Appropriate methods for technology development in urban agriculture

Safiétou T. Fall 1) and Henk de Zeeuw 2)
1) ISRA, Senegal
2) ETC-RUAF, the Netherlands

1. Introduction

The urban agricultural production system is characterised by a variety of agricultural micro-enterprises (apart from a minority of industrial-scale producers around cities), the performance of which is not only limited by bio-climatic, land and socio-economic restrictions, but also by important technical restrictions (Fall et Fall, 2001).

Although urban farmers are quite dynamic and innovative and have a vast scope for technical improvement, the rate of technology development and diffusion in these systems is still limited (CIRAD, 1985; USAID, 1989; FAO, 1995; Fall et Fall, 2001).

In urban farming systems, these low levels of technology development, adaptation of agricultural production technologies to the specific conditions of the urban context and acceptance by the urban farmers are due primarily to the following factors:

• The bias towards rural agriculture in the agricultural research and extension institutions and, until recently, the limited attention given to agriculture by most urban authorities,
• The lack of technologies that are well adapted to urban production conditions (such as adapted varieties, technologies for space-confined production, technologies for safe use of urban wastes and wastewater),
• Lack of attention for the innovations made by the urban farmers themselves,
• Lack of participation of the urban farmers in the identification of the priorities for technology development and the testing and evaluation of new or adapted technologies.

This raises multiple questions concerning the approach and methodologies applied in urban agricultural research and extension. This article will attempt to answer these questions by exploring the methods and procedures that may be successfully applied in urban agriculture.

2. Urban agriculture compared to rural agriculture

Urban farmers and urban farming conditions differ from those in rural areas, which has important consequences for technology development in urban agriculture.

Land tenure systems
Availability of space and land tenure system differ widely between rural and urban sites. Space constraints are more acute in cities than in rural areas. Urban land tenure systems are more complex, land prices are higher and land security is much lower than in rural areas.

Ecosystem
Soil characteristics under urban conditions may be strongly influenced by human activity and may differ from site to site. Soil and water quality in the urban areas have a higher risk of being affected by residues from traffic, industry, hospitals and households. Multiple water sources are used in urban agriculture: seasonal rainfall
allows the growth of tropical species, while irrigation and wastewater recycling are common practices in the urban production system.

Parasitic load, plant sensitivity and soil degradation are more acute in urban agriculture, which is more demanding regarding soil fertility management to ensure good crop performance, particularly in intensive, year round horticultural production systems. The use of elevated amounts of chemical fertilisers and pesticides may be a source of pollution in urban agriculture and a threat to urban public health. These are reasons why such practices need to be revised.

Producers
In rural communities, farmers comprise a large part of the community; they know each other, and information and technologies are exchanged continuously. In urban settings, farmers may live in neighbourhoods where most of the people are involved in other economic activities, their agricultural plots may be far from their houses and they may know few other farmers, or these other farmers may come from other socio-cultural backgrounds. This hinders communication and co-operation.

The socio-economic characteristics of urban producers are more diverse than their rural counterparts. The average level of education is normally higher in the cities.

Rural farmers are almost continuously occupied with agriculture, while a large proportion of urban farmers are involved with agriculture as a secondary occupation.

Most rural farmers are always present on their farms, and a large proportion of them are owner-farmers. In the urban context, a large proportion of the producers may not own the land. Land rental is quite common; the system of payment may involve sharecropping. Urban farms are often operated by hired employees, while the owner, who is generally absent, makes the main decisions.

Production methods and use of local knowledge
Over the years, farmers in the rural setting have developed a complete body of traditional technical knowledge. Rural farmers who migrate to the cities are confronted with the fact that much of their traditional knowledge has limited value in the city: soil and water conditions are different, other crops must be grown, and other constraints and opportunities have to be dealt with.

Some of the urban farmers are urban natives who have begun farming out of necessity or as a personal choice; they may lack the traditional technical knowledge of rural farmers. However, urban farmers may have much more insight into the urban market and the food demands of urban citizens than their rural colleagues.

Due to a lack of agricultural research and extension services focussing on urban agriculture, the technologies applied are often rather basic and not well adapted to urban conditions. However, as a result of urban production conditions and the proximity to markets and urban consumers, urban producers often are more dynamic and eager to experiment with new technologies and products that function better under these conditions and are more in accordance with market demands.

A farm in the rural area normally involves various components that mutually reinforce each other. In the city, farmers may just concentrate on one component (e.g. production of fodder) and leave the other components to other households (e.g. raising animals).
Products
In urban agriculture there is a greater diversity of products than in rural agriculture, including products that are rarely seen in the rural areas. Perishable vegetables, milk, poultry and eggs, ornamental plants, herbs and spices, flowers, mushrooms and fruit are usually plentiful in urban agriculture.

Marketing
Urban agriculture has the advantage of its proximity to large and quickly growing populations of consumers. It also has a good position for export due to the proximity to airport or seaport facilities.

Processing, marketing and consumption in urban agriculture are often more closely related than in rural agriculture, and the urban producers have more opportunities to sell directly to the consumers. There is a good potential for the improvement of post-harvest operations (preservation, processing, packaging and marketing) by micro enterprises and small enterprises.

Institutional environment
Urban agriculture has been largely ignored by agricultural research and extension, which traditionally focus on rural agriculture. On the other hand, most institutions involved in agricultural development are located in the cities. Urban producers who have the ability and time to do so can seek direct contact with agricultural extensionists to talk about projects and investments. Many NGOs are also located in cities, but few of them attend to the needs of urban producers.

3. Identification of technology needs
The identification of the need for specific technologies is the first step in the research-development chain. This involves characterising the production systems and farming households in the selected area in order to make a reliable diagnosis and prioritisation of the problems, and – in co-operation with the urban farmers – identifying the technology to be developed. Other stakeholders at various levels of the production, distribution, processing and consumption chain should also be included in this analysis (Drechsel, 2001).

The study of the location implies a physical and socio-economic characterisation of the target area. Special attention should be given to the analysis of the direct stakeholders: their number, ethnic group and social behaviour. This analysis must be participatory and lead to a consensual characterisation of the various social groups involved, especially concerning their skills, preferences and technology needs (Quansah, 2001). A wide range of participatory and other rapid appraisal methods and instruments can be applied in the analysis, such as focus groups, interviews, community resources mapping, seasonal calendars, problem trees, Venn diagrams, ranking tools, stakeholder analysis and participatory institutional diagnostics (Ly, 2001; see also Topic 1). These methods should be adapted to the specific requirements of the urban setting.

The participation of the direct stakeholders in the process of situation analysis is an important condition for identifying priority technology needs and the criteria that should be taken into account during technology development and testing in urban agriculture. The use of participatory tools for analysis allows rapid exploration of the location and ensures the involvement of stakeholders and their local knowledge in the analysis of the situation and the subsequent identification and testing of possible
solutions to key problems.

But one should also take the limitations of participation into account: the transaction costs of participation may be high for the farmers, the reliability of the information gathered in participatory processes should be assured by triangulation (combining various sources and methods), intensive participation may generate expectations beyond the resources or mandate of the researchers, etc. Furthermore, after the stakeholders (usually of varying social origin) are consulted, the complexity of information levels can be high. A stratification is therefore recommended.

Special attention to the direct and active participation of sensitive groups is required. Male leadership often prevents young people and women from expressing themselves. This can lead to biases in the information gathered regarding the functioning of the farm households and their technology needs.
Investigation of technological options for recycling municipal waste in urban agriculture (Drechsel, Cofie, Vazquez and Danso, 2001).

An IDRC supported project in Ghana investigated the options for safe recycling of urban organic wastes in urban and peri-urban agriculture. The project involved several stakeholders in the diagnosis of the present situation and identification of feasible options for reusing urban organic wastes: municipal authorities (especially health officials), farmers, producers, the private sector, project personnel and merchants, university students in Ghana and participants from two European universities.

There were four aspects to the analysis: i. Supply structure (quality, quantity and availability of organic materials); ii. Compost demand (who, where, how much, perception and price); iii. Waste and compost collection process; iv. Legal and institutional aspects.

The foremost methods were PRA tools (structured interview, focus group, matrix classification, etc), household surveys to collect the experiences and opinions of the various stakeholder groups, laboratory techniques to analyse the quality of the organic materials, computer tools to forecast the evolution of the supply-demand ratio and a literature study (especially regarding the institutional and legal aspects).

The results of the analysis involve the:
- generation of information on rural–urban food flows, consumption, waste, compost demand, recycling options,
- support of decisions taken by the municipal authorities,
- demonstration of technical schedules for the preparation of compost,
- development of the skills of the population to participate in technology development and implementation.

4. Technology development

After identifying the technology needs or registering the demands, the process of technology development can begin. Its aim is to develop schedules and/or procedures that allow the improvement of production. Related but equally important issues at urban and peri-urban sites, such as the protection of the environment, require other elements besides simple production performance criteria to also be considered.

Research at research facilities

To gain a proper grasp of the technological basis, tests and laboratory work may be needed during the first phase of the technology development process, especially when the technology is still at a basic stage with many uncertainties regarding performance, resource requirements and the risks involved. But this work must focus on the priority need that has been identified and take into account the characteristics of the main stakeholders and farming systems and the agreed criteria for monitoring and evaluating the performance of the technology. Maintenance of communication with the direct stakeholders during this stage is recommended to enhance transparency and ensure successful participation during later stages of technology testing and dissemination.

Reducing pollution in two lakes in Hanoi (Sy and Vien, 2001)

Hanoi is crisscrossed by 18 lakes which vary in size from 1 to 526 hectares. The total area of these lakes is 615.4 ha. At the request of the Department of Technology and Environmental Sciences, research was carried out to evaluate the sources and the level of pollution in these lakes with the aim of drawing up recommendations concerning cleanup procedures and the means to prevent further pollution. These lakes represent reservoirs of irrigation water and a source of income for approximately 100 fishermen (about 35 species of fish live in these lakes).

A series of surveys and field studies, including taking samples and conducting chemical and bacteriological analyses in laboratories, have allowed the main pollutants to be identified. These include mercury, lead and cadmium, which lower the water quality of these lakes. The sources of this pollution have also been identified.

Preliminary recommendations:
**Implement preventive measures to limit water pollution from multiple sources and reduce the amount of sewage disposal in the lakes.**

* Continue fish production with species that control phytoplankton and other undesirable aquatic plants, and introduce new species of zoobenthos-eating fish.

The recommendations will be discussed with those who cause the pollution, the fishermen, municipalities and other stakeholders.

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**Participatory technology development**

Participatory methods for development, adaptation or evaluation of technologies have gained wide acceptance because they offer a number of advantages over station-based research. The technologies are tested and adapted under the conditions where they must be applied, which often differ greatly from the conditions at the research station. By doing so, the chances of adapting the technology to the local conditions and farmer preferences are significantly enhanced. This is crucially important, especially in the urban environment, since most agricultural researchers are not very well acquainted with urban farming conditions and the preferences of urban farmers.

The involvement of farmers in technology development allows farmers' knowledge about local conditions to be utilised along with their creativity and problem solving capacity. Due to the adaptation to the local farming conditions and the evaluation criteria of the direct stakeholders, the resulting technologies will be more easily adopted by the local farmers.

Researchers, urban farmers and other stakeholders should closely co-operate in the design, implementation and evaluation of local experiments throughout a number of steps or stages.

The identification of urban farmers who are willing and able to participate in the local experiments is a first and crucial step. The "Senegal Food System" project identified producers who are characterised by their flexibility and openness to innovation, patience and discipline. These aspects are crucial to the successful implementation of the experiments (Fall et al., 1993).

In the Participatory Technology Development project in Peru and Bolivia, a group of farmers were asked to identify colleagues who were known locally for having innovative ideas and trying them out on their own farms (De Zeeuw, 2001). Other selection criteria were:

- Their knowledge of and interest in the crop, animal or cultural practices which the new technology relates to,
- Their capacity and willingness to share their knowledge with others,
- Whether they were representative of the various social strata and farming systems in the area,
- Equal participation of male and female experimenters.

After identifying the farmer-experimenters, the points of view of researchers and farmers are brought together concerning the objectives and expected outcomes of the experiments, the design of the experimental plan, the selection of the site or sites, the establishment and management of the experiments and their monitoring, registration and evaluation.
Technicians make suggestions about the criteria for selecting the experimental sites and take a leading role in the design of the experimental plan. However, the producers also make decisive contributions, since they know their surroundings and will have to be able to manage and evaluate the experiment on their own.

The experimental plan should be simple. It is not a matter of transferring protocols from facilities or experimental models from laboratories to the field. Rather, it implies translating biological or socio-economic indicators into more accessible terms. The monitoring and evaluation of these experiments must involve all partners, especially the users. The establishment of follow-up calendars will aid in planning this activity. The organisation of follow-up teams that include representatives of partners, researchers, extensionists and producers appears to be effective for promoting the exchange and harmonisation of their views on the development of the experiment and the results obtained.

The dissemination of results deserves special attention. The farmer-experimenters may also act as farmer-extensionists during and after the realisation of the experiments and the organisation of open days on the experimental plots. Networking with other local organisations appears to be a useful tool to ensure that the experimentation phase is followed by an extension programme (Cardinale et al., 2001; Fall, 2001).

During the entire experimental process, emphasis should be placed on strengthening the experimenters’ group, enhancing their experimental capacities and their direct links with research institutes, NGOs and other sources of technical information, while securing the small amount of funding needed for the local experiments. This will ensure the continuation of the experimentation and technological innovation process after the researchers have left (Niang, 2001; Diop and De Jong, 2001).

There is a fast growing repertoire of methodologies such as Participatory Technology Development (see Guyt and van Veldhuizen 1998), the Farmer-to-Farmer approach and the Farmer Field School approach (Gallager et al.; Van der Fliert and Braun, 1999).

Box 3 Development of safe production methods in peri-urban poultry keeping in Dakar (Cardinale et al., 2001)

Peri-urban poultry raising is fairly well developed in the city of Dakar. There are 800 production units generating approximately 5 million birds per year. One of the main limitations to the development of peri-urban poultry raising is the existence of pathological limitations responsible for the mortality of the animals, but which also threaten the quality of poultry products and the health of the consumers.

The actions directed by ISRA and CIRAD have the aim of identifying sources of contamination of poultry products at various locations in the production chain and promoting healthier poultry production methods. Several stakeholders are involved in the process: researchers and technicians provide diagnostics in the lab, while veterinarians manage the liaisons between researchers and poultry farmers. The latter are the main stakeholders in the process. Raising the awareness of farmers about good production practices is essential to minimise the risks of disease and improve the quality of products.

Together with the farmers, the entire production chain was evaluated in order to identify the main sources of contamination. Appropriate methods were subsequently developed to ensure the control of diseases. The latter methods included educating the producers about the various forms of contamination and alternatives for preventing this contamination.
The process began as an initiative of researchers, but the involvement of the direct stakeholders in the process of generating and disseminating information has steadily increased. This has resulted in the identification of effective treatments and enhanced awareness and knowledge among the poultry producers.

This experience has been an example of the establishment of a partnership between researchers, extensionists and farmers. Interactions are permanent and have allowed an adequate control system to be established. The network is informal, but the beginnings of institutionalisation are apparent. Thirty-five participating veterinarians and technicians are in charge of collecting and disseminating information. A newsletter and an annual report are published. Sensitive information is handled confidentially to assure the continued trust of the partners.

5. Conclusions

Many conventional and participatory methods and instruments have been developed for use in rural areas. However, their adaptation to the urban context is just beginning, and most of the challenges discussed at the beginning of this article still remain.

During the recent workshop in Nairobi on Appropriate Methodologies for Urban Agriculture, it became apparent that agricultural researchers who enter the urban sphere tend to become more conventional in their choice of methods (e.g. survey type methods for situation analysis, classic experimental designs and researcher controlled experiments). They do this to gain recognition and reduce their feelings of insecurity in this new field.

This tendency should be reversed; deliberate effort is needed to carefully adapt existing methods and instruments – and create complementary ones – to make these methods and instruments more appropriate and effective for use in urban agriculture.

Most urgently needed are concerted efforts of national governments, research institutes and universities, in cooperation with NGOs, extension organisations and Municipal Departments, to set up projects for facilitating technology development and dissemination in urban agriculture. Such programmes should allow for the careful design of the methodology (preferably participatory) and the documentation and evaluation of the experiences gained during the application of such methods.

6. References


DRECHSEL P., COFIE O., VAZQUEZ R. AND DANSO G., 2001. Technology development for municipal organic waste recycling for urban and peri-urban agriculture - a holistic


