II.D Communication Approaches in Applied Agrometeorology

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II.D.1 Introduction

Farm-level management decisions are mostly determined by the knowledge of the interactions between the environment, the characteristics of crops and animals, technology, socio-economic factors and the institutional context (including agricultural education, government rules, customs, etc.). Among these factors, weather remains the largest source of variability of farm outputs, directly and indirectly. It can be estimated that 20–80% of the inter-annual variability of yields stems from the variability of weather (depending on the level of development), while losses due to pests, diseases and weeds are normally around 15% (Oerke et al. 1994). Post-harvest losses are also of the same order of magnitude.

Next to "background weather variability", extreme agrometeorological events are factors that can provoke massive destruction of infrastructure, crops, livestock, fishing gear, etc. and the loss of human life (Gommes 1999, 2003). The current interest in climate change has increased public awareness of the need to reduce impacts of climate variability (in the short run) and climate change (in the long run), at a time where new sources of data and modern communications make available the tools to improve "agrometeorological communication" (Jarvis et al. 2002).

II.D.2 What Is Communication?

Communication implies a two-way process with exchange of ideas, information and knowledge. There are several components of communication such as the generation of information, its dissemination (in the sense of a one way information flow) from producer to user, information management and information sharing (in the sense of double or multiple ways of information flow), as well as knowledge generation (two way communication flow required) and knowledge management. It is stressed that communication, including agrometeorological communication, does not necessarily

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flow from one level to another, and that it takes place also inside a community, for instance among farmers or inside the agronomic research community (e.g. Stigter et al. 2007; Roncoli et al. 2009). See also Chap. IV.5. Finally, the flow of information, like heat, electricity or money, is driven by gradients. This is to say that it can be driven by supply, demand or, ideally, by both. This also means that communication at the same "level" may be more difficult than between levels, but significant innovations with a decisive advantage can eventually spread fast "by contagion" from neighbour to neighbour. Needless to say, it can be the role of communication to facilitate the contagion of innovations and to bridge technical disciplines and other soft and hard barriers.

"Communication" can also be described according to the technical means used to communicate something. For instance, conflict management communication uses specific methods and media. In this case, video has been used successfully to allow each party to explain their interests and then allow the other side to view the recording; it is a form of structured listening. Another way for classifying communication is according to the themes or areas for its applications such as environmental communication, health communication, and agrometeorological communication. The present chapter focuses on communication with and between farmers, which themselves constitute a major channel of transmission of agrometeorological information (e.g. Stigter et al. 2007; Gakuru et al. 2008; Roncoli et al. 2009). See again also Chap. IV.5.

According to Blench and Marriage (1998) (see also Mukhala 2000), studies of the impact of climate forecasts in southern Africa suggest that there is a considerable gap between information needed by farmers and that provided by Meteorological Services. There are communication barriers since the two parties have been interacting for a long time, but apparently have not been communicating effectively. Farmers know what they want (demand) and the Meteorological Services believe they know what they need to provide to farmers (offer). The communication has failed because there are no, or few shared meanings. The effectiveness of meteorological communication is determined, amongst other things, by the extent to which all persons involved in the communication transaction are competent in communicating and interpreting meteorological messages. A failure of communication means that there may be 'noise' in the communication transaction. The concept of noise refers to any factors which disturb the communication and interpretation of messages, e.g. messages being viewed as targeted for wealthy farmers and hence the emerging farmers do not pay attention.

II.D.3 Communication Targets, Messages and Meta-Messages

II.D.3.a Different Categories of Audiences

Agrometeorological communication can address several targets or "audiences", keeping in mind that, due to the bi-directional nature of communication, the concept of target is not always meaningful, nor is the target always the end-user of the message being communicated. A good example is the financial mechanisms that have been developed in the ambit of the Multilateral Environmental Agreements (MEA) such as the UN Framework Convention on Climate Change (UNFCCC). The primary message (meta-message: "remove carbon from the atmosphere") is relevant to governments as, for instance, a government may earn credits for carbon sequestration in biomass (see also Box III.4.11 in Sect. III.4.2.(ii) and Sect. III.4.5.(ε)), or, hopefully, in the post-Kyoto regime, soil carbon storage as well.

Soil carbon storage has a number of immediate benefits for smallholders, including increased soil fertility, and higher soil water holding capacity, which both result in improved food security through less variable production. If the primary message has to be implemented at the national level, it must first be converted into agricultural policies that provide incentives to reduce forest degradation or favour soil carbon sequestration (e.g. conservation agriculture). The advantages of the local measures at the individual level have then to be explained by efficient extension services: the message to smallholders is not "store soil carbon" but "achieve more abundant, more regular and more sustainable food production".

The audiences of agrometeorological communication can arbitrarily be subdivided into the categories listed below. To some extent, they are all "decision makers", even if some are active in marketing, others in politics and, others still in farming:

1. Producers, people who are engaged in the actual production of crops, livestock, forestry and inland fisheries products. This includes actually a very large array of people, including subsistence farmers and industrial farmers, mushroom growers, bee keepers and those who collect wild honey, traditional Asian shrimp growers in brackish water, women growing vegetables in cities for sale at the local market, the owners of large industrial fishing boats on lakes, etc. The least sophisticated customers, from a technological point of view, are also those more difficult to reach, particularly for real-time applications: poor farmers not having access to "modern" channels of communication, or modern types of information, such as seasonal forecasts (Meza et al. 2008). See also Chaps. IV.2 and IV.5.
2. Extension (see also Chap. IV.5), often called "outreach", includes the people and the techniques responsible to ensuring the circulation and efficient use of the messages. According to IAC (2004) three models of agricultural extension have dominated extension debates in Africa since independence. First the quantitative model, which was introduced in the 1960s by experts who assumed that new technology could be transferred by massively expanding agricultural extension services. The systems collapsed mainly because of high costs. The second model – the Training and Visit (T&V) extension model – put a lot of emphasis on improving the management of national extension systems, but turned out to be expensive and ineffective. A third extension privatization model is being tested based on the positive experience of private extension and many village and church groups in Africa who set up their own extension networks after the collapse of T&V programs.

3. Experts (see also Chap. IV.4) are not a "usual" category. At the more traditional/subsistence end of the spectrum, producers, decision makers and "experts" actually overlap. At the more technical end, there is a specialised category of people who design farm buildings and stables and air conditioned tractors, scientists who develop crop yield-weather models, those who breed new varieties of broilers, biotechnologists, crop insurance experts, those responsible for warning and advisory services, specialists writing up agricultural policies, etc.
4. "Commercial" categories involved in marketing and trade, the manufacturing and trade of farm tools and inputs (fertiliser, pesticides, machinery, infrastructure), manufacturers of livestock and poultry vaccines. See also Chap. IV.3.
5. Policy decision makers at international, national, regional, local levels ((inter)national institutions, ministries, administrations, municipalities). See also Chap. IV.2.

Diverse communication tools are needed for these different categories: producers need very concrete recommendations for planting, crop and natural resources management, harvesting; extension people need guidelines, tools; decision makers need short documents with highlights and precise recommendations for action; technical experts need analytical documents on data and methodologies.

II.D.3.b Differences Between Audiences

To communicate effectively taking into account the various audiences listed above, agrometeorologists need to recognize the characteristics and needs of the target audience. This helps them to encode information in ways that will be easy for farmers or other users to decode. Agrometeorological Services, who are often the original source of agrometeorological advice should ask questions like: What are the characteristics of the target audience? What type of farming systems do they operate? Which information do they need? What are their levels of education or literacy? What language would they be comfortable using? What is their socio-economic status? What is their gender? What media or channel can be appropriate to transmit information? Unless such questions are taken into account, communication (sharing of meaning) may not take place.

Language is a basic tool of communication through which simple or complex ideas are conveyed. An effective communicator should be sensitive to the nature of his or her language (Whitman and Boase 1983). When writing for the public, Yopp and McAdams (1999) stress that technical terms or jargon should be avoided as much as possible. The use of technical terms creates a perception that the information is for "insiders" only, those who are familiar with the jargon. "Outsiders" or non-experts who could benefit from the information can be estranged both from the source and the message. If jargon is used for farmers with low education levels, technical terms may create a feeling that the information is reserved for elite farmers. As a result, poorly educated farmers may feel excluded or perceive the information as exclusive.

Providers of meteorological information, including agrometeorological information, should understand that words do not have the same meaning to all people. To assume that they do, is to ignore a fundamental principle of language – Words do not have meaning, only people do. Meteorological Services (NMHSs) or meteorologists know what they want to convey in a seasonal climate forecast, but farmers may perceive the information differently. A failure in communication can occur even when using everyday language. If misunderstanding can take place so easily in everyday language, imagine the problem with scientific or technical language. Information only has value when it is disseminated in such a way that the end-users get the maximum benefit in applying its contents (Weiss et al. 2000). This statement is even more valid for agrometeorological information.

The inventory elaborated by FARA-Africa (Gakuru et al. 2008) shows that the provision of weather forecasts on a daily basis is just information. Generic data are made available by a provider and are sent to the rural community through various media such as radio, television, newspaper, rural telecentres, and mobile phone alerts. However, the rural community does not get involved in the generation, validation, evaluation, understanding and appreciation of this information. This "take it or leave it approach" puts the rural community as a passive observer. The horizontal transfer of knowledge should be a more integrated learning process, where learning by doing, learning through participatory research, evaluation and knowledge management, CD and internet based learning, face-to-face interactions, etc. are the basis of the capacity building process (Roncoli et al. 2009).

A study, prepared by the Stockholm Environment Institute and commissioned by the Rockefeller Foundation, wanted to identify and understand the extent to which, and ways in which, information from climate change models is being integrated into agricultural development practice and decision making in Africa (Ziervogel et al. 2008). One of the recommendations refers to the need of "translators" who understand the challenges on meteorological information providers and farmers and can act as information channelling (Throughout this book these "translators" have been called "intermediaries", as defined and exemplified in Part I and also dealt with in Chap. IV.5). The challenge with this task is that it requires skills that many of the people currently engaged in climate change adaptation simply have not developed. Specifically it requires the ability to translate science concepts into those that users understand and can use, without distorting the concepts. It also requires in-depth understanding of users' needs and the potential opportunities for using climate change projection data (See again also Chap. IV.5.)

II.D.4 Communication and Agrometeorology

II.D.4.a Sectors Affected by Weather

We take agrometeorology in the broadest sense, i.e. the "science" of the interactions between weather and climate and agriculture, where agriculture too is taken in the broadest sense, i.e. fisheries, forestry, crops and animals from production or collection to consumption, i.e. including the items in Fig. II.1. All the steps illustrated in Fig. II.1 are weather-dependent and, therefore, are likely to benefit from agrometeorological knowledge (science) and advice. The figure covers both quantitative and qualitative aspects. In the area of food, we could mention food production (amounts), food security (amounts and regularity of supply over time) and food safety (quality of products, including contamination by toxic chemicals, germs and, in general, nutritional balance and quality of nutrients). Advice and the corresponding agrometeorological communication issues could be treated systematically according to the product (commodity), step in the food chain, data requirements and other criteria.

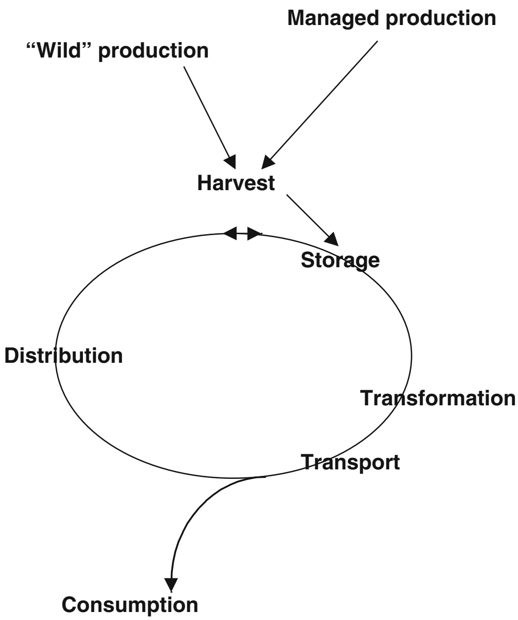

Fig. II.1 Agrometeorology deals with all the weather-sensitive components of the food chain, from production to consumption of all agricultural products, specifically including animals and plants (after Gommes 1998a)

It is interesting to observe that the "communication" of information and knowledge can be described very much along the same lines as the Fig. II.1, as the messages have to be produced and collected, stored and eventually used. With the development of the climate change "problematique", the analogies are reinforced by the fact that farming is not only a victim of climate change, but also one of its causes!

It has been the ambition of most farmers in the world to limit the impact of weather and climate on their production. This was achieved from the early civilisations through irrigation and flood recession cropping. In many developed countries, we witness a tendency to use technology to reduce dependence on weather, as in greenhouses or air-conditioning of buildings and tractors. To a large extent, the fact that many farmers in developed countries practise preventive control of pests and diseases by systematically resorting to pesticides and other inputs is also a way to abstract, as much as possible, farming from weather. Preventive phytosanitary treatments allow the producers to decide the time of their interventions, which otherwise would be determined by environmental conditions conducive to the development of pests and diseases. Warning systems, one of the best established forms of agrometeorological communication, have the potential to reduce the cost of farming, but they also entail some risks making farmers' planning more difficult (Rijks and Baradas 2000).

As a result, less environment friendly farming in combination with little reliance on farm advice is often regarded as less risky: even when farmers have been using weather forecasts directly for a number of years to plan their operations. Models, however, have not really entered the farm in spite of their potential. The main causes seem to be a mixture of lack of confidence and lack of data (Rijks 1997). Most of the times, lack of confidence is caused by the lack of data. This is the reason why very simple approaches like "response farming" (see Sect. II.D.9.b below) do have a great potential but in reality are not frequently applied. For examples see earlier in Part II of this book. The same reasoning can apply to crop insurance: great potential but lack of confidence due to the lack of data.

II.D.4.b Different Perceptions of Weather

In some cases, the perception of the same weather event is different for the expert and for the farmer. In Jamaica, for example, the mid summer dry-spell (MSD) is the most critical climate obstacle towards crop productivity for local farmers (Allen et al. 2008). The MSD is related to both local and remote factors that contribute to unfavourable precipitation patterns by limiting tropical convection. The MSD is evident in both farmer perception through extensive surveys and through a remotely sensed lagged vegetation response. However, the favourable 29-year climate trend contradicts negative farmer perception. This difference between perception and trend can play a significant role towards climate related policy by elaborating a long term (2–3 month) forecast suited for farming needs resulting from direct farmer input.

In other cases farmers' perceptions of climatic variability are in line with climatic data records (Gbetibouo 2009) as farmers in the Limpopo River Basin of South Africa have appreciation for temperature's increase and the related reduction of rainfall. Farmers with access to extension services are likely to perceive changes in the climate because extension services provide information about climate and weather. Having access to water for irrigation increases the resilience of farmers to climate variability; therefore, they do not need to pay as much attention to changes in the patterns of rainfall and temperature.

With more experience, farmers are more likely to perceive change in temperature. Although farmers are well aware of climatic changes, few seem to take steps to adjust their farming activities. In this case study, only approximately 30% of farmers have adjusted their farming practices in order to take into account the impacts of climate change. The main adaptation strategies of farmers in the Limpopo River Basin are switching crops, changing crop varieties, changing planting dates, increasing irrigation, building water harvesting schemes, changing the amount of land under cultivation, and buying livestock feed supplements.

II.D.5 "Client Centred" Communication

Communication does not serve to disseminate the "instructions" of the research or extension worker, but to channel adequately focused information to help farmers to master field management skills and also to feedback farmers constraints and findings in order to sustain a permanent dialogue with all partners. The practical methods or channels that can be used for the actual dissemination of agrometeorological information depend on the client to be reached and the sender as well as the format of the message or information. The communication channels can be broadly divided into three groups, namely mass and electronic media, group methods, and individual contacts. In general, the use of more than one channel gives a greater chance of reaching the client or user. The individual contacts can be time consuming but also build good rapport and help maintain credibility between the role-players.

In identifying the clients, it is often useful to focus on a specific homogeneous target group likely to have sufficiently similar needs and, therefore, can also benefit from similar information and specific communication approaches (Rijks and Baradas 2000; Stigter et al. 2007). This target group may not be existing groups, as such, but more a category of clients or farmers who would be able to identify similar weather dependent decisions. Therefore, the same sort of uniform recommendations, advisories, or information can be formulated to address these critical decisions and provide the desired weather and climate information using the same format and language, etc. The group methods include the use of already existing farmer groups, such as alumni of climate field schools (Winarto et al. 2008), or other interest groups such as co-operatives, growers association, seed producers network, etc.

The client centred communication also provides face-to-face contact with people who are the clients and enables the agrometeorologists to obtain more specific feedback from groups of users concerning the information provided. This is a way of making better use of scarce human resources, and groups can meet on a regular basis. Group meetings can be informal or formal, a discussion, or formal farmers' days of information meetings. There are advantages for both the farmers and for the extension staff. The groups allow farmers to be exposed to other farmers' successes as well as to realize that they may encounter similar problems or obstacles.

The client centred approach encourages the groups or networks to preserve and to consider alternatives that may have been used by others within the clientele group.

It also helps to share experiences and opinions and identify gaps in the knowledge or information flow (Joyce 2003). Groups can also commit together to take certain action and then support each other throughout the process (Bembridge 1991). The groups can be used in follow-up to both mass media and individual contacts. The use of mass media for communication of agrometeorological information has the advantage of reaching many more people with each action (e.g. Stigter et al. 2007).

Participatory methods are required to meet farmer needs in less productive and highly variable environments (Witcombe 1999; Roncoli et al. 2009) helping to make better informed farm decisions (Hartmann et al. 2002) through targeted communication. The Farmer Field School (FFS) approach is a direct response to support improved access to learning about integrated farm management of the farming communities. As a result of a Participatory Assessment and Planning (PAP) exercise, the farming communities indicate their priorities for technical information particularly in relation to agrometeorological management, improving the efficiency of planting, fertiliser use, increasing output and controlling costs.

The FFS approach underlines the following key concepts and principles (Hellin and Higman 2001; Ortiz et al. 2004; Tripp et al. 2005; Mancini and Jiggins 2008):

- Farmers are experts: farmers learn by carrying out for themselves the field studies/comparisons related to the particular farming practice, they are interested in "learning by doing";
- Field based education: real live examples in the field (farmer domain) is the primary learning material. Farmers interact in small sub-groups (10–15 farmers) to collect and analyse data and perform action. Farmer driven research should be responsive to field needs as part of the research network and supporting educational programs;
- Decisions based on farmer analyses and shared with others in the group for further discussion, questioning, and refinement;
- Extension workers are facilitators, not teachers: extension workers only offer guidance to farmer projects (mainly principles but no packages nor atomised messages);
- Problem posing/problem solving: problems/challenges confronted in the field along the season are tackled in real-time using numerous analytical methods within farmer groups;
- Holistic approach integrating all technical, ecological, socio-economic and educative aspects;
- Group dynamics within farmer teams for skill building in communication, problem solving, leadership towards higher quality of farmers, farm management skills.

II.D.6 Contents of Agrometeorological Messages

The substance of the agrometeorological message is twofold: (1) to help farmers avoid the negative effects associated with climate variability and (2) assist them in making optimal use of available resources, this including climate resources per se (solar radiation, heat, water), but also the financial mechanisms available under the MEAs. Details about specific variables are given in Sect. II.D.7 below.

Climatic conditions and anthropogenic factors (e.g. those associated with increased pressure on the land) mutually reinforce chronic vulnerability to climate variability and natural disasters. Technology, on its own, is at best a partial solution. Technological solutions (including communication) should be embedded in the relevant social and environmental contexts. Neither an agricultural nor any other single sectoral intervention alone can provide sufficient scope to manage the risks associated with climate change and variability. Short-term and long-term adaptive measures in agriculture, linked with clear focus on possible future risks, must be integrated into cross sectoral planning.

The list below provides a schematic overview of the technical areas in which agrometeorological communication is relevant. Most items can be categorised as "emergency" and "non-emergency". It is more or less arbitrarily subdivided into "awareness and risk management", "societal and institutional adjustment", "improved practices" and "short and long term planning". The earlier examples of agrometeorological services in this Part II illustrate many of these areas.

Awareness and risk management

- Awareness creation and advocacy on risk management, linking them with climate change and adaptation issues;
- Strengthening of community resilience, including local institutions and self-help capacities;
- Non-emergency advice on how to maximise the use of climate resources (orient the rows NS or EW), plough along elevation contours, plant after rain starts, avoid swamps with cattle in August, adopt mulching and conservation agriculture very gradually and crop insurance;

Societal and institutional adjustment

- Socio-economic adjustments (livelihood diversification, market facilitation etc.);
- Strengthening of formal institutional structures and environment;
- Policy formulation to catalyse enhancement of adaptive livelihood opportunities;
- Introducing alternative enterprises/farming systems, such as agroforestry;
- Risk mapping, to know how/where to target the communication. "The notion of risk communication refers to a social process by which people become informed about hazards, are influenced towards behaviour change and can participate in decision making about risk issues" (Rohrmann 2000);

Improved practices (adaptation to climate variability)

- Physical adaptive measures (e.g. link canals, irrigation, water harvesting, storage facilities for retaining water, microclimate manipulation, drainage, increased soil carbon concentrations);
- Adjustment of existing agricultural practices to match anticipated risks (e.g. adjustment of cropping pattern, selection of adapted varieties of crops, diver-

sification of cropping and/or farming systems, better storage of seeds and fodder, dry seed beds, switch to alternative crops, more efficient use of irrigation water on rice paddies, more efficient use of nitrogen application on cultivated fields, improved water management including water harvesting);
- "Tactical" day to day planning of farm operations;

Short and long term planning

- Current weather warning: frost tomorrow morning, too much wind for spraying pesticides;
- Longer term weather warning (early warning systems);
- Seasonal and decade-long forecasts for planning of operations and warning;
- Climate change impacts for targeting government interventions (10 years from now and beyond);
- Knowledge e.g. about options available to countries under Multilateral Environmental Agreements (MEAs) such as the UNFCCC, UNCCD etc.

While it is relatively easy to define technical messages that can be communicated, we have to look beyond "adaptation to current climate variability" and target the basic vulnerability factors of rural communities. Communication also aims at improving the learning process and creates the capacity to cope with climate variability.

This is particularly relevant in the current period of rapidly changing variability patterns, which are probably best approached from the broader ecosystem perspective. In pursuing this goal, agrometeorological communication should focus on support for the decision making and capacity building processes that shape social learning, technology adaptation, innovations and development pathways. This process of adaptation needs to explicitly address the needs of poorer farmers and marginalized groups that are most vulnerable to the types of climatic and socio-economic changes that are likely under perturbed climates. Agrometeorological services as defined in Part I of this book and exemplified earlier in this Part II can be used in this support.

Efficient communication also needs institutional capacity building and strengthening of organizational networks across all levels and sectors as a basic precondition (e.g. Stigter 2006). The experiences clearly show that provision of a comprehensive approach with concrete roles for action is necessary to motivate change in local perceptions and ensuring meaningful interventions through local service providers including government institutions. A lot can actually be achieved with a full buy in and work though the existing institutions, if everybody involved gains from the new roles.

II.D.7 Role of Data, Information and Knowledge in Customizing Communication Products

Applied agrometeorology advocates communication of a variety of information and knowledge available through varied sources ranging from scientific techniques to local indigenous knowledge for farm decision making. Most difficulties in decision making become apparent with the identification and recognition of available alternatives, the determination of relevant data, and collecting of relevant information (Backus et al. 1997). Building an improved data base of climatological, meteorological, phenological, soil and agronomic information is a priority to operationalise communication approaches at the farm level.

Apart from the above category of data, additional information on land characteristics, cropping systems, institutional services and support services are necessary. Institutional and Support Services perform most important functions of observing, monitoring, archiving, analysis, communicating reliable data and information to the required agencies and to end users. The development of these databases usually is dependent on the availability of institutional and technical capacity, which very often is weak due to low level vocational education systems (e.g. Stigter 2006).

The typical meteorological and climatological data are in most of the cases maintained by the NMHSs. These data sources are rarely used by the department of agriculture or agriculture extension professionals, while these are the major source of information on latest technologies on agriculture. Applied agrometeorology advocates that the essential part of these data bases be available at the local level within the reach of information providers in agriculture, livestock, forestry and fishery sectors. Modern data sources like remote sensing and satellite imagery deliver additional data on land use, land cover, vegetative index, cloud cover, sea surface temperature, etc., providing more details for developing value added information products to farmers. The general data requirements, their sources and intended purposes are exemplified in Table II.1.

II.D.8 Facilitating Effective Communication Through Indigenous Knowledge

Existence of indigenous knowledge about weather and climate as well as on coping with risks motivates farmers to know more and act on their decisions. “Local” or indigenous knowledge is an integral part of the culture and history of every local community or society. It is essential to build communication approaches on the existing indigenous knowledge on weather and climate and management alternatives (e.g. Stigter 2007). See also Chaps. IV.4 and IV.9.

The process of incorporating new information into the indigenous knowledge base is iterative (Pinners and Balasubramanian 1991) and the approach could be used to combine the local knowledge base with suitable climate information for effective communication. Indigenous knowledge is commonly held by communities rather than by individuals. Indigenous knowledge is the basis for local-level decision making in agriculture, natural resource management, and a host of other activities in communities.

Farmer’s best merge “new” scientific and technical information at field level: testing and practising themselves is one of the most efficient ways to convince

Table II.1 Categories of data required for customizing communication products, their potential sources and examples of intended use for agrometeorological applications and services

Category	Types of data	Potential source	Examples of intended use for agrometeorological applications and services
Meteorological and climatological	Historical daily/decad/monthly data on precipitation, temperature (max, min) solar radiation, relative humidity, evaporation etc.	National Hydro-Meteorological Services, meteorological agencies, agrometeorological centres and universities	Evaluations of water supply, water requirement calculations, dates of onset and cessation of the rainy season, dry spells, rainfall intensity, water balance
	Wind speed and direction	Meteorological and agrometeorological centres	Designing windbreaks and shelterbelts
	Leaf wetness, temperature and relative humidity	Agromet stations	Pests and disease incidence
Land and soil	Land slopes, surface drainage, water table	Geological department, public works, land and water resources, river authority	Land suitability, water source and availability
	Soil properties (depth, texture, structure, fertility, water holding capacity, available water, salinity, acidity and other problems)	Soil research institute, agriculture department, soil testing laboratory, national soil bureau	Water balance, water stress characteristics, fertilizer recommendations
Crops and cropping systems	Crops, varieties, duration, monocropping, mixed-, relay-, inter-cropping systems	Department of agriculture	Matching crops and cropping systems with the rainy season; crop and varietal choice decisions
Agronomic management	Time of sowing, planting, quantify and time of fertilizer application, weeding, thinning, row width, method of irrigation, pest and disease control measures, time and method of harvesting	Department of agriculture, community representatives, farmers surveys, focus group meetings	Developing management alternatives, planting time, plant population, row spacing, fertilizer application options
Socio-economic and market information	Livelihood groups, livelihood objectives, risk perception, market demand, access to credit, inputs, commodity price etc.	Community representatives, key informants, local institutions, community based organisations, etc.	Input optimisation, identification of target groups within the community, crop and varietal choice

Table II.1 (continued)

Category	Types of data	Potential source	Examples of intended use for agrometeorological applications and services
Institutions	Availability of enabling institutions, mandates, structure, facilities, technical capacity, technical advice, access to support (transport, market), local cooperatives, micro financing etc.	National level relevant ministries, departments	Identification of focal agencies for implementing agrometeorological products and services and their relevance to contribute to the overall processes

farmers. However, group discussions at community level facilitate understanding and sharing of experiences among community members. Other partners involved in the convincing process include:

- Intermediaries as farmer advisers: mainly the agricultural extension services but also officers of agricultural co-operatives, input suppliers, woman organisations which provide technical and economic advisory services to farmers;
- Researchers develop and provide updated information used by advisers at national and regional level, but sometimes also directly to farmers, particularly within research and development farmer networks.

Much of the research and development needed for less-favoured lands does not involve high science, but rather the spread and adaptation of indigenous knowledge and practical innovations. NGOs have been very successful in pursuing this agenda and in working with local communities to overcome social and institutional constraints. There is a need for more participatory approaches for structuring innovative communication approaches and test new technologies which shall be adopted by the small farmers (Roncoli et al. 2009).

II.D.9 The Role of Technology

II.D.9.a Case Studies

A very extensive inventory of the uses of Information and Communication Technology (ICT) to provide farmer advisories in Africa by Gakuru et al. (2008) concludes that there will never be a “one fit for all” system. But the report suggests that systems which use a voice-platform or audio files provide an innovative and promising entry point to farmer information, while the other platforms (SMS and web-based platforms, see Li et al. 2008) remain essential to provide a back-end, offering more detailed information.

In September 1999, a World Bank funded workshop titled "Users responses to seasonal climate forecasts in southern Africa: what have we learned" was convened in Dar es Salaam, Tanzania. The objective was to present, discuss and compare meteorological research, primarily in relation to the agricultural sector in southern Africa. Two aspects came out as significant for sustainable agricultural production and food security. The first was that there were communication barriers and that there is need to develop appropriate information channels. The second was that there were bottlenecks in the effective use of seasonal climate forecasts by farmers (Cicero Report 1999; see also Meza et al. 2008 and Chap. IV.12). In any agricultural development programme, effective communication is a requirement to success. In the case of seasonal climate forecasts, users frequently have not been able to "decode" the information disseminated (e.g. Stigter 2007).

In a survey conducted in villages in Phaswana in South Africa, Bembridge and Tshikolomo (1998) found that among the respondents, 92% owned radios, 52% owned television sets and 32% were connected to telephone facilities. With regard to television and telephone facilities, the survey results may not be representative of the situation in southern Africa given the relative economic advancements of South Africa. However, the survey provides basic information that target audiences in South Africa have access to electronic media.

Being in possession of a television or radio does not guarantee understanding of information through these media, but the survey demonstrated that farmers in South Africa make use of electronic media as sources of agricultural information. Electronic media can potentially be reliable channels to communicate seasonal climate information as long as appropriate terminology is applied to ensure shared meanings. However, the fact that information has been disseminated does not necessarily mean that communication has taken place.

The Bembridge and Tshikolomo (1998) survey ascertained how the respondents obtain information for agricultural management. They found that 46% of the respondents had access to written information, mainly in the form of popular journals with little research-based information. The majority of the respondents (76%) claimed to listen to radio broadcasts on farming, but indicated that the information did not contain technical information for farm management. The information was of a general nature. The same was claimed regarding information through television. Respondents also obtained information from other farmers, farm demonstrations and government and corporate extension officers.

Farmers obtain information for farm management from printed media (newspapers, journals, etc.) and electronic media (radio and television). Rural radio is a major source of information for the farming community in developing countries (e.g. Stigter et al. 2007). This may be true for meteorological information as well (Gommes 1992, 1998b, 2001). They also have other sources of information, including farm demonstrations, farm discussions, farmers' days, meetings with other farmers, government extension and corporate extension. Among these media, the most popular is radio (76%), farm demonstrations (72%), farm discussions (58%), and other farmers (56%).

The least contacted source is government extension officers. The reason for the low level of interest in government extension officers as sources of agricultural information could be the low training level of the officers (Mukhala and Groenewald 1998) or their attitudes (Stigter 2006). Exceptions to this rule are the intermediaries in charge of agrometeorological services as exemplified in the earlier parts of this Part II, but the problems discussed in intros II.A and II.B hint among others at these same issues.

Similar examples can be found in other parts of Africa (IAC 2004). An example is the "Mapping of Pastoral Movements in the Sahel", where the population has access to information on how to use their pasture resources effectively during the dry season. Tools such as Geographic Information Systems (GIS), Global Positioning Systems (GPS) and thematic maps of seasonal movements of livestock reinforce the identification of relevant know-how. Effective methods of livestock farming incorporating information and communications technology are identified. These help to reduce conflicts between growers and breeders and to alleviate animal pressure on pasture lands, while enhancing the productivity of traditional livestock farming, with the direct consequence of increasing family income.

In India an experimental network connected more than 20 isolated rural villages to a wireless internet service. About half the population in most of these villages had a total family income of less than US$25 per month. The project aimed at providing knowledge on demand to meet local needs using information and communication technology, and it did so through a bottom-up process. Volunteer teams helped poll the villagers to find out what knowledge they seek.

Particularly popular were women's health information, advice on growing local crops and disease control, the daily market prices for these crops, local weather forecasts, and information about government programs to aid poor families. An expanded concept of a global electronic network was envisioned to connect scientists to people at all levels – farmer organizations and village women, for example. The project intended to demonstrate that empowering people through access to timely and relevant information can make a difference in the life of the rural poor, and that new information and communications technology can play a crucial role in this effort. A unique feature of the project is the fact that most information is collected and fed in by the local community (from IAC 2004).

As with breeding and biotechnology, information technology can assist agricultural production practices to overcome the gaps between the actual and attainable yield and between attainable and potential yield, and to increase the potential yield level. Rapid, effective information processing and management can help agriculture. Some examples are resource allocation, crop and animal production modeling and improved resource-use efficiency. In addition there is a strong need for risk-reducing information such as for the Sahelian zone, as mentioned above for livestock movements.

Agro-ecological analyses may reveal substantial production potentials (Bindraban et al. 1999, 2000), but risk-reducing information is vital for farmers considering use of new technologies, such as drought tolerant crops (Jagtap and Chan 2000). Decision support systems for strategic and tactical (operational) decision making are needed to supply such information. The whole arsenal of new information and communication technologies, such as remote sensing, GIS and crop and climate modeling, can be employed for this purpose (see Chaps. IV.17, IV.18, IV.19 and IV.20).

II.D.9.b Farm Adaptive Dynamic Optimisation (FADO)

FADO is a technologically sophisticated approach that basically constitutes a modernization of response farming, a concept developed by Stewart (1988) in the seventies and applied in its original form in a number of countries [see also Part I and http://responsefarming.org/]. The FADO philosophy underlies the experience of the Australian work on Whopper Cropper (see for details the site http://www.apsru.gov.au/apsru/Products/Whopper/NationalWhopperCropper.pdf) developed, among others, by the Queensland Department of Primary Industries. Based on the above-mentioned Southern African, Sahelian and Indian experience, FADO may now be considered a technically feasible approach, which, however is rarely implemented in developing countries. FADO finds its justification, among others, in the fact that subsistence agriculture is expanding more and more into marginal areas, with at least some intensification taking place. Smallholders face the problem of further degrading their environment, increasing variability of their production, while at the same time having to produce more in a context of growing populations and increasing urbanisation.

FADO aims to develop advisory services to help farmers stabilise their production and income by making better use of environmental resources, such as climate (rainfall, sunshine), soil etc. The advice is based on local farming, historical weather data (risk assessment) and actual current season weather conditions. In practice, information on rainfall, planting dates etc. is systematically collected in real-time from villages, analysed centrally and then management options are fed back to the village, tailored to local conditions. The concept of FADO is very relevant in the present context, as it entails two-directional flow of information and the intensive use of communication and data processing technology.

FADO (Fig. II.2) includes the following steps/components: (1) collect real-time local, village-level weather and crop (e.g. phenology) information and transmit them to a central location, for instance the National Agrometeorological Service; (2) simulate management options based local conditions (e.g. soil, farming practices) and market data (crop and input prices); (3) feed back the advice/management options to the village. The advice is based on local farming (crops, soil, practices), local historical weather data (risk assessment) and actual local current season weather conditions, taking into account seasonal weather forecasts (Meza et al. 2008) and historical local climate risk.

The technology to implement the steps above (optimisation of local decision making) now exists, including downscaling and the preparation of local data

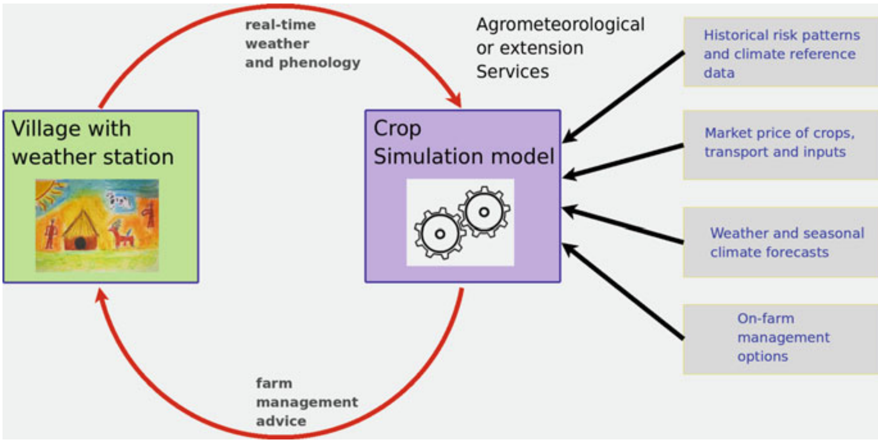

Fig. II.2 Data flow in a Farm Adaptive Dynamic Optimisation (FADO) system. Source of African village drawing: http://www.ec-freinet-acheres.ac-versailles.fr

(Bernardi et al. 2006; Wratt et al. 2006), models for decision support (Orlandini et al. 2008), including fertilizer management (Kersebaum et al. 2005) and farm nutrient management in a participatory context (Cabrera et al. 2008), the use of climate forecasts (Everingham et al. 2008) and the net-based tools for data dissemination, including maps. Basically three categories of applications of FADO can be identified (Gommes 2001):

- What-if experiments to optimise the economic return from farms, including real-time irrigation management. This is the main application and the only area where models are well established, including in some developing countries (Smith 1992) (There are good case study illustrations in this Part II)
- Optimisation of resources (pesticides, fertilizer) in the light of increasing environmental concerns (and pressure);
- Risk assessments, including the assessment of probabilities of pest and disease outbreaks and the need to take corrective action.

Providing agrometeorological information and services as part of building agricultural based livelihoods in a post conflict country presents new challenges which have not been addressed adequately by the latter professionals. The climate does not recognise post-conflict communities and hence they are subjected to the same environment, as they try to rebuild their lives. What are the best methodologies to provide them with agrometeorological information in order for them realise reasonable yields and production?

Southern Sudan is one such a case (see for comparable details Box III.2.7. in Sect. III.2.1.(e)), the extension system is almost non-existent, the motivation for government staff is also low. FAO is putting in place agrometeorological stations and data have started flowing. The challenge is to provide such information and services to the target audience. These are the circumstances that demand a well thought agrometeorological information communication strategy.

II.D.10 Capacity Building for Effective Communication

It is increasingly acknowledged that the complexity of agricultural development demands an array of technological solutions and service structures, including a readiness to adapt and change these management alternatives, as situations change and understanding increases (Walker 2005). In "demand-driven" communication approaches, farmers are being viewed as "clients" for whom agrometeorological information and services need to be tailored. The definitions and roles of extension officers and extension agencies are changing, especially because of the need to cover the information and training needs of a diverse, heterogeneous clientele.

Agricultural Extension Services are being reoriented in order to respond to the need for participation by a wide range of stakeholders, to improve responsiveness and accountability, and to include non-conventional messages that incorporate environmental issues. Main orientations are: (i) Decentralised and open to multiple delivery mechanisms, including delivery by private-sector enterprises, NGOs and producer associations and (ii) Respond to tremendous differences in needs and priorities among farmers according to their access level to resources, social and gender status (e.g. Stigter et al. 2007).

Within the key approach to establishing a farmer centred decision making process at the community level, an educational approach appears essential to stimulate adapted use of improved technologies in developing countries. Targeted capacity building initiatives are an essential component of the communication process (Table II.2) [See also Chap. IV.5.]

II.D.11 Monitoring and Evaluation of Communication Approaches

Monitoring and evaluation of the effectiveness of communication in agrometeorology need to be a continuous process. Monitoring is a continuous process, while evaluation is performed periodically to measure the impact of communication approaches: both need to involve users and providers of information and services. Monitoring and evaluation need to answer the following key questions:

- Has the information reached the user?
- Has the user used the information?
- Has the information been helpful (by how far)?
- What feature the user did like or dislike about the delivery system?
- What improvement the users would suggest?
- How can diverse types of agrometeorological data be integrated into useful information that responds to the often dissimilar application needs of farming communities?

Table II.2 Level of operation of clients, the target groups and examples of contents of the demand driven capacity building for client centred communication

Level of operation of clients	Target clients	Capacity building for communication targets
Agrometeorological service	Agrometeorological services providers with the agency responsible for Agrometeorology and/or Hydrometeorological Services staff responsible for communicating climate/weather information along with options	– interpretation of regional and national forecast products; – analysis of location specific risks related to climate phenomena; and – communication of information to the relevant sectoral agencies
Extension at the head quarters	Agricultural extension officers and responsible officers for livestock and fisheries as service providers	– development of impact outlooks relevant to agriculture and allied sectors – preparation of alternative management practices in response to forecasts
Extension at the decentralised level	District/provincial extension officers; sub-district extension officers; intermediaries and service providers	– communication and use of climate/weather information – mobilising resources in response to the climate/weather information
Farmer and community level	Intermediaries, community representatives, community leaders; CBO representatives; developmental NGOs; farmer groups, farmer cooperative representatives	– mobilising the members and/or farmers to respond to the risks associated with the forecast information

- What type of information is needed by diverse groups of end-users, given their different farming socio-economic and cultural systems?
- Which are the appropriate communication technologies for each social group?

Impact of information on local farm output by surveys and/or focus groups should provide a quantitative basis to improve information and services and their communication systems. Effectiveness and use of climate information and services can be improved through close collaboration and co-ordination among the relevant agencies and organizations, National Extension Services, National Agrometeorological Services, specialized NGOs and farming communities (Weiss et al. 2000).

II.D.12 Conclusions

Agrometeorological communication addresses all weather dependent aspects of crop and animal production, food and non-food forest products, as well as fisheries.

It aims at improving or stabilising production or income through the exchange of "messages" (data, information, knowledge), with feedback, between a "producer" and a "target" or "audience". Types of audiences (clients) vary a lot and the messages must be customized and refined by experience to achieve maximum impact. This also applies to the communication media. As to their contents, agrometeorological messages can vary from awareness creation and awareness advocacy to on-farm management advice, warnings, knowledge and information useful for planning at the level of individuals, institutions and government.

While efficient communication relies on reliable and up-to-date data and information, reference to and actual use of indigenous knowledge can lead to an easier adoption of the message. We stress that modern communications technology, including the internet and wireless telephones, offer tremendous potential to improve agrometeorological communication, such as the establishment of Farm Adaptive Dynamic Optimisation (FADO) schemes. FADO is based on the real-time collection of on-farm information such as weather and phenology and the off-site processing of the information in order to derive farm management options that are fed back to the village. We concluded by discussing training requirements and the need to systematically assess the effectiveness of agrometeorological communications systems.

A possible scheme to develop agrometeorological communication for development could adopt the following criteria: (1) a holistic approach that embraces the complexity of the system and its multiple stakeholders; (2) the acknowledgement that information and communication must be part of every stage of an intervention; (3) the recognition that the communication dimension is not simply about information and messages, but about two-way exchange of perspectives using a variety of methods and media; (4) the realization that all communication activities must be planned ahead, involve the multiple "world-views" of the different stakeholders, and include evaluation of their ways of learning and sharing; (5) the understanding that a combination of several communication functions will be necessary in any communication strategy and, eventually, the realization that the communication processes enable the sharing of information (meaning) and knowledge influencing vulnerability related factors.

Modern agrometeorology can resort to a number of sources of data and techniques of analysis and telecommunication including crop models, geographic information systems, stochastic weather generators, spatial interpolation techniques, wireless telephones and the internet. This results in the transmission of crop and weather data from the rural areas to the national agrometeorological services being now much easier than in the past.

However, transmitting local advice directly or in services to farmers, while often feasible technically, is too rarely done in practice. Exceptions are exemplified in this Part II. National Services responsible for agrometeorological communications should, therefore, optimise the use of human, institutional (including educational), technological and climate resources to develop deferred and real-time advice tailored to local (village) conditions and particulars, and ready for use by farmers.

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