Scientific Animations Without Borders™: cell-phone videos for cowpea farmers

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Abstract

Over the past several decades, researchers and extension agents have described methods that cowpea farmers can use to reduce insect damage to the cowpea crop in the field and in storage. Some of these methods, which are based on both scientific research and indigenous knowledge, are currently being used in local, regional, national, and transnational extension programs. Cowpea farmers in Africa and other developing regions, however, often remain unaware of the methods based on scientific research because the farmers are low-literate and the information may be available only in a written form. Farmers also may remain unaware of methods based on indigenous knowledge because such information usually remains local. These problems are exacerbated by the limited resources of extension programs. Here we describe how pest control information in the form of short animations can be transferred to low-literate farmers via cell-phone technology and through the World Wide Web. Voice overlays in a diversity of languages can be easily added to these animations so that ideas can be efficiently shared across cultural groups. The animated videos, which are being developed by the organization Scientific Animations Without Borders™ (SAWBO), can be viewed on cell phones and can be transmitted between cell phones using Bluetooth® technology.

Introduction

Subsistence farmers worldwide face numerous challenges in producing their crops. These include, but are not limited to, pests, poor weather, poor soil conditions, uncertainty of local and regional market places, and losses during crop storage. These are all challenges faced by West African cowpea farmers.

In many cases, solutions to these challenges or problems have been developed through research by scientists or through trial and error by the farmers themselves, the latter falling into the domain of indigenous knowledge. Unfortunately, a significant number of these solutions often remain unavailable to farmers in developing countries. Solutions based on scientific research may be unavailable because the information is presented in a technical form (such as a research paper) that is inaccessible to nonscientists. This inaccessibility becomes acute when the farmers are illiterate, as is the case with many farmers in developing countries. Solutions based on trial and error may be developed in one community and then not shared with distant communities simply because the communities are isolated. Although extension services are extremely valuable because they disseminate these kinds of information, extension services are often limited by inadequate resources. In the present paper, we propose that information on crop management can be efficiently transmitted from extension services to farmers and then from farmer to farmer by use of animated videos that can be viewed and exchanged via cell phones and the World Wide Web (WWW).

Cowpea pest management as a model system

Cowpea, *Vigna unguiculata* [L.] Walp. is the most important food legume and is an essential component of cropping systems in the moist and dry savanna regions of West Africa (Singh et al. 2002). Cowpea is also the most traded indigenous African grain legume within West and Central Africa, where about 80% of the world cowpea trade takes place (Langyintuo et al. 2003). Recent FAO statistics indicate a total world cowpea production of 5,689,562 tons for an estimated area of 11,862,341 ha (FAO 2010). The resulting overall average yield is 479 kg/ha, which is a mere fraction of the estimated potential yield of over 2 tons/ha (Singh et al. 1997). The reasons for this yield gap are diverse, and low yields usually result from a combination of limiting factors, both abiotic (e.g., drought, poor soil fertility) and biotic (e.g., arthropod pests, diseases, birds, and rodents). In the savanna region of West Africa, the largest cowpea production area in the world (Coulibaly and Lowenberg-Deboer 2002), insect pests are reported to be the single most important constraint to cowpea production (Singh et al. 1990; Dabire et al. this volume).

Insect pests on cowpea

The most important cowpea insect pests have been described in detail by Singh et al.(1990) and are briefly summarized here. The groundnut or cowpea aphid, *Aphis craccivora* Koch (Homoptera, Aphididae), is the first important pest appearing early during the cropping season on growing plantlets. Apart from causing direct damage through phloem sucking, it can also transmit destructive plant viruses. During the vegetative phase of the plant, and particularly during dry spells, the leaf thrips, *Sericothrips adolfifriderici* Karny (Thysanoptera, Thripidae) can cause curling of young leaves and serious stunting of the plant. At the onset of flower bud formation, the legume bud thrips, *Megalurothrips sjiostedti* Trybom (Thysanoptera, Thripidae) attacks terminal vegetative buds, flower buds, and flowers causing discoloration of plant tissues and important shedding of flower buds and flowers in cases of severe infestation. Caterpillars of the legume pod borer, *Maruca vitrata* Fabricius (Lepidoptera, Crambidae) bore into all reproductive parts of the plant, including peduncles, flowers, and pods and are estimated to cause up to 80% yield loss if uncontrolled. A complex of heteropteran pod sucking bugs attacks young growing pods and developing grains in older pods; the attacked buds shrivel and the attacked grains abort. The most important pod bugs in West Africa are *Clavigralla tomentosicollis* Stål, *Riptortus dentipes* Fabricius, and *Anoplocnemis curvipes* Fabricius (Heteroptera, Coreidae). After harvest, two storage beetles are particularly destructive on stored grains if uncontrolled: *Callosobruchus maculates* Fabricius and *Bruchidius atrolineatus* Pic (Coleoptera, Bruchidae).

Technological challenges and opportunities for deployment of useful content to cowpea farmers

Because most cowpea farmers are low-literate learners, people and organizations providing training to cowpea farmers (e.g., regional scientists, extension agents, and NGOs) face the additional challenge of how to provide such educational information for those that cannot access written materials. In the last two decades, the availability of "printed" material has improved dramatically due to development of new technologies, such as the WWW and cell phones.

Although the WWW and cell phones have increased the accessibility of printed knowledge to many literate groups around the planet, illiterate and low-literate individuals still have no or only limited access to useful and important scientific concepts. This is unfortunate because access to relevant scientific information has the potential to create social and economic mobility for low-literate and low-income populations, especially in the developing world. As is the case with literate learners, the ability to access and understand relevant scientific information can greatly enhance the daily lives of low-literate learners (Souter et al. 2005). This scientific information can be used for practical purposes such as improving health, increasing access to water, increasing the productivity and well-being of livestock, improving the control of local crop pests, and improving participation in the marketplace (Bello-Bravo et al. 2010). Despite the apparent benefits, this information has largely remained unavailable to low-literate learners.

Cell-phone use is increasing in many developing countries as the cost of acquiring and using cell phones continues to decline (Bello et al. 2010). This is especially true in Africa. As a consequence, extension programs in Africa now have a new and effective tool for interacting with farmers. The cell-phone technology of course goes beyond the simple exchange of spoken words. Cell phones are also capable of transmitting files, videos, and other kinds of information.

Development of content for cowpea farmers

As noted earlier, cell phones are increasingly being used by farmers in many African countries, and cell phones therefore represent an important new way by which educational content can be effectively and easily exchanged among peoples with different languages and cultures. What is needed now is a form of educational content that is compatible with this new technology and with farmer background. Given the diversity of languages and cultures in Africa and given that most farmers in Africa are low-literate learners, the form of the information should be both pictorial and spoken rather than written. One option is the filming of live-action actors, but this has several significant limitations. First, filming of live actors can be costly and requires a filming crew in each area where the videos are produced. Second, when one wants to make a video with a different language or for a different cultural group, one would need to overdub in a new language or re-film in the new area. Another option, one that is less expensive and easier to modify for different languages and cultures, is to develop animated messages.

With the advent of the digital era and the advancements in psychological and communication studies, animation is now considered a "mature arts medium" (Wells 2008). The power of animation lies in its ability to communicate ideas while generating emotions in the audience. Animated films and videos can make use of both logic and emotion to effectively deliver the desired message (Pereira 2005; Mayne 1993). The creation of iconic animated characters can generate empathy between the viewer and the character and can thereby increase the willingness of the viewer to understand and accept the new information.

In the remainder of this article, we outline a new system for enhancing agricultural development for cowpea farmers via animated videos that can be transferred to cell phones using Bluetooth® and other technologies (Figures 1 & 2). The animations can be easily modified with voice overlays in new languages and can be easily distributed into new regions around the world (Figure 2). This overall program has been termed Scientific Animations Without Borders (SAWBO™); one of the first objectives of this program is to use animation technologies to develop content useful for the cowpea community. SAWBO™ is being developed by an international group of scientists, extension educators, and animators focused on improving the quality of people's lives by providing valuable and practical information via the WWW and cell phones (Figures 1–3). The current animations are based on concepts that have been successfully used in extension programs in West Africa.

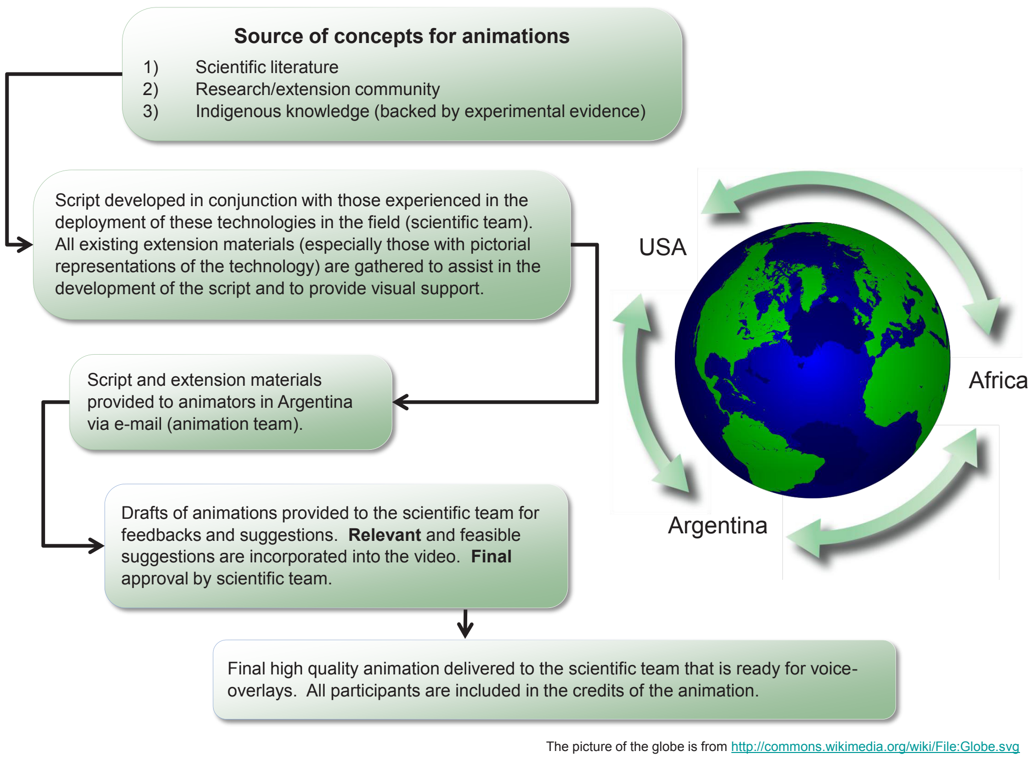

Figure 1. Flowchart explaining the development of animated videos through an international network of collaborators.

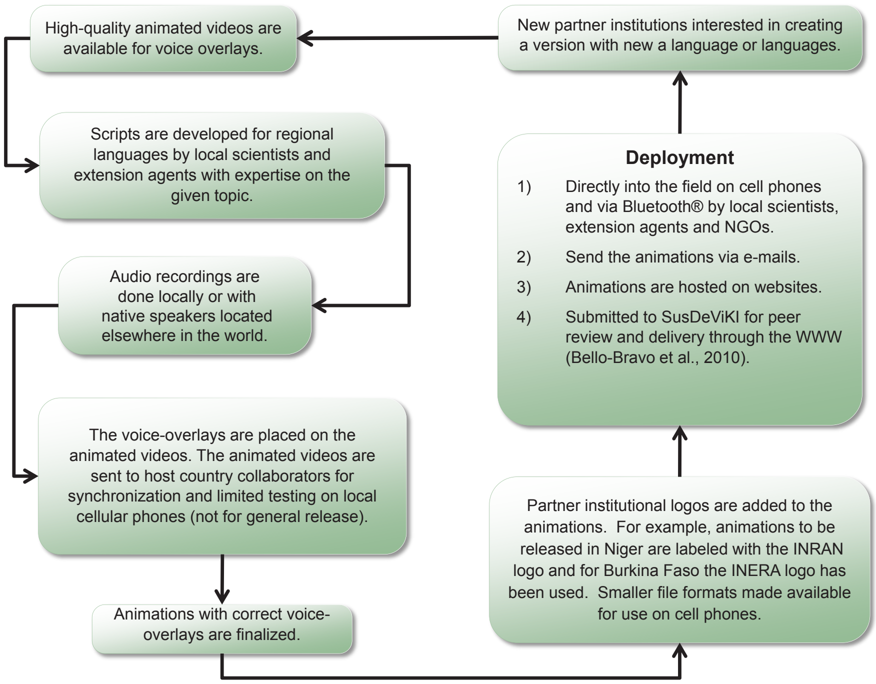

Figure 2. Flowchart explanation of the process by which the audio files are created and overlaid on the animated videos.

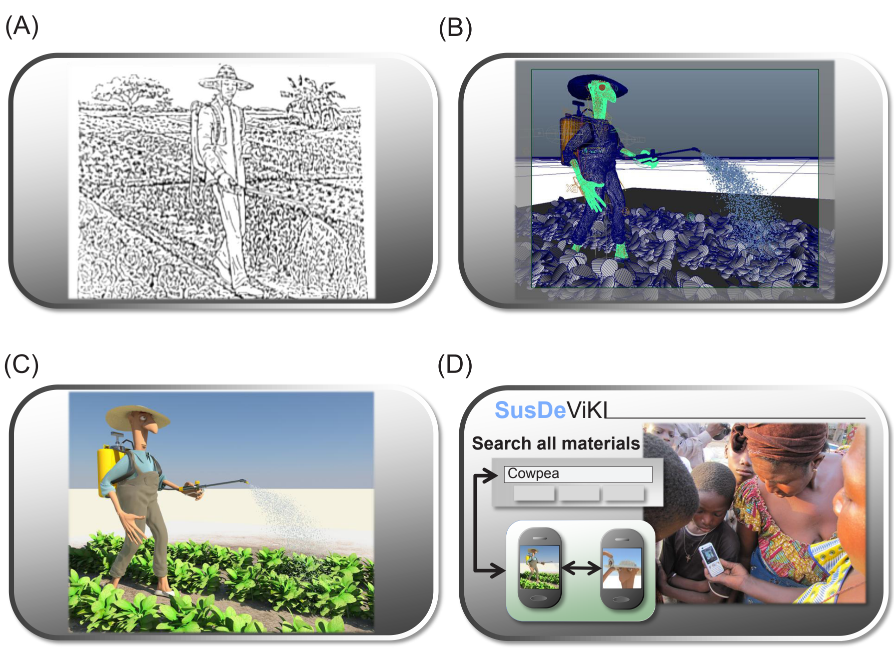

Figure 3. Steps taken in the creation and the deployment of an animated video: the production and use of neem sprays is used as an example. (A) Existing extension materials are used as the basis for the development of the animations. (B) A wire framework is initially developed, and once the initial concepts of the scenes are accepted. (C) A complete draft of the animated video is created and edited, and a final version is produced with voice overlays. (D) The final cell-phone-ready animated videos can be placed on the Sustainable Development Knowledge Interface (SusDeViKI; Bello-Bravo et al. 2010) for easy download onto a computer and transfer onto cell phones, where the animated videos can be transferred between cell phones, via Bluetooth® technology, and used by farmers in the field.

Sources of information for development of content

National, regional, and international research programs have developed or are developing many different control methods for pests of cowpea. For insect pests that attack cowpeas in the field, control methods include application of pesticides (Singh et al. 1990), release of biological control agents (Tamò et al. 2003), viral sprays (Tamò et al. this volume), and the planting of resistant varieties or transgenic plants expressing a *Bacillus thuringiensis* toxin (Kushwaha 2008). For insects that attack cowpea in storage, controls include physical methods (such as hermetic sealing of cowpea seeds and solar treating of cowpea seeds to prevent bruchid attack), pesticide treatment, and biological control via parasitoids (Kitch et al. 1997; Murdock et al. 2003; Amevoin et al. 2006). Although these methods often result from scientific research, some methods and the application of most, if not all, methods depend greatly on indigenous knowledge.

Indigenous knowledge represents an important resource for developing solutions to many challenges including pest control (Mihale et al. 2009). Indigenous knowledge can be defined as information, perceptions, and behaviors that guide the use of land and natural resources by local communities. It is created and sustained by local community members as a means to meet their needs for food, shelter, health, spirituality, and savings. This knowledge can be simple or complex but it is not static. Indigenous knowledge evolves in response to changing ecological, economic, and sociopolitical circumstances, based on the creativity and innovation of community members and as a result of the influence of other cultures and outside technologies (www.worldwildlife.org/bsp/publications/africa/biome/indknow.pdf).

Indigenous knowledge comprises all knowledge pertaining to a particular people and their territory, the nature or use of which has been transmitted from generation to generation (Daes 1993). This knowledge includes "all kinds of scientific, agricultural, technical and ecological knowledge, including cultigens, medicines and the rational use of flora and fauna" (Daes 1993). The preservation of a cultural heritage is an important component of indigenous knowledge in many communities. Indigenous knowledge is passed from one generation to the next through example, ritual, stories, and other forms of oral transmission. For the purpose of this paper, the terms "indigenous", "local", and "traditional" will be used interchangeably.

Indigenous knowledge of course differs from scientific knowledge. In contrast to the indigenous knowledge generated by farmers, knowledge generated by scientists is usually based on experiments that include controls, replication, and statistical analysis (Lyotard 1987). The people who generate scientific knowledge are often not the direct users of that knowledge. In focusing on long-term understanding, scientists may overlook local and or practical aspects that can greatly affect how that knowledge may be used. In contrast, traditional knowledge is created by the people who depend on that knowledge for achieving a profit and, in many cases, for surviving (Berkes et al. 1992). Traditional knowledge is closely related to the day-to-day and season-to-season requirements of the users. Instead of being separated, local knowledge and scientific knowledge should be integrated to achieve the greatest benefits to the local users.

Examples of technologies based on the indigenous knowledge of farmers include wood ash storage of seeds to prevent storage-insect attack, storage in pods or sand, smoke fumigation of granaries and/or cowpea seeds, and application of biopesticides (Murdock et al. 2002; Kitch et al. 1997; Ahmed et al. 2009). With respect to biopesticides, traditional farmers throughout India and Africa have known about the insecticidal properties of the neem tree for centuries. In Niger and Mali, for instance, farmers have long observed the resistance of neem leaves to the desert locust (Emsley 1991). Although most farmer practices based on indigenous knowledge reflect local conditions, the practices can have broader use. For example, insect pests are unlikely to develop resistance to neem because it contains many active ingredients (Hoddy 1991). Neem works as a repellent and antifeedant to many chewing and sucking insect pests in the larval and adult stages including rice and maize borers, pulse beetles, and rice weevils (Heeds 1991). For these reasons, indigenous knowledge about the use of neem as a biopesticide should be valuable in many different communities worldwide. Also, in some areas of sub-Saharan Africa, farmers mix sieved ash from cooking fires and cowpea seeds to protect the seeds from bruchids (Golob and Webley 1980). According to surveys of cowpea storage by the Cowpea Collaborative Support Research Program (CRSP) scientists, ash storage of cowpea is common in northern Cameroon even though the method in which the ash is used differs from farmer to farmer (Wolfson et al. 1991).

Two important problems associated with indigenous knowledge

As noted earlier, scientific knowledge is often presented in a technical language that is inaccessible to farmers and especially to low-literate farmers in developing countries. Indigenous knowledge, however, also has problems. The first concerns information transmission. Although indigenous knowledge is readily shared among members of the local community where it is generated, it is not easily shared with communities in other regions and countries. Also, because indigenous knowledge is embedded in the practices and experiences of a particular community or group of people, it is most commonly exchanged through personal/oral communication and demonstration, which makes dissemination to other communities in other regions a challenge (World Bank 1998).

The second problem with indigenous knowledge concerns its survival. Strong global trends tend to impose uniform processes that oppose diversity and heterogeneity. People or systems find it difficult or impossible to resist the homogeneity resulting from globalization (Jude 2003). As technology advances, most information and knowledge originates and radiates from central areas, flowing freely from centers to peripheral areas but not flowing freely in the other direction. As a result, indigenous knowledge and indigenous identity are on the brink of extinction in many parts of the world (Mizrahi 2007).

In the case of broadly applicable indigenous knowledge, backed by scientific data, both of these problems have the potential to be reduced by the approach devised by the SAWBO™ group. First, the use of animation and voice overlays make it possible to transmit indigenous knowledge (and scientific knowledge) among communities that are separated by language, mountains, oceans, as well as other physical and cultural barriers. Second, SAWBO™ animations have the potential to facilitate the rescue, restoration, and preservation of important elements that secure the identity of those communities where the knowledge was originally generated. Thus, SAWBO™ is engaging “local knowledge holders” in cooperation with local institutions and organization to save and spread the traditional knowledge generated in remote areas. Significantly, SAWBO™ takes the approach of “farmer first” (Chambers et al.1989), which means that agricultural development should include farmer knowledge and farmer participation in decision making and project planning.

Animation development

Creation process: techniques applied in the production of our animated videos

In creating animated videos, we have explored how to transfer scientific knowledge in short and intense "sessions" that capture the attention of many different kinds of viewers. SAWBO™ animated videos use both a two-dimensional (2D) format and a three-dimensional (3D) computer graphics format. Many of the algorithms and procedures applied in both techniques are similar and complementary. 3D animation is achieved through a three-stage process. In the first stage, objects and characters are mathematical models of 3D geometric entities, resulting in the creation of a wire-frame of the rendering. In the second stage (layout and animation), the objects are placed in a contextual position in the scenes, and the sequence and concatenation of movements are simulated. The third stage involves a process known as 3D rendering in which the created models are shown in a realistic manner through the interaction with light and movement.

Image has often been used as a unit of language where the images per se transmit a message (Pereira 2005). In our first animation dedicated to the storage of cowpea in triple bags, we used a 2D-animation that showed hands performing partial actions rather than showing complete human figures. The images were used to support the technical report that was communicated in the form of a speech. In subsequent animations using a 3D model, we have incorporated an iconic character, whose facial features and clothing allow us to present a generic farmer with whom individuals can relate. His movements and gestures are used to make the character believable. In this case and in contrast to our first animation, the technical report (speech) supports and explains the actions shown by the character. Some actions performed by the character go beyond technical aspects and have been specifically created to help establish links, at a human level, with the viewer. For example the farmer dries his forehead after working very hard as a sign of fatigue.

The animation format facilitates the interaction of our SAWBO™ team with collaborators and cowpea farmers around the world. The creative process requires numerous interactions and feedback from those experienced in the use of the techniques in the field. The system has incorporated interactivity principles so that new "horizontal" relations can be established and many people contribute to and help create the final animation. In this way, cowpea producers in Africa and Latin America and our regional partners contribute their own views, suggest changes in the animated videos, or submit other techniques or methods. The system favors the establishment of virtual networks in which participants discuss and share opinions and generate their own proposals. As a consequence, the animation format and the emphasis on interactivity have resulted in the creation of multiple versions of each animated video that differ not only in language but also in specific content.

Cell-phone technology makes it practical to add voice overlays to the animated videos so that people with different languages can understand the information. Cell-phone technology also means that the information can be easily and rapidly transmitted even in areas that are difficult for extension agents to visit. Transmission of animated videos on cell phones will not completely replace the conventional farmer field school and extension agents, but the technology will help farmer field schools and extension agents reach more people, including those in remote areas or those who simply do not have time to attend field schools.

Challenges related to the production of the animations

Several questions persist regarding the efficient development and deployment of animated videos. First, how can one create content in a manner that is cost-effective and allow for rapid adaptation into other languages? Second, will these animated videos be sufficiently neutral or universal to be used across countries and cultures? Third, are the resources, collaborators, and equipment sufficient to record clear voice overlays that can be heard on cell phones? Fourth, and especially for those programs with limited resources for extension activities, how can resources be used most effectively to develop content? Although effective deployment of such cell phone-based content is obviously extremely important, there will be little to deploy without a methodology to efficiently create useful and effective content. Finally, how should the progress of SAWBO™ be assessed, i.e., how will we determine whether the project is achieving its long-term goals (Figure 4)?

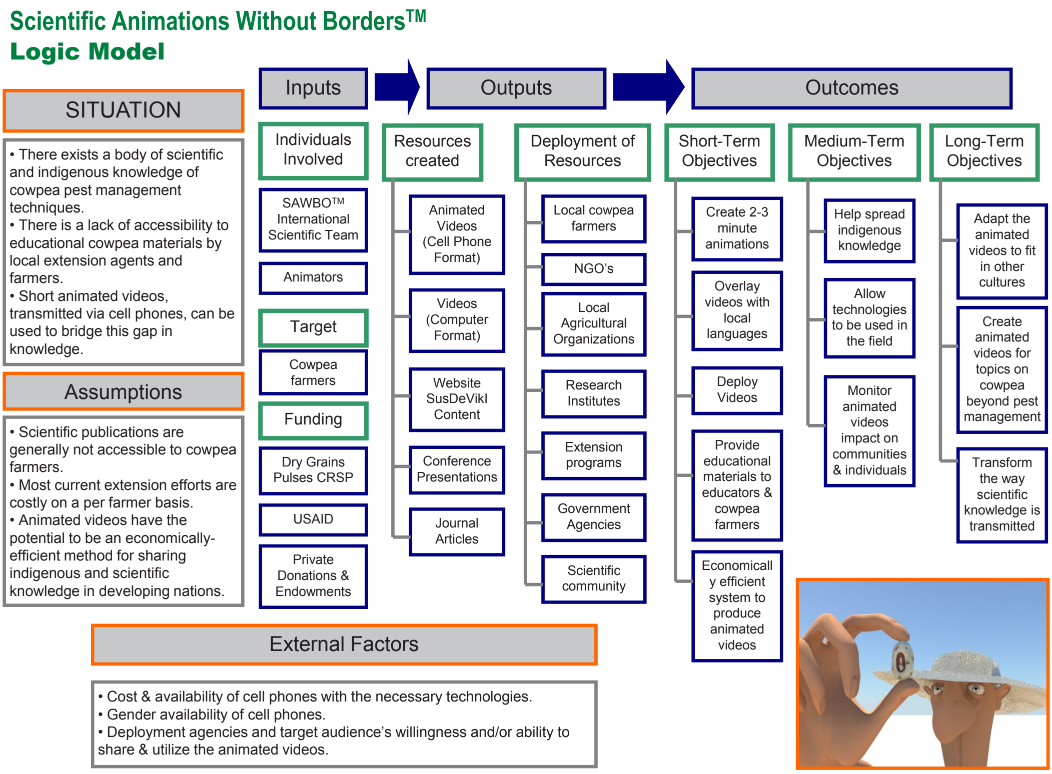

Figure 4. A logic model for the Scientific Animations Without Borders™ project including both projected variables and potential outcomes.

Release strategies

Dissemination and impact assessment of animations

The release strategy for these extension videos is still in the developmental stage. The three technological aspects that will play a critical role in the release of these animated videos are (i) e-mail accessibility to NGO's, organizations, and other local extension groups worldwide; (ii) a central website dedicated to the videos and from which the videos can be downloaded in multiple formats to individual computers or cell phones (Bello-Bravo et al. 2010); and (iii) Bluetooth® technology, which will allow for fast transfer of video files between individuals.

One of the key elements of any extension program, especially those affecting developing nations, is the evaluation of the program's net impact. Because this is often a difficult and sometimes forgotten element of program design, very little information is available regarding the billions of dollars that have been spent on outreach (Center for Global Development 2006). Impact assessment (IA) is defined by Maredia (2009) as "the changes in people's lives brought about by a given action or series of actions in relation to a counterfactual scenario." The two broad categories of IA are macro-level IA and micro-level IA. Currently, we are focusing on implementing an effective micro-level IA. As we continue to produce more videos, we will develop a more detailed IA strategy, including a macro-level IA.

A micro-level IA focuses on short- and medium-term outcomes, including the immediate impact of the project on the target individuals or organizations. There are four typical steps in a micro-level IA: (i) selection of the specific program or project and its corresponding outputs; (ii) estimation of the number or size of the individuals, organizations, or populations affected by the outputs; (iii) determination of the size of geographic area affected; and (iv) approximation of the project benefits as a function of average effect size and effect scale (Maredia 2009). As explained throughout this chapter, the first step in the micro-level IA involves the development of the project idea and outputs, which SAWBO™ has done extensively. Additionally, as outlined in the Logic Model (Figure 4), SAWBO™ has clearly defined targets within the cowpea community and beyond. We have also approximated that the cost of production per target individual could be fractions of a penny. Steps ii through iv will continue to be followed once feedback about each video is received. This knowledge can then be used to target those individuals and areas in need of specific information and to improve the current methods of dissemination. Additional comparisons will need to be made between pre-existing extension methodologies on their own and with the supplementation of animated scientific videos to determine the effectiveness of the proposed approach.

Challenges related to monitoring the impact assessment

With respect to monitoring how the animations have had an impact on local farmers and communities across the world, feedback is limited by a number of factors. According to the Center for Global Development, impact assessment is limited by technical, bureaucratic, and political factors (Center for Global Development 2006). Because most of the actual dissemination of the videos will be between local NGO's/organizations and farmers or between local farmers themselves, determining the exact number of individuals who have viewed the videos is difficult. While videos could be tagged to monitor when they are downloaded and transferred from cell phone to cell phone, this involves ethical issues related to the use of human subjects and individual rights of privacy. Any collection of human data requires informed consent and preservation of anonymity. Other questions are "How do we determine whether the information viewed by the individual farmer is actually being implemented?" and "Is the knowledge gained beneficial to the overall community?" As mentioned previously, the current strategy for assessing distribution and impact of the animations is to rely on collaborator and NGO/organizational feedback.

Conclusion

The use of animated videos for educational purposes for low-literate learners is currently in its infancy. However, there is a tremendous need for the cowpea community to develop educational content concerning pest control solutions that can be easily accessed by extension educators and cowpea farmers. We believe that the system described here, "Scientific Animations Without Borders™", will be useful to the cowpea community and will serve as model for other communities.

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