

Data sharing and use of ICTs in agriculture: working with small farmer groups in Colombia

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This article describes the experience of analyzing groups of Colombian fruit farmers' capacity to collect information and their interest and ability to take advantage of the opportunities offered by information and communication technologies (ICTs). Three cycles were designed to understand the attitudes, skills, and current practices of fruit growers and to define the necessary conditions for effective information sharing. The three cycles involved individual farmers, farmer groups meeting face to face, and virtual meeting with farmer groups. The results contribute to the design of strategies for farmer engagement in the knowledge-sharing online platform of the AES-CE (Acronym in Spanish for Sharing Experiences for Site Specific Agriculture) project, designed to assist growers in improved decision making through sharing of multiple types of information from multiple sources. We find that farmers understand the usefulness of record keeping, but data collection is often imposed externally, and records are not generally used to better manage production. Farmers, overall, were positive towards information sharing and understand the benefits of using information from a wider environment, shared through an ICT platform, but shortage of skills in using these technologies is a serious limiting factor to expansion to a broader scale. We discuss future strategies that can be used to the design and implement ICT platforms which farmers can use to share information and improve their management.

Keywords: ICTs; knowledge platforms; farmers; horticulture; knowledge sharing; Colombia

Colombia possesses a diversity of socio-economic ambiences, landscapes, climates, and soils; affording it numerous areas with potential for fruit production. However, currently there are large differences in productivity between regions with similar social and environmental conditions. We suggest that these differences are due, at least partially, to lack of information on how to produce fruits. This information gap likely exists for formal knowledge and also for both tacit and local growers' knowledge. We surmised that farmers could improve the productivity, profitability and decision making processes regarding their fruit crops by sharing their knowledge and experiences and having better access to pertinent information. Furthermore, information and communications technologies (ICTs) could play an important role in

information exchange. The importance of ICTs in agriculture is growing, as increasingly innovative ways of using ICTs that favor agricultural and rural development are being designed (Seyed and Seyed 2012). In Colombia's highly mountainous terrain and remote areas, modern information and communications technologies (ICTs) are obvious enablers for information access and sharing of experiences between farmers.

Information support to Colombian fruit growers

The Fruit Growers' Association of Colombia (ASOHOFRUCOL, its Spanish acronym) approached the Decision and Policy Analysis (DAPA) Program at the International Center for Tropical Agriculture (CIAT, its Spanish acronym) to jointly establish an information sharing system, with emphasis on farmers sharing experiences. The system to support the Colombian fruit producers was based on the experiences gained when the Colombian sugar industry established an information sharing system. However, due to differences in the social organization the experiences in sugarcane with ICTs could not be applied directly to fruit production. In addition, most of the existing studies on ICTs for rural areas were not relevant: they concentrated on the role of ICTs in removing barriers to adoption (Nagel 2012), the value of different ICT canals for reaching farmers (Olaniyi, Adetumbi, and Adereti 2013), the impact of ICTs on development (Stienen 2006), and the use of ICTs for accessing markets (Lasagna, Hermosilla, and Martínez 2011): they did not emphasize the two way flow of information between farmers themselves and between farmers and other agencies.

Field data was a fundamental component of the information exchange we envisaged. Research on tools for collection of field data has concentrated on remote sensors and high technology precision agriculture systems (Mulla, 2013). However, little research exists on ICTs as tools for recording field data, or on their use as a medium for farmers to share experiences as a means of facilitating decision-making. Furthermore, the existing studies do not generally take into account the skills and attitudes that need to be acquired before people can adopt and effectively use ICTs. Thus, for example, farmers may need to learn new skills towards data collection and keeping of records, and also to become familiar and comfortable with computers, tablets or cell phones.

To fill these gaps in our knowledge, and as part of the larger knowledge-sharing online platform pilot project, we observed both farmers' attitudes and capacity to collect information and also their interest and ability to take advantage of the opportunities offered by ICTs.

In this article we describe the conceptual base for sharing knowledge, and briefly give an overview of the overall Sharing Experiences for Site Specific Agriculture (AES-CE, its Spanish Acronym) project. Subsequently the case study approach to describing farmers' attitudes and opinions and the results are described in detail. We present the results of three cycles of intervention, and discuss the implications of these results in the design of ICT platforms of this type.

Conceptual base

Most fruit crops in Colombia have not been intensively researched by government or private agencies. At the inception of the pilot project for information sharing, conventional wisdom suggested that growers depend largely on their own experiences and the guidance of technical experts to define which crops to grow and how to grow them. Much of the knowledge base used to make these decisions was not readily accessible, being stored in the minds of the experts and individual growers as tacit knowledge. A problem with much of this tacit knowledge is that, even if made explicit, it needs to be put into context. This is of particular importance in the highly heterogeneous landscape of Colombia. The opinion or recommendation of what is likely to be an optimum practice in a semi-arid area of the North Coast is most unlikely to be pertinent for a cloud forest in the Andes. The hypothesis that underlies obtaining value from information sharing is: if the environment in which a particular experience occurs is adequately described, then that experience can be usefully used by others who have a similar environment. Here, we note that the idea of environment encompasses not only the purely the physical and biological aspects associated with soils and weather, but also the socio-economic ambience. If farmers have at their disposal a large amount of information on a particular crop and how it performs under a range of environmental conditions and management, they should be able to put their experiences into the context of a specific environment. Farmers, technicians and experts should then be able to make sense of the information and hence make better decisions. Most of the decisions will have to be made within the context of Controllable Factors (CFs), such as the crop they plant, the cultivar or variety they use, the agronomic and phyto-sanitary practices and the harvesting procedures and Uncontrollable Factors (UCFs), such as weather, inherent soil traits or topography. Thence, if growers' experiences are put into the context of similar UCFs, and management practices are described, it should be possible to evaluate the effects of particular sets of management practices on the specific crop or cropping system within a given set of comparable UCFs.

In Colombia, a “digital gap” exists between urban and rural zones. This gap is characterized by scarce access and use of ICTs¹ in rural areas (Felizzola Cruz 2010). According to Nagel (2012) OSILAC's 2008 census indicated that only 2.5% of rural homes in the country had access to a computer and only 0.3% had access to Internet (Nagel 2012). To rectify this situation, the Colombian government has developed several initiatives, including:

- The *National ICT Plan* (Plan TIC, its Spanish acronym): operating within the National Development Plan (2006–2010), the Plan proposes that all Colombians are using ICTs by 2019 in order to improve their social inclusion and competitiveness.
- The *Compartel Program*: a social telecommunications program proposes to bring together the country's remote parts by improving their access to telephony and Internet (e.g. 1669 rural community centers for access to Internet in 2011).

- *Plan Vive Digital*: this plan proposes to bring about a great technological leap by extending Internet to the entire population and developing the national digital ecosystem through adoption and use of the technology²

Whilst these initiatives have the advantage of being government-run and supported, they lack effective actions to: (i) increase awareness of their existence; (ii) provide training for technical personnel and communities in the use of ICTs and (iii) to sustain the programs such as Compartel. These deficiencies are compounded by problems of energy supply, connectivity, and infrastructure. Together, these difficulties have reduced the impact of ICTs in rural Colombia (Felizzola Cruz 2010).

Project AESCE (Sharing experiences for Site specific Agriculture)

The DAPA and ASOHOFrucol project, financed by the Colombian National Fund for the Promotion of Horticultural and Fruit Production (FNFH, its Spanish acronym), was designed to assist growers in decision making through sharing of multiple types of information, including tacit knowledge, from multiple sources. The premise of the project based on the conceptual framework outlined above, was that farmers can make better decisions if they access information that is relevant to their particular circumstances.

ASOHOFrucol chose four crops (mango, citrus, plantain and avocado) to pilot the exchange of knowledge exchange between fruit growers in 12 departments of Colombia with an online platform. The project promoted three principles: (i) a culture of measurement based on the maxim that “what you don’t measure you cannot manage”; (ii) collective knowledge is more powerful than individual; and (iii) modern ICTs facilitate information exchange and dialogue. An essential feature of this framework is that farmers themselves must participate in the capture and transmission of data concerning both their farm and their production experiences. Furthermore, in order to take advantage of collective knowledge, the data from individual farms has to be standardized and compiled in databases so that it can be analyzed as an ensemble and the knowledge generated returned to the farmers for interpretation as an aid to decision making: this is only feasible using ICTs. The project established an online platform for capturing data directly online.

The process of sharing information is not static: it is not a question of simply obtaining the data, putting it into context and then using that information to make better decisions. Not all the inferences made will stand the test of time. However, if growers continually monitor their experiences and describe the environment under which they are obtained, they will be able to infer which of their innovations are advantageous and which are not. As they innovate and share their individual information with others, a “virtuous cycle”, or learning loop, will be set in place with farmers testing new ideas, and adopting those innovations that are beneficial.

Methodology

We used the Theory of Change (ToC) as a planning tool for research on knowledge management (see Staiger-Rivas et al. 2014) to make explicit and discuss the critical assumptions the project was making, especially about the desired changes in farmers' practices regarding the sharing, accessing and using information in the platform. The critical assumptions related to farmers' ability to share, access and use information effectively were identified as:

- *Farmers record data:* farmers understand the need and benefits of routinely recording details of their management practices and yield.
- *Farmers are willing to share experiences:* on identifying the benefits of sharing information, farmers will share their farm data with other farmers, researchers other agencies that support them.
- *All information generated and shared should be in a format comprehensible to farmers:* The information to be collected and shared with farmers should be in a standardized format readily understood and grasped. The standardized format is necessary to compare information from distinct sources.
- *Farmers can improve their decision-making if they have access to site-specific information:* information generated by the study can help fruit growers improve their decision-making and, as a result, help close production gaps.
- *The contents are of sustained interest to farmers:* The site-specific information produced provides farmers with resources and the facilitating ambience that enables them to make beneficial changes to their production systems.
- *Farmers can use ICTs to share information and access information online, using computers with access to Internet:* ICTs have reached the field through different governmental programs. Communities are trained and rely on centers near their residences.

These assumptions allowed us to design the central questions for our research, regarding farmers' ability to collect and share data:

- What are Colombian fruit growers' in this study current data management practices?
- What knowledge, attitudes, and skills do Colombian fruit growers need to collect and share data?
- What are the pre-requisites for farmers to effectively manage data and use ICTs?
- What conditions do farmers need to actively participate in an information sharing system?

The team appraised the state of ICTs in rural areas of Colombia through a literature review. The team then analyzed farmers' data collection, sharing, and decision-making in three settings: individual farmers, farmer groups meeting face to face, and virtual meeting with farmer groups. Farmer Field Schools and participatory workshops were used to elicit current practices in data management and attitudes towards information sharing through ICTs. Three cycles, each with a corresponding workshop, were designed to understand the attitudes, skills, and current practices of fruit growers and to define the necessary conditions for effective information sharing. Each

cycle focused on a decision-making situation/phase: (1) individual decision-making; (2) collective decision-making, with the community present; and (3) collective decision-making via virtual communication. From May 2012 to May 2013 we worked with 12 groups of plantain, mango, avocado, and citrus farmers associated with Farmers Field Schools FFSs.

ASOHORFUCOL had established a modified version of the FFS methodology to assist farmers in their decision making. The FFS methodology, developed by FAO, can be described as a toolbox for designing workshops to strengthen the capacities of farmer groups (Pontius et al. 2002). The methodology centers on the exchange of knowledge among farmers, with the help of a facilitator. Originally the methodology was applied to annual crops: ASOHOFUCOL modified the methodology to be suitable for perennial fruit crops and the idiosyncrasies of Colombia's farmers (Rivas Rincón and Aldana 2009). The "Colombian fruit growers"- farmers that participated in this study are part of these established FFS groups.

In phase 1, we used the FFS box test FFS (Rivas, Rincón and Aldana 2009) to obtain an online base for three themes (recording, access to information, and ICTs), using quantitative data, which was complemented by qualitative data from semi-structured interviews. Formats were designed with the farmers to obtain a minimum or common basic record of crop management. In addition and group discussions focused on the advantages of collecting these records. In phase 2, the capacity to discuss and make decisions with data-based information was explored: farmers had to make decisions, first with scarce information, and then with additional technical and economic information. The farmers also compared and analyzed records to discover which actions or decisions made by others could be beneficially copied or imitated.

In phase 3, farmers received pre-processed datasets and maps which had been prepared by CIAT scientists. These maps were socialized and discussed with the farmers as a mechanism to validate information collected from all over the country through the virtual platform. Two groups of farmers, each from a distinct geographic region but growing the same crop shared experiences via ICTs. They used three communication tools: videoconference with tablets, computer chats, and mobile telephone calls. They evaluated their own skills, their preferences for use, and the communication potential of each medium.

Results

Farmers' records

Only about one third of farmers routinely recorded data, but farmers' attitudes towards data recording were, on the whole, positive, with 92% seeing it as useful (Figure 1).

Farmers who answered that they never keep written records, or make notes, of farm information, cited as their reasons, in order: Don't know **what** to write; don't know why I should keep written records; I can't write; and I don't **need** written records. With the notable exception of the

plantain producers in Urabá, data is generally collected only when required for a specific purpose, which is often imposed externally: records are not kept to improve management. Data are commonly recorded in an exercise book at home on a weekly basis or on rest days. Fifty six percent of those interviewed, record data in an unplanned manner sometime after the work has been completed.

Those few farmers that did keep records did so for various reasons. Those that kept their own farm records to help them manage their crops mostly had previous experience with data collection. This prior exposure was usually through employment on large, more technologically intensive farms (e.g. flowers, livestock production, and banana) or non-agricultural sectors. Plantain producers bag fruit bunches to protect them from pests, and the standard practice is to harvest in the eleventh week after bagging. Producers thus record the date of bagging to program the harvesting date. Other examples are the plantain producers in Urabá who sell to buyers who then export their product. The buyers demand specific quantities at specific times and the only way that the producers can plan to meet these requirements, and also have in place traceability controls, is by routinely keeping records as a means for synchronizing their production and harvesting.

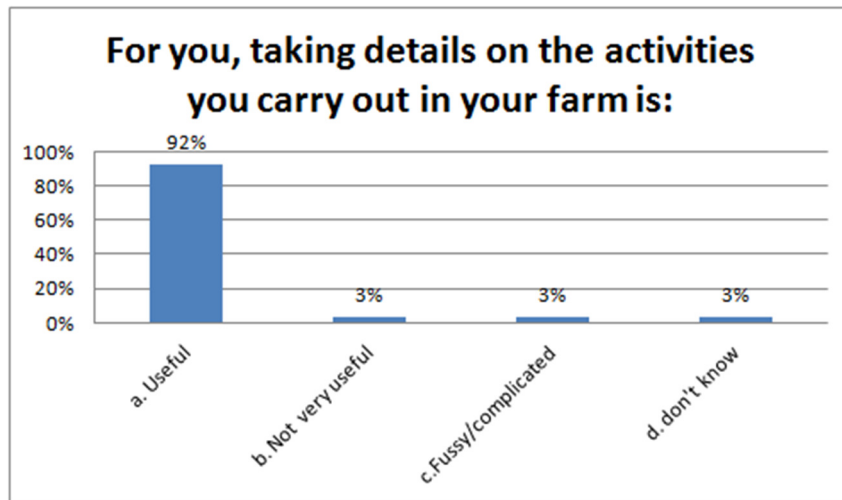


Figure 1. Taking notes on Farm Activities

Many farmers keep records for a specific ‘immediate’ and often external reason, rather than as a systematic practice to help them manage their farms. Thus sharecroppers in Huila, Santander, Meta and Cauca, often have to provide accounts of expenses to the farm owners, and consequently keep mainly financial records. Similarly, coffee and plantain growers often sell certified products: in order to be certified they have to keep records. Where there is a tradition of growing a crop in the area, as in the case of the local mango crop in Cauca and Magdalena, and

the local avocado crop in Santander, growers do not normally keep data and none maintain a detailed record of their activities.

The farmers were not capable of filling out the data-recording form we provided without assistance nor were they sufficiently proficient with ICTs to use the online platform. Five percent of farmers reported that they had improved their record keeping after the first workshop. Participants in the workshops indicated better understanding of the importance of record keeping and the advantages it brings to decision making. Table 1 below summarizes the knowledge, attitudes, skills, and practices of small farmers towards data collection.

Table 1. The knowledge, attitudes, skills, and practices of small- and medium-scale fruit growers towards data collection as a tool for improving decision-making at the individual level

Knowledge	Attitudes	Skills	Practices
Strong oral transmission culture Tacit on climate, soils, and management Concept of scientific theories but these are not applied	Positive towards data collection	Difficulties in completing a data collection form Difficulties to know <i>how</i> to use data records	Recording is absent or completed as needed on a weekly basis in an exercise book No use of agronomic data records

Farmers' willingness to share

Farmers share information either through organized meetings or informally: the majority of farmers (89%) liked to obtain information on their crops from workshops and by sharing experiences with other farmers and technical assistants (figure 2). This results may have been affected by the questions having been asked in an ASOHOFRUCOL workshop: farmers may have given a biased opinion in the presence of their own technician, particularly with respect to identifying the technician as a key source of information.

We noted that farmers not only shared information, but also when working in groups, complemented each other's skills and aptitudes. Thus when working in groups those farmers who could read and write helped those who lacked these skills to fill in forms and to understand written presentations. We note that in parallel studies with larger farmers the willingness to share experiences and use complementary skills was much less: the groups working in FFS do not compete with each other, but rather work together to improve their situation.

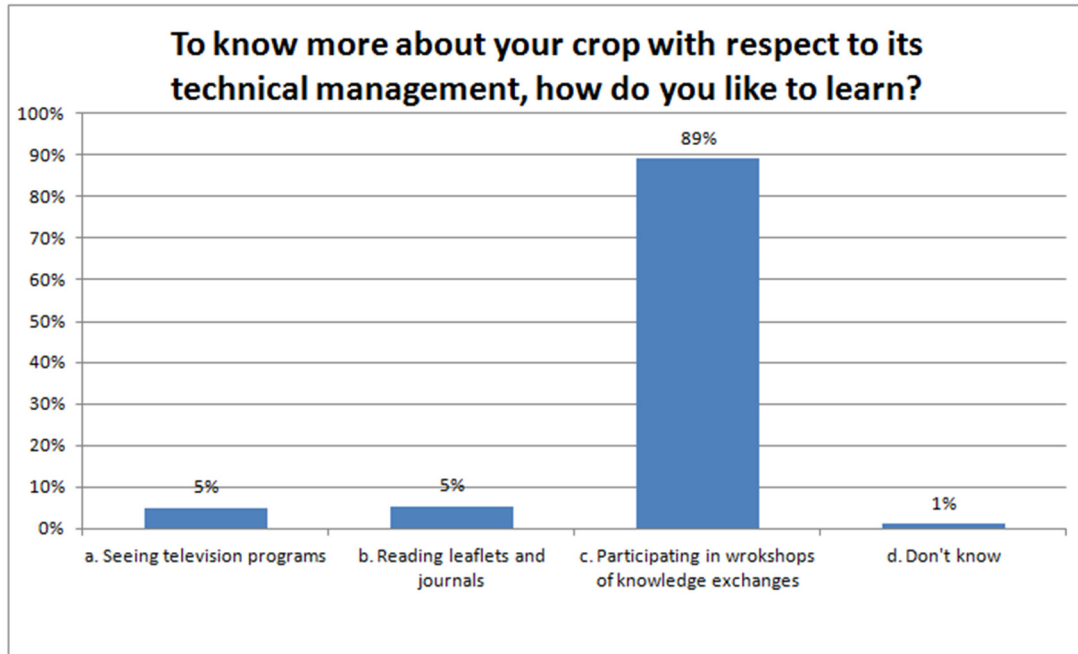


Figure 2. How do you like learning about the management of your crop?

Comprehensible format

Farmers understood theoretical concepts, such as pH, effective soil depth, and texture presented to them in the analytical reports produced by the study that described specific agro-ecological conditions. Sixty four percent of the producers know the average temperature behavior in their region and 61% of the observations agreed with the data gathered from nearby weather stations. On the contrary, for rainfall, only 37% of the producers had reference data and just 15% of them match the weather station data. In regard to soil variables like pH, 41% of the farmers provided pH data and 88% of these matched real data. However, the farmers were not able, initially, to use these concepts to make decisions about their own farming activities as they were not able to describe the agro-ecological or edapho-climatic conditions of their particular farm or plot. Instead of records, farmers use their tacit knowledge of climate, soils and crop management practices as the basis for their decisions. However, in rounds two and three the farmers compared their crop management practices in a group activity. The participants were provided with information on the weather and soil conditions (UCFs) of their farms to assist them in understanding the effects of management practices (CFs). All participants agreed that these tools facilitated comparison of management practices (CFs) and enabled them to understand and explain differences due to variation in weather and soils (UCFs). Table 2 below summarizes the knowledge, attitudes, skills, and practices of small farmers towards the exchange of knowledge.

Table 2. Knowledge, attitudes, skills, and practices of small- and medium-scale fruit growers towards the exchange of knowledge within the community

Knowledge	Attitude	Skill	Practice
Tacit	<ul style="list-style-type: none"> • Passive towards seeking explicit information • Relying on the technician • Preferring participation in workshops 	Understand and use explicit information for decision-making	<ul style="list-style-type: none"> • Follow fads • Share knowledge with other growers

Decision making and site specific information

Previous casual observations in Colombia had suggested that farmers tended to follow fads, often making decisions from a very restricted knowledge base. Our study seemed to confirm these observations. In an exercise, farmers were first presented with information supposedly from “the agricultural institutions” recommending that farmers plant macadamia. Sixty two percent of farmers indicated that they would plant the new crop with no other information than the initial conversation and observations of what their neighbors were doing (Figure 3). However, in the second round workshops, when presented with more detailed information on the environmental suitability, production costs and possible income of their farm with the new crop, only 18% said they would consider planting it. This indicates that farmers can use well-presented information put into the context of their particular site to assist them in making decisions.

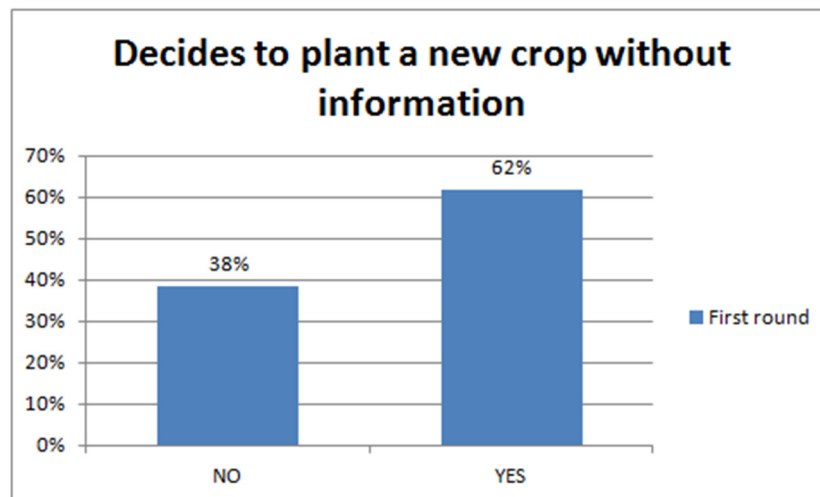


Figure 3. Making decisions about planting

Use of ICTs

Eighty three percent of the farmers in the study used mobile phones, largely restricted to making and receiving voice calls. The attitude to further use of ICTs is captured by the following comments of one farmer: “We have bought a computer for our daughters. But to be honest with you, I haven’t used it;” “My daughters and my wife know more than I (...)” “The youngsters, they are so surprising! Seeing them just 7-8 years old and navigating on those computers!” These comments reflect a generalized fear by the older farmers of using modern ICTs for anything more than telephone calls and a lack of the skills needed to handle them. In one of the FFS groups of approximately 24 people, only one participant was reasonably proficient with a computer. In the workshops we had to teach most of the participants how to use a mouse to move the cursor on the screen. The participants who had computers in their household corroborated the comments mentioned above, indicating that they had obtained a computer so that their children could study. We observed in the workshops that the women and children who attended were mostly more proficient with computers than the men. In spite of the lack of computer skills, the farmers, accustomed to oral and visual communication rather than reading and writing, found videos and tablet computers useful tools. Table 3 below summarizes the knowledge, attitudes, skills, and practices of small farmers towards ICTs.

Discussion

The farmers’ preferred means of obtaining information was in groups. They had a strong tradition of oral sharing of tacit knowledge which had not been formally registered. Tacit knowledge constitutes a form of contextual empirical knowledge that is generally used in an unconscious, intuitive way (Hoffmann et al. 2007). In contrast, explicit knowledge is based more on theoretical and scientific knowledge (Nonaka 1994) and is normally based on some form of written report or record. Eastwood et al. (2012) suggested that, when faced with explicit knowledge, farmers, understood certain theoretical concepts related to climate and soils but did not apply them when making decisions. Instead, farmers develop an empirical learning, using their tacit knowledge of climates, soils, and crop management to make decisions. Our work partially supports this view: farmers **do** rely on individual experience and a strong oral tradition and, in the absence of factual information, will follow fads. However, farmers understood the concepts of NCFs and CFs, and when they had access to information on NCFs and CFs, and how these could influence the productivity and profitability of novel crop enterprises or management practices, they were capable of gaining insights that would help them make better decisions.

Table 3. The knowledge, attitudes, skills, and practices of small- and medium-scale fruit growers towards ICTs.

Knowledge	Attitude	Skill	Practice
Mobile phones (calls and messages)	<ul style="list-style-type: none"> • Fear and lack of confidence towards the computer • Great interest in the tablet and videos 	More developed in young people and women	Limited (because of the lack of the right tools, skills, and attitudes)

Having established that the FFS farmers, some of whom were not able to read and write, were capable of using information to make better decisions, the question becomes how to obtain pertinent information and to make it available to farmers. In recognition of the importance of tacit knowledge and farmers' experiences and their preference for working in groups, we focused on the small producers' groups. We studied the aspects of receiving information from external sources, as well as providing and sharing information with others. In order to share data or experiences with ICTs, the data or information must be collected and put into a format that can be readily shared using ICTs and the growers must be willing to share their data. More importantly, the farmers must have the capacity to use that information to provide insights on how to better manage their crops and farms.

Sharing information: farmers groups and facilitators

Farmers, overall, were positive towards information sharing at all three levels, individual decision-making; collective decision-making, with the community present; and collective decision-making via virtual communication. Furthermore, we confirmed the importance of farmer participation in the design of new technologies for sharing information. The FFS provided an excellent forum for diagnosing the status of the community members' skills, attitudes, and practices, and also on obtaining their feedback on the study's results. The whole exercise clearly demonstrated farmers' willingness to provide and share information and their capacity to participate in the interpretation of the results.

Agricultural extension and technology transfer models are increasingly seeing the role of the agronomist or adviser as a facilitator who helps farmers make their own decisions rather than baldly telling them what they should do (Marsh and Pannell 2006, Ingram et al. 2010). Ingram et al. (2010) clearly indicate that agronomist–farmer encounters that are underpinned by trust, credibility, empathy, and consultation provide an effective context for knowledge exchange potentially facilitating farmers' adoption of good management practices. Group learning has become popular as it brings together farmers' tacit and explicit knowledge. It enhances the ability to assess relevance of innovations and new systems from inputs by both peers and experts (Millar and Curtiss 1997, Montaner, 2004). However, group learning based solely on farmers' knowledge is not sufficient: it does not replace good scientific research to provide new solutions

to problems (Marsh and Pannell, 2006). Co-development and collaboration between researchers, extension agents and farmers are key to learning about new technology and developing skills in its use, and hence its adoption (Douthwaite 2006). As pointed out by Chambers (1984) technology is often not adopted, as it was developed without taking into account farmers needs and their physical, social, and economic conditions. For technology to be successfully adopted farmers' views must be taken into account from the beginning.

All the small farmers in our study were associated with the FFS, which have a facilitator. Hence, it was no surprise that they saw the facilitator as the most important source of information. At the same time, farmers expressed a strong preference for group learning in which they shared experiences with other producers and technologists (figure 2). The groups took advantage of synergies and complementary skills: this was dramatically illustrated when literate farmers helped those who could neither read nor write, while at the same time accepting and discussing their opinions and observations on crop management. Our experience suggests that the facilitators require not only technical knowledge but also social and organizations skills, which is in accordance with the findings of Ingram et al. (2010) and Marsh and Pannell (2006). Small farmers in the FFS recognized the need for intermediaries or facilitators (whether one of the farmers themselves or professional in technical assistance) in the field who can take up the role of spokesperson or bridge between researchers and farmers. Such intermediaries provide cohesion and communication between farmers, researchers and experts, as well as follow up and support for decision-making and implementation of novel technologies or practices. Furthermore, we suggest that group learning solely within small groups *does* draw on the knowledge and experience of many local farmers, but misses the opportunity of sharing information between a larger numbers of farmers. As farmers move from individual decision making, to community based collective decision making and finally to using virtual communication, their access to information widens and they become better informed and consequently capable of making better decisions

Active generation of spaces for farmers to discuss and exchange ideas is important as farmers rarely meet together on their own initiative (Nagel 2012). The FFSs opened up spaces for sharing experiences thus improving farmers' capacities to solve problems and make decisions. The facilitator has a supporting role in the construction of collective knowledge through a democratic and egalitarian relationship with the farmer group. The facilitator promotes self-learning through the participatory dynamics in the field on technical, environmental, social, and economic themes, taking as a starting point the participants' skills, knowledge, and real life new skills and aptitudes are developed (Rivas Rincón and Aldana 2009). Strengthening this approach with farmers and facilitators using ICTs constitutes a promising, novel technology transfer model that builds on the FFS concept.

Use of ICTs

ICTs have the potential to increase information flows and empower poor people if properly deployed (Marker et. al. 2002). In earlier experiences in the Colombian sugar industry modern

information technology was used to share information and experiences from thousands of individual production plots (Cock et al, 2011). The basic data was collected by the mills and managed by the industry's research arm. Both the mills and the research center possessed excellent ICT capacity. However, in the case of fruits there were no mills to collect the information, and no research arm to manage it. At the start of the program little was known about the farmers' capacity as individuals or as group members to access internet or other modern communications technologies. This project was specifically designed to explore on a pilot scale how institutional support could be strengthened and hence to, at least partially, make up for the lack of strong institutional support.

The FFS groups found that the internet systems crashed frequently in rural areas. In a parallel study several farmers with larger businesses maintained urban offices to ensure reliable access. However, government agencies and policies provide support and private companies are improving access to the internet and coverage via mobile phone networks and satellites with high velocity access to internet increasing rapidly (see for example El Espectador, 2014). We envisage continual improvements in the coverage and access to internet in the rural areas making it possible to increase the information flow and sharing of information.

Access to internet or other ICT systems is not, however, sufficient: farmers must be capable of using these services effectively. Chaparro and Cock (2015) note that the quality of education in rural Colombia is not commensurate with development of a competitive agriculture. Indeed, first results of the National Agricultural Census shows that 11.5% of people older than 15 years old are illiterate (El Tiempo, 2015). Our study indicates that problems of literacy and the general level of education limit the ability of farmers to use ICTs effectively to share information. Whilst the education level is a concern, our observations suggest that the younger generation and women provide a certain level of competency in handling ICTs. Women and children may play a key role as the presence of a computer, which may or may not have access to Internet, is often explained by the presence of children in the home (Nagel 2012). In the Compartel community telecenters in Colombia, 61% of users were less than 24 years old (CEDE, 2007). Nevertheless, none of the farmers used ICTs for keeping farm records, and only 5% used them for obtaining information. For the facilitation/empowerment model of extension to be successful, information access is critical and the abilities of individuals, organizations and communities to handle information needs to be improved (Coutts and Roberts, 2003). We suggest that in Colombia not only improvement of physical access to information through ICTs is required, but also active building of the human capital required to effectively enter into dialogue via ICTs. Obstacles to knowledge creation and sharing were related to poor access to ICT infrastructure in some rural areas, inconsistency or lack of experience with data collection and management practices, and a shortage of skills in using ICTs. These obstacles reflect the dismal education in the rural areas and the general lack of attention given to the rural areas in Colombia by government (Ocampo, 2014). We propose that the FFS programs should include use of ICTs for information sharing in their curriculum.

Recording data

None of the farmers from the FFS maintained farm records on a regular basis that could be used to support crop management decisions effectively. There simply is not a culture of “measuring to manage”. If farmers kept records at all, these were mainly for accounting purposes. Initially the farmers did not understand either how to keep farm records or their utility. However, after one workshop explaining the advantages, 5% of the farmers improved their record keeping. Adoption by a small number of early adopters is common (Rogers 1983) suggesting that with time more of the farmers would adopt record keeping practices. The growers were generally more comfortable with keeping records on paper than with ICTs. The high average age and lack of formal education, explains both the fear and lack of confidence farmers have towards ICTs, and their lack of skill in using them. Consequently, farmers recording data directly in a digital form for electronic transfer to the centralized database is not a viable option at this time. Initiation of regular data keeping should probably be supported by paper and ink tools designed to make record keeping easy for growers who are ill at ease with ICTs.

We suggest that attractive, easy to use aids to record keeping designed with the participation of farmers would be a logical first step in promoting record keeping by small farmers. The testing of the aids and training in their use could be channeled through the FFS or similar groups. As growers gain confidence with record keeping on a routine basis and they become more familiar with ICTs, it should be possible to move from paper and ink to ICTs for record keeping. Other experiences suggest the same: Corporación Biotec with the participation of farmers designed and tested attractive calendars with information on the Andean blackberry (*Rubus glaucus*) and lulo (*Solanum quitoense*) (Sánchez et al., 2006). Farmers used these calendars as a means of keeping farm records until the project ceased due to lack of funds. Similarly in this project and others farmers have used the field guide for Rapid Soil and Terrain (RASTA, Cock et al., 2010) to record data on soil characteristics. More than 4,000 farmers have used this simple guide to characterize their soils.

Ability to use technical information

When presented with maps, climate information and the information derived from their own RASTA data, farmers were capable of understanding and using the information to provide insights that assisted them in decision making. This capacity was clearly demonstrated by the farmers’ attitude to the supposedly “in vogue crop”, macadamia, when presented with technical data. The farmers with the assistance of the facilitators were able to grasp and understand technical concepts so as to change their point of view (figure 3).

In the first round of the workshops farmers had difficulty relating particular management practices (CFs) to the NCFs on their farms as their tacit knowledge on their farm conditions could not be compared with the experiences of others or with results obtained by formal research agencies. However, when presented with information on the NCFs that characterized their farm or lots they were able to interpret this information. The lack of records on the CFs obstructed

interpretation of which management practices were most suitable for particular environmental conditions or NCFs.

Conclusions

In conclusion, farmers like working in groups and take advantage of synergies and complementary skills. Farmers, overall, were positive towards information sharing within both their own immediate circles and on a broader scale. However, shortage of skills in using ICTs and the lack of farm records is a limiting factor to sharing on a broader scale.

The farmers' knowledge on keeping records and using them as a management tool was minimal. Farmers do not regularly keep farm records and have no means to share information other than through oral, anecdotal transmission. There is no culture of precise measurement as a management tool. However, farmers rapidly grasp the advantages of regular record keeping and the advantages of sharing information, including that obtained from a wider circle than the FFS environment. They also rapidly grasp and understand technical information presented in a simplified format when accompanied by facilitators.

There is a role for education of farmers in fostering a culture of measurement. Training in ICTs and infrastructure development in rural areas constitute key elements for farmers to share information and use it to better manage their farms. Farmers will keep records if they have simple, attractive tools which they have helped design. Currently these tools should be filled in by hand, rather than through digital media. The study confirmed that successful implementation means that target users must be involved from the outset in the use of technologies generally and specifically in the case of online knowledge-sharing platforms that support decision-making. In developing a new technology involving data collection and use of ICTs, researchers need to adjust their methods and tools to the context and knowledge, attitudes, skills, and practices of their various immediate users. Researchers also need to generate spaces for feedback from and interaction with their users.

Farmers currently have poor access to internet and are not comfortable using ICTs, however, the younger generations and the women on the farms are more adept at using ICTs. To facilitate farmers' adoption of technologies that include access to ICTs, their families, especially those with youths and children, should be included. Virtual technologies may constitute tools that will help empower farmers. However, to achieve this objective, an in-depth understanding of both the users' needs and their ambience as a pre-established condition (facilitating ambience) is required.

References

Chambers, R. (1984) 'Agricultural research for resource-poor farmers: the farmer-first- and-last model', *Agricultural Administration* 20, 1-30: Brighton.

- Chaparro, F. and Cock, J.H. (2015) Estrategias para fomentar la innovación en el sector agropecuario como locomotora del desarrollo rural and Colombia. In: Misión de Ciencia, Educación y Desarrollo - Balance 20 años después. ACAC (Asociación Colombiana para el Avance de la Ciencia). 121-131.
- Cock, James H., Alvarez, Diana M. y Estrada, Marcela. 2010. RASTA: Rapid Soil and Terrain Assessment – Guía práctica para la caracterización del suelo y del terreno. Versión 2. Centro Internacional de Agricultura Tropical, Corporación Biotec, y La Universidad Nacional de Colombia.
- Cock, J., Oberthür, T., Isaacs, C., Läderach, P., Palma, P., Carbonell, J.A., Watts, G., Amaya, A., Collet, L., Lema, G., Anderson, E. (2011) Crop management based on field observations: Case studies in sugarcane and coffee. *Agricultural Systems* 104(9):755-769.
- Coutts J and Roberts K 'Models and Best Practice in Extension' presented at the 2003 APEN National Forum, 26 - 28 November 2003, Hobart. Web site www.regional.org.au/au/apen
- Douthwaite, B. (2006) 'Enabling innovation: technology and system level approaches that capitalize on complexity', *Innovations* 1(4), 127-159: London.
- Eastwood, C.R., D.F. Chapman, and M.S. Paine (2012) 'Networks of practice for co-construction of agricultural decision support systems: case studies of precision dairy farms in Australia', *Agricultural Systems* 108
- El Espectador (2014) La tecnología llega por primera vez al país: El campo de conecta con internet satelital. *El Espectador (Colombia) TECNOLOGIA*, 26 July 2014.
- El Tiempo (2015) El censo del agro confirma fuerte atraso del campo colombiano: El Dane presentó resultados del estudio. Los campesinos no tienen asistencia técnica ni créditos. *El Tiempo (Colombia)*, 12 August 2015.
- Felizzola Cruz, Y.M. (2010) 'Tecnologías de información y comunicación para el desarrollo rural en Colombia', *Economía, Gestión y Desarrollo* 10, 97-124: Cali.
- Hoffmann, V., K. Probst 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: Windhoek.
- Ingram, J., Fry, P., Mathieu, A. (2010) Revealing different forms of knowledge held by agricultural scientists and farmers in the context of soil protection and management. *Land Use Policy* 27: 51–60.
- Lasagna, M., A. Hermosilla, and J. Martínez (2011) De las comunidades virtuales al proyecto "Yo Agricultor", IDB: Washington DC.

- Marsh, S.P., Pannell, D.J. (2006) Agricultural extension policy in Australia: the good, the bad and the misguided. *Australian Journal of Agricultural and Resource Economics* 44(4):605-627.
- Marker, Phil, McNamara, Kerry and Wallace, Lindsay (2002). The significance of information and communication technologies for reducing poverty. DIFID, London, UK.
- Millar, J., Curtis, A., (1997) Moving farmer knowledge beyond the farm gate_case study on farmer knowledge in group learning. *European Journal of Agricultural Education and Extension*. 4(2):133-142.
- Montaner, J. 2004 Successful integration of research and extension combining private and public organizations: lessons from Argentina. 4th International Crop Science Congress September 2004 Brisbane, Australia.
[http://www.cropscience.org.au/icsc2004/symposia/4/6/2083_montaner.htm](http://www.cropsscience.org.au/icsc2004/symposia/4/6/2083_montaner.htm)
- Mulla, D.J. 2013 Twenty five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. *Biosystems Engineering* 114 (4):358-371
- Nagel, J. (2012) Principales barreras para la adopción de las TIC en la agricultura y en las áreas rurales, ECLAC: Santiago
- Nonaka, I. (1994) 'A dynamic theory of organizational knowledge creation', *Organization Science* 5(1), 14-37: Tokyo.
- Ocampo, José Antonio (2014) Misión para la transformación del campo: saldar la deuda histórica con el campo. Marco conceptual de la misión para la transformación del campo. Departamento Nacional de Planeación (DNP), Bogota.
- Olaniyi, O.A., S.I. Adetumbi, and M.A. Adereti (2013) 'Accessibility and relevance of information and communication technologies (ICTs) among cassava farmers in Nigeria', *African Journal of Agricultural Research* 8(35), 4514-4522: Ogbomosho.
- OSILAC (Observatorio para la Sociedad de la Información en América Latina y el Caribe) (2010) 'Compendio de prácticas sobre implementación de preguntas de TIC en encuestas de hogares y en encuestas de empresas en América Latina y el Caribe: revisión 2010' ECLAC,
repositorio.cepal.org/bitstream/handle/11362/3782/lcw340_es.pdf?sequence=1
- Pontius, J., R. Dilts and A. Bartlett (2002) Ten years of IPM training in Asia—from farmer field school to community IPM, FAO: Rome.
- Rivas Rincón, M. and M. Aldana (2009) Guía para la implementación del modelo metodológico ECA, USAID: Washington DC.
- Rogers, E.M. (1983) *Diffusion of innovations* (3rd ed.), Free Press: New York.

- Sánchez, J.D., Álvarez D.M., Cock J.H., Llanos G., Marín, N., Muñoz, L.A., Rojas A.,
Sánchez M., Guía para el registro de información en frutales., ISSN: 1909 – 5368,
2006 vol: 1, Fasc: 2 Págs: 1- 32: Cali
- Seyed, R. and M. Seyed (2012) ‘Role of information and communication technologies in
modern agriculture’, *International Journal of Agriculture and Crop Sciences* 4(23),
1725-1728: Hamedan.
- Staiger-Rivas, S., S. Alvarez, J.A. Arana, F. Howland, F. Cunha, B. Valencia, L.A. Muñoz,
and K. Feijóo (2014) ‘Diseño de intervenciones de gestión de conocimiento en la
investigación agrícola para el desarrollo: metodología, experiencias y lecciones
aprendidas’, *Knowledge Management for Development Journal* 10(1), 35-50: Cali.
- Stienen, J. (2006) Las TIC para el desarrollo agrícola: impacto y lecciones aprendidas de
programas apoyado por el IICD, IICD: The Hague.

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Howland, F., L.A. Muñoz, S. Staiger-Rivas, J. Cock, and S. Alvarez. 2015.
Data sharing and use of ICTs in agriculture: working with small farmer groups in Colombia.
Knowledge Management for Development Journal 11(2): 44-63
<http://journal.km4dev.org/>

Endnotes

¹ ICTs are understood to be “technologies that arise from advances based on informatics, Internet, telecommunications and audiovisual technologies” (J. Nagel 2012 pp 6). In this study, we focus on the use of the computer or tablet and Internet.

² <http://www.minicts.gov.co/portal/vivedigital>