fischer, M. M. (2001) Innovation, knowledge creation and systems of innovation. *The Annals of Regional Science* 35(2):199-216.

Funes, F., García, L., Bourque, M., Pérez, N. and P. Rosset, (2002) Sustainable Agriculture and Resistance - Transforming Food Production in Cuba. Food First, Oakland, U.S.A.

García Pleyán, C. (2006) Desarrollo local y gestión del conocimiento. In: A. Guzón Camporredondo (Ed.) *Desarrollo Local en Cuba: Retos y Perspectivas.* La Habana.

GebreMichael, Y. (2001) Community assessment of local innovators in northern Ethiopia. In: C. Reji and A. Waters-Bayer (Eds.) *Farmer Innovation in Africa.* London: Earthscan Publications Ltd, pp. 171-177.

Gonsalves, J., Becker, T., Braun, A., Campilan, D., Chavez, H.d., Fajber, E., Kapiriri, M., Rivaca-Caminade, J. and R. Vernooy (2005) Participatory Research and Development for Sustainable Agriculture and Natural Resource Management: A Sourcebook. Volume 1: Understanding Participatory Research and Development. International Potato Center-Users' Perspectives with Agricultural Research and Development, Laguna, Philippines and International Development Research Centre, Ottawa, Canada.

Haverkort, B. (1991) Farmer's experiments and Participatory Technology Development. In: B. Haverkort, J. van der Kamp and A. Waters-Bayer (Eds.) *Joining Farmer's Experiments.* London, UK: Intermediate Technology Publications, pp. 3-17.

Hellin, J., Bellon, M.R., Badstue, L., Dixon, J. and R. La Rovere (2008) Increasing the impacts of participatory research. *Experimental Agriculture* 44(01): 81-95.

Hippel, E. v. (1988) *The Sources of Innovation*. New York: Oxford University Press.

Hoffmann, V., Probst, K. and A. Christinck (2007) Farmers and researchers: How can collaborative advantages be created in participatory research and technology development? *Agriculture and Human Values* 24(3):355-368.

Ingram, J. (2008) Agronomist–farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. *Agriculture and Human Values* 25(3):405-418.

Kummer, S. and C.R. Vogl (2009) Bäuerliche Experimente. Forschung ohne Wissenschaftler. *Ökologie & Landbau* 152(4).

Leitgeb, F., Sanz, E., Kummer, S., Ninio, R. and C.R. Vogl (2008) La Discusión académica sobre los experimentos de los agricultores – una síntesis. *Pastos y Forrajes* 31(1)

Malerba, F. (2002) Sectoral systems of innovation and production. *Research Policy* 31(2):247-264.

Miles, M.B. and M.A. Huberman (1994) *Qualitative data analysis: an expanded sourcebook.* California: Sage Publications.

O.N.E., (2008) Panorama Uso De Tierra: Cuba 2007. Oficina Nacional de Estadistica, La Habana, Cuba.

Reece, J.D. and J. Sumberg (2003) More clients, less resources: toward a new conceptual framework for agricultural research in marginal areas. *Technovation* 23(5):409-421.

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

Reijnties, C., Haverkort, B. and A. Waters-Bayer (1992) *Farming for the Future. An Introduction to Low-External-Input and Sustainable Agriculture*. London: The Macmillan Press Ltd

Roseboom, J., Cremers, M. and B. Lauckner, (2001) Agricultural R&D in the Caribbean: An Institutional and Statistical Profile. International Service for National Agricultural Research, ISNAR Research Report No. 19, The Hague.

Sanz Soro, E. (2008) Experimentos de productores en la agricultura urbana – El caso de Cuba. MSc thesis, BOKU University, Vienna, Austria

Spielman, D.J. (2006) A Critique of Innovation Systems Perspectives on Agricultural Research in Developing Countries. *Innovation Strategy Today* 2(1):41-54.

Spielman, D.J., Ekboir, J., Davis, K. and C.M.O. Ochieng (2008) An innovation systems perspective on strengthening agricultural education and training in sub-Saharan Africa. *Agricultural Systems* 98(1):1-9.

Sumberg, J. (2005) Systems of innovation theory and the changing architecture of agricultural research in Africa. *Food Policy* 30(1):21-41.

Sumberg, J., Okali, C. and D. Reece (2003) Agricultural research in the face of diversity, local knowledge and the participation imperative: theoretical considerations. *Agricultural Systems* 76(2):739-753.

Thrupp, L. A. (1996) *New Partnerships for Sustainable Agriculture.* World Resources Institute, Washington, USA.

Vázquez Moreno, L. L. (2008) Desarrollo de la innovación agroecológica por los campesinos cubanos. Agricultura Orgánica. ACTAF.

Wortmann, C.S., Christiansen, A.P., Glewen, K.L., Hejny, T.A., Mulliken, J., Peterson, J.M., Varner, D.L., Wortmann, S. and G. L. Zoubek (2005) Farmer research: Conventional experiences and guidelines for alternative agriculture and multi-functional agro-ecosystems. *Renewable Agriculture and Food Systems* 20(4):243-251.