The Sustainable Agriculture Learning Framework: An extension approach for indigenous farmers

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Abstract. Sustainable agriculture has been linked as a potential pathway to food security for developing countries. In many developing countries, indigenous farmers have been practising sustainable methods of agriculture for hundreds, often thousands of years. Agricultural extension in developing countries is failing to capitalise and build upon what is a potentially valuable asset, being, the agricultural knowledge of indigenous farmers. This paper proposes an extension approach which shifts extension officers from the role of teacher to the role of facilitator, by recognising and valuing indigenous knowledge and culture and incorporating the principles of andragogy into an extension approach. It is suggested that the approach, coined the sustainable agriculture learning framework, will assist extension projects to enhance sustainable agriculture among indigenous farmers, thereby improving food security.

Keywords: Sustainable agriculture, indigenous knowledge, agricultural extension, andragogy

Introduction

Indigenous farmers have been practising agriculture for hundreds, often thousands, of years. Over time they have adapted agricultural practices to the local environment, resulting in community food security and conservation of agrobiodiversity (Altieri 2004). However, changed land use, population growth and climate change are placing pressure on indigenous farmers to rapidly adapt their practices to ensure sustainable food security. International bodies suggest two paths to food security: the first path depends on industrial agriculture, the second on sustainable agriculture (Flora 2010).

The path of industrial agriculture is constructed on the concept that food security can be achieved by producing more staple crops and shipping these crops (using public subsidies) to areas of resource scarcity. The path to sustainable agriculture is based on improved knowledge of agroecosystems and becoming less reliant on non-renewable external inputs (Flora 2010).

Unlike industrial agriculture, sustainable agriculture does not rely on trades and markets for food security, does not have adverse effects on the environment and is accessible to farmers. However sustainable agriculture is knowledge intensive, requiring an extension approach which works with farmers to create knowledge which is relevant, practical and is farmer-centric.

There is often a view that to create a sustainable agricultural system one simply substitutes or removes industrial inputs. This is a simplistic view and in fact sustainable agriculture approaches which include industrial inputs have been successfully developed (Flora 2010). Sustainable agriculture is more about refocusing agricultural systems. There are ongoing debates about which systems are sustainable and which are not, but the key principles of sustainability are to integrate biological and ecological processes, minimise the use of non-renewable inputs, make use of farmer skills and knowledge and make productive use of people's collective capacity to work together (Pretty 2008). The intention of sustainable agriculture is not to reduce or limit production levels but rather shift the mechanisms of production. Shifting the emphasis from fertilisers to nitrogen-fixing legumes and chemical pesticides to natural pesticides and natural pest enemies are examples of re-designing production systems to become more sustainable.

Whilst it is evident that a broad range of factors such as climate change, population growth, war, political instability and unsustainable farming practices influence food security and rural development; it is clear that agricultural extension holds a pivotal role in promoting sustainable agriculture (Qamar 2005; Kroma 2006), food security (Swanson & Rajalahti 2010) and rural development (Maiangwa et al. 2010). In fact, agricultural extension has a role to play in four of the UN Sustainable Development Goals (United Nations 2015); being zero hunger, quality education, gender equality and sustainable land management.

This paper proposes an approach to agricultural extension which enhances sustainable agriculture for indigenous farmers through adult education and the integration of science and indigenous knowledge and culture. The agricultural extension approach described as the 'sustainable agriculture learning framework', fits within the set of participatory agricultural extension approaches, but differs in its approach to indigenous knowledge and culture.

This paper is part of the author's wider research, which examines the application of indigenous knowledge and culture to enhance sustainable agriculture among farmers in Papua New Guinea and Vanuatu. This paper begins with a review of agricultural extension in developing countries,

identifying failures of some past and present extension efforts. The paper then links the paradigms of adult education and agricultural extension, suggesting an alternative agricultural extension approach coined 'the sustainable agriculture learning framework'.

Agricultural extension in developing countries

The purpose of this section is not to provide a detailed description of the various agricultural extension approaches, but to highlight some of the constraints of past and current approaches so that an alternative approach may be considered.

Agricultural extension services in developing countries have been described as inadequate (Swanson 2008) in disarray, barely functioning, failing farmers (Rivera, Qamar & Van Crowder 2001) and a major concern to all stakeholders (Madukwe 2006).

The failure of agricultural extension in developing countries may be associated with the shift to independence from colonial powers. Such transitions often place significant challenges on extension projects. Anandajayasekeram et al. (2008, p. 2) describes these challenges as:

- Managerial transitions – from colonial to local research and extension administrators;
- Scientific transitions – from expatriate to national scientists;
- Financial transitions – from dependence on financial support from colonial governments and large-scale farmers to mobilising support from national governments, donors and beneficiaries;
- Political transition – from commercial farms to smallholders to private research and extension; and
- New forms of public-private-civil society research-extension partnerships.

With many of these factors beyond the control of extension officers, agricultural extension approaches must focus on what can be controlled: that is, to shift from high input transfer of technology extension to an approach which is based on low external input and uses knowledge creation and learning as drivers for sustainable agriculture.

Historically, the function of agricultural extension in developing countries has been to disseminate technologies developed by public research institutes with the expectation that these new technologies would improve levels of agricultural production. This method of dissemination is known as the transfer of technology approach, a linear model between the research, extension and farmer (see Figure 1). The transfer of technology approach is designed to be a top-down structure where a technology which may improve production is developed, extension officers are trained to use the technology, often to varying degrees, and they in turn teach the farmers to use the technology.

Figure 1. Linear approach to transfer of technology

Despite being highly successful in developing the green revolution, the transfer of technology approach is becoming less suitable for the development of resource-poor farmers.

Andragogy for improved extension

Transfer of technology relies on pedagogy as a form of teaching. Pedagogy is the 'art and science of teaching children' (Knowles 1970, p.40). Pedagogy does not encourage or stimulate continued learning, it fails to connect experience with learning and it does not identify motivations for learning. Simply, it is not suitable for adult learners. As most of the target population for agricultural extension is adults, extension must apply the principles of adult education.

Andragogy, as opposed to pedagogy, is the art and science of teaching adults. Andragogy is the foundational theory of adult learning (Merriam 2001). The term andragogy was first used in 1833 by German high school teacher Alexander Kapp in a book entitled 'Platons

Erziehungslehre' (Platos Educational Ideas) where, although he does not define andragogy, Kapp justifies it as the practical necessity of the education of adults (Reischmann 2004).

Andragogy, like pedagogy, is based on a set of assumptions, however the impact on the learner is very different see Table 1.

Table 1. A comparison of the assumptions of pedagogy and andragogy

Regarding:	Pedagogy	Andragogy
Concept of the learner	The learner is dependent. Society expects the teacher to determine what, how and when learning takes place.	The learner is self-dependent or is shifting towards self-dependence. Adults have a deep psychological need to be self-directing.
Role of the learner's experience	The experience learners bring to a learning situation is of little value. They gain from the experience of the teacher.	Learners' experience is a rich resource, for them and for others.
Readiness to learn	The learner is ready to learn whatever society 'tells' them to learn.	Learners are ready to learn when they have a need for it, for example, to solve a real life problem.
Orientation to learning	Learners acquire subject related content, which will be useful only at a later time.	Learners want to apply what they learnt today to living more effectively tomorrow.

Source: Knowles (1970)

Although the assumptions of andragogy, when compared to pedagogy, would seem like a better approach, pedagogically based transfer of technology continues to be the primary mode of extension in developing countries, leading to the decline of small and medium scale farmer incomes (Swanson 2006). The continued application of transfer of technology in developing countries is evidenced by Greer (2008), Thapa (2010), Sitapai (2012), Rasheed (2012), Curtis (2013), Abdullah et al. (2014), Buyinza et al. (2015), Mossie & Meseret (2015) and Ragasa & Niu (2017). The time is ripe for extension services of these countries to review the applicability of the transfer of technology approach for sustainable agriculture and consider a shift from a linear to a participatory approach.

Participatory approaches to agricultural extension recognise and value andragogy and are embraced as a solution for improved extension (McEntee 2013). Participatory approaches to agricultural extension shift the priorities of extension officers from transfer of know-how to strengthening farmer problem solving of local agricultural issues by combining social and technical innovation (Fleischer, Wailbel & Walter-Echols 2002). There are many and varied approaches to participatory extension but due to the constraints of this paper, only three are considered: farmer field schools, farmer-to-farmer approach and action learning.

Farmer Field Schools (FFS) were originally developed to support farmers in making decisions on pest management that allowed them to reduce pesticides and improve crop management (Braun et al. 2006). FFS programs are generally based around season long, weekly workshops, which focus on biology, agronomy and agroecology (Simpson & Owens 2002), developing farmer confidence and expertise to make evidence based decisions (Van de Berg & Jiggins 2007). FFS programs provide opportunities for farmers to apply what they learn, androgogically speaking, an orientation to learning. Despite the success of farmer field schools, they have been described as lacking an understanding of local needs, poorly funded, having inadequate facilities (Korani 2012), based almost exclusively on 'western' knowledge and perceptions (Simpson & Owens 2002) and having had limited or no effect on economic or environmental performance and impact (Davis 2008; Taye 2013).

The farmer-to-farmer approach is based on the idea that farmers themselves are the ones who have knowledge of the local conditions and culture and have the trust of other farmers (Kiptot & Franzel 2015). The farmer-to-farmer approach provides a social learning environment where farmers share their experiences and knowledge. Andragogically there is a clear role for farmer experience. Although approaches vary, the key feature of the farmer-to-farmer approach is that a volunteer farmer is trained by external agents and the volunteer farmer then shares this knowledge with others (Kiptot & Franzel 2015). It is assumed that if the volunteer farmer adopts a practice or technology then other farmers may learn from the volunteer farmer creating a multiplier effect (Kiptot et al. 2006). The limitations to the farmer-to-farmer approach include: information sharing being limited to kinship ties, jealousy of those who possess the

information and the potential for volunteer farmers having difficulty explaining technical principles (Kiptot et al. 2006).

Action learning addresses sustainable agricultural development through affective, cognitive and psychomotor learning (Battisti, Passmore & Sipos 2008). Androgogically action learning acknowledges farmers are ready to learn. Action learning is a useful tool for developing strategic directions, guiding meeting processes and assisting in group reflection processes when conducting on farm research (Collins et al. 2001). Action learning requires a coach or facilitator who is the mobiliser, learning advisor and learning catalyst (Hale 2012). Action learning is considered a holistic approach (Battisti, Passmore & Sipos 2008) however it lacks a framework for the integration and entwining of science, farmer knowledge and culture. Extension projects which integrate local and western science in collaborative partnership become dynamic learning environments (McEntee 2013). Indigenous knowledge and western science are epistemologically and cosmologically very different and require a framework which can guide the entwining of the two kinds of knowledge.

Building on andragogy for indigenous farmers

The change to more participatory extension approaches is widespread. However, there are many developing countries that continue with pedagogically-based transfer of technology. The time is ripe for extension services of these countries to shift toward a new professionalism, from teaching to facilitation. Facilitation of agricultural extension projects should be constructivist, build trust, and be multidisciplinary (Pretty 1995). Applying the assumptions of andragogy to agricultural extension goes some way to respond to this new professionalism, yet when working in the context of indigenous farmers, andragogy requires further enhancement. Agricultural extension to indigenous farmers should be contextual, value knowledge and culture, create trust, be holistic and understand the impacts of globalisation and post colonialism.

Contextual Agricultural extension should be locally relevant (Mur, Oonk & Bitzer 2016). Agricultural extension must allow for thick contextualisation by linking the local environment, indigenous culture and practices and the concepts of sustainable agriculture.

Culturally aligned Culture characterises a society's beliefs, language, technology, laws and identity. Indigenous cultural knowledge may be stored in various forms such as traditions, customs, songs, legends, proverbs and myths (Omolewa 2007). Indigenous cultural knowledge is often viewed negatively by younger generations (see Muthu et al. 2006; Radcliffe 2016). Promotion and re-valuing of cultural knowledge may shift the learner's identity from one that is often negative to one which is positive (Guy 1999). The principles of sustainable agriculture for indigenous farmers entwine two cultures, therefore both, indigenous culture and western culture, should be acknowledged. Darder (1991) defines this type of education environment as biculturalism, defining it as 'a process wherein individuals learn to function in two distinct sociocultural environments: their primary culture and that of the dominant mainstream culture of the society in which they live' (p.48).

Trust Trust is often raised as a constraint within indigenous adult education (see Kral & Falk 2004; Riggs 2005; Radcliffe 2016). An insufficient understanding of the local context by outsiders and a distrust of Western science accounts for the low adoption rates of many improved agricultural practices and technologies (Verlinden & Daycot 2005). Agricultural extension projects must incorporate mechanisms which strengthen trust between extension officers, learners and cultures.

Valuing indigenous knowledge Agricultural extension officers often have a limited appreciation of indigenous knowledge, hampering their ability to understand local problems, communicate with farmers and identify opportunities for improved practices (Sinclair & Walker 1999). Agricultural extension approaches should attempt to create new knowledge by valuing the knowledge of both indigenous and western worlds. A lack of understanding of a learner's prior knowledge will result in new knowledge being presented in a format which cannot be incorporated into the learners construct, likewise 'if the learner's attention is not drawn to their prior knowledge, the learner will either ignore or incorrectly incorporate the new knowledge' (Baviskar, Hartle & Whitney 2009). The theoretical framework for this approach is constructivism (McGrath 2007) which is based on the principle that learning uses previously acquired knowledge to construct meaning between the new and the old.

Post-colonialism Developing countries are preparing for their third stage of colonisation. The first stage was the need to 'civilise' the non-white people, the second was to 'develop' and finally there is a need for the developed world to 'protect the environment' of the developing countries (Mies & Shiva 1993). Agricultural extension approaches must recognise that developing countries are still to be collaboratively developed, thus any efforts to protect the

environment through a colonialist approach will only promote the Eurocentric social construction of superiority and dominance (Battiste 2004) and leave indigenous farmers lacking self-determination, feeling de-valued and out of place.

Globalization Globalisation was predicted to enhance food security by increasing availability of food to the poor, open trade and improve employment opportunities; the reality is that globalization has led to a decline in household subsistence production (Reddy 2007) and an erosion of indigenous and national culture and language (Pirnea, Lanfranchi & Giannetto 2012). Globalisation is having an irreversible impact on developing countries through land use change, deforestation and land degradation (Mertz, Wadley & Christensen 2005). Globalisation has resulted in many developing countries being shifted to the 'fourth world', moving from a 'structural position of exploitation to a position of structural irrelevance' (Castells 1993, p. 37), what Pirnea, Lanfranchi & Giannetto (2012) term corporate colonialism.

Holism of indigenous farmers Indigenous knowledge is passed from generation to generation in a holistic way (Berkes & Berkes 2009), yet agricultural extension projects are often delivered in fragmented 'chunks' of information. The International Assessment of Agricultural Science and Technology for Development (IAASTD) recommended radical changes and a reorientation of agricultural science and technology, including a more holistic approach (McIntyre et al. 2009). In order for extension projects to establish holistic links, McGrath (2007) suggest three key questions to ask:

1. When we map out the program, what themes will tie the program together?
2. How will different trainers incorporate the themes?
3. What overlap and repetition exists between learning outcomes?

Agricultural extension must acknowledge the multidimensional worldviews of indigenous farmers and not only develop intellectual and vocational aspects of farmers, but also the physical, social, creative and cultural aspects (Mahmoudi et al. 2012).

The Sustainable Agriculture Learning Framework

The central principle of sustainable agriculture is that it must enshrine new ways of learning about the world, but learning should not be confused with teaching' (Pretty & Roling 1997, p.6)

Whilst there are many and varied approaches to agricultural extension including top down, participatory and advisory, there are no clear frameworks which incorporate science, indigenous knowledge, indigenous culture and adult education to enhance sustainable agriculture practices.

Sustainable agriculture has the potential to match the productivity of European farming practices (Ponisio et al. 2015) whilst improving food security and community livelihoods. Sustainable agriculture does not rely on calendar-based activities, but rather observation and anticipation (Pretty & Roling 1997). Hence, to promote sustainable agriculture, agricultural extension projects must provide the necessary learning which helps farmers assess their farms and adjust their systems. Agricultural extension approaches should focus on enhancing sustainable agricultural practices of indigenous farmers through an approach which values science, indigenous knowledge and culture, is farmer-centric and incorporates philosophies of adult education.

Reform needs to shift learning from the reductionist methods of agricultural extension into a new paradigm of learning. Methods of instruction such as transfer of technology must be pushed aside to allow for a deeper learning to take place, as it is proposed that it is this deeper learning which will enable indigenous farmers to understand the purpose, method and practices of sustainable agriculture.

The philosophies of adult education, the principles of sustainable agriculture and the national directives can be drawn together to create a target point for sustainable agricultural extension (see Figure 2). The focal point for these three objectives may be considered as the equilibrium for a sustainable agriculture learning framework.

The underlying objective of the *sustainable agriculture learning framework* (SALF) is to promote learning for change. Although there are various interpretations of learning, it is typically defined as 'a relatively permanent change in behaviour or behaviour potential brought about by experience' (Skinner 2010, p. 167). Learning is multi-dimensional and should not be only measured by the recall of facts or the successful application of a skill. Learning includes the development of judgement, attitudes and values (Hooper-Greenhill 2004). A new set of skills or facts will not necessarily shift indigenous farmers to more sustainable practices. Real change requires a shift in attitudes, values and behaviours along with the knowledge to carry out change.

Figure 2. The target point for the sustainable agriculture learning framework
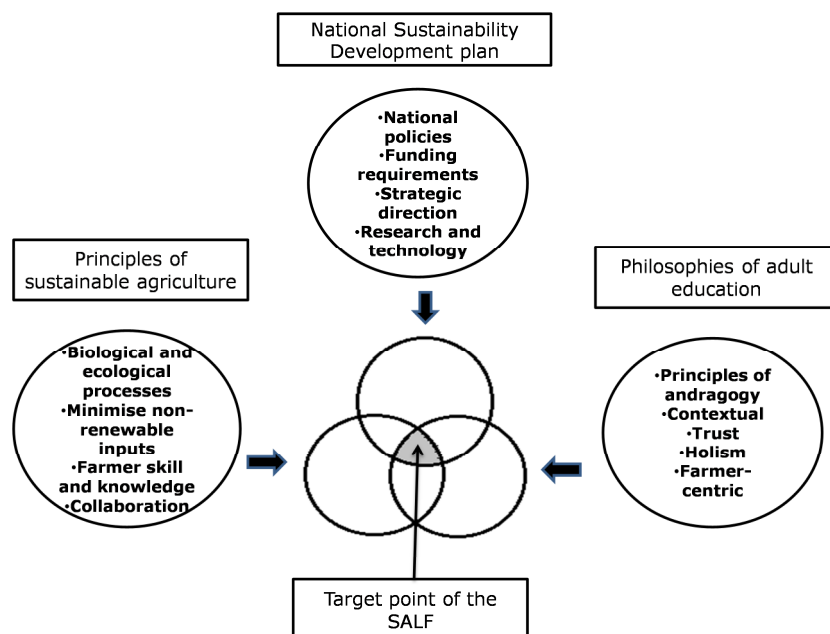
The SALF is a learning framework for the whole self: that is, a holistic philosophy that is relevant to cultural identity and heritage and incorporates prior knowledge, specifically indigenous knowledge and indigenous culture. The agricultural issues which indigenous farmers face are multidisciplinary problems requiring multidisciplinary solutions. As such, the SALF does not focus on a single discipline of science, rather it provides an integrated response which is directed by farmers and facilitated by an agricultural extension officer.

In contrast to the epistemologies of industrial agriculture, sustainable agriculture requires a more social-scientific perspective (Curry & Kirwan 2014). The SALF is not a new set of skills or knowledge, it simply facilitates learning from a perspective different to current extension approaches. The SALF is based on a clear set of philosophies, outlined in Table 2, and is derived from the fundamentals of constructivism, which promote complex, authentic, contextual learning (Huang 2002) and are farmer-centric (Curry & Kirwan 2014).

In keeping with the philosophies of andragogy, the SALF connects into the vast repository of indigenous agricultural knowledge and culture of the farmers. The SALF values the prior knowledge and experiences of indigenous farmers, thus creating an approach which is inclusive of the farmer. Through consultation, indigenous knowledge and science may be woven to create knowledge and learning experiences which enhance sustainable practices. The challenge in doing this is firstly identifying the relevant knowledge, both indigenous and scientific, which enhances sustainable agriculture.

Western science, indigenous knowledge and indigenous culture

Western science is dominated by a positivist, reductionist, rational and compartmentalised way of understanding. It is generally viewed that science should be applied universally as it is based on theoretical concepts founded by research and characterised by objective statistical analyses of controlled experiments (Haverkort & Reijntjes 2010). Indigenous knowledge, on the other hand is based on observation, is subjective and is generally transmitted through oral tradition. At first glance, there are conceptual tensions between science and indigenous knowledge, but when viewed epistemologically neutral, tensions subside and the potential for knowledge creation is clear.

Not all scientific knowledge will enhance sustainable practices, just as not all indigenous knowledge and culture will enhance sustainable practices. All knowledge must be carefully evaluated for inclusion in the SALF. The knowledge for the SALF is evaluated using a set of guiding questions designed to allow for sustainable agriculture knowledge creation with consideration of cultural, social and economic factors. It should be noted that selection of

knowledge components to be integrated into the SALF requires a collaborative partnership between the farmer, community and the extension officer.

Table 2. Philosophies underpinning and guiding the SALF

Philosophy	Understandings of the philosophy
Sustainable agriculture	The underpinning philosophy of the SALF is to provide learning which promotes sustainable agricultural practices. Learning focuses on the social, economic and environmental components of agriculture.
Indigenous knowledge and culture and western science	The framework entwines indigenous knowledge, indigenous culture and science, establishing a post positivist constructivist approach.
Social negotiation and shared responsibility of farmers	A shared responsibility between farmers and extension officers provides a sense of ownership, empowerment and self-determination.
Evaluates the multiple systems involved	Learning should incorporate natural, social and artificial (print and other media) systems.
Multi-modal	The framework identifies and allows for multiple intelligence and incorporates multiple modes of learning.
Farmer-centred	The framework encourages deeper learning by facilitating indigenous farmers to create knowledge as opposed to passively receiving information.
Contextual/ Authentic	The framework offers contextual learning, that is, it: • has an emphasis on problem solving and critical thinking • enhances self-regulated learning • encourages shared learning • is authentic/real.
Facilitated learning	The framework facilitates dialogue, experimentation and evaluation of knowledge and resources rather than teaching knowledge.
Critical thinking/reflection	Opportunities to reflect during and after learning may encourage farmers to critically evaluate their learning.
Built from internal motivations	Clearly identifying farmer internal motivations enhances engagement, participation and a willingness to learn.
Empirical	Learning should be based on observation and experimentation within the socio-cultural and economic contexts.
Shared knowledge	The framework relies on knowledge being shared between farmers, the community, extension officers and government departments.

Guiding questions for knowledge evaluation

The evaluation of knowledge for inclusion in the SALF is guided by nine questions that are as follows:

1. Is it considered as valuable knowledge?

Knowledge considered for the SALF must be considered as valuable. The term 'value' refers to its potential to positively impact agricultural practices, skills or knowledge within the context of where it will be used. The potential value of knowledge should be established collaboratively with farmers, elders and the extension officer.

2. Will this knowledge build community capacity?

Knowledge should only be selected if it focuses on enhancing the community's ability to identify and address agricultural constraints by accessing information, developing skills and knowledge, and managing resources.

3. Does it support community aspirations?

The knowledge selected should align with the aspirations of the community. Aspirations of the community may be shared through a community of practice, interviews, surveys and/or observation. In situations where the aspirations of the community are not clearly shared, the facilitator of the SALF may consider requesting feedback on particular components of the SALF during facilitation. Feedback should be recorded for future reference.

4. Will it promote sustainable practices?

The primary objective of the SALF is to promote sustainable agricultural practices, thus knowledge should be evaluated for its potential to enhance current agricultural knowledge and/or skill in practices. To be accepted as knowledge which will promote sustainable agriculture, it should meet the requirements of four key requirements, derived from Pretty (2008), being:

1. the knowledge integrates biological and ecological processes
2. the knowledge minimises the use of no-renewable inputs
3. the knowledge makes use of farmer skills and knowledge
4. the knowledge enhances the collective capacity of people working together.

5. Will it promote experimentation and innovation?

The agricultural landscape is ever changing, perhaps more rapidly than ever before, requiring farmers to adapt through experimentation and innovation, particularly in regions where agricultural extension is rare. Knowledge, indigenous or scientific, should be evaluated for its ability to promote farmer experimentation and innovation.

6. Does it build or maintain trust?

Knowledge must be evaluated for its potential to maintain or enhance trust, within the community and between the community and the extension officer. Knowledge which limits trust may include knowledge which does not align with cultural or custom practices, knowledge which benefits a particular person or family or knowledge which comes with restrictions (often a basis of donor-funded projects).

7. Does it support gender neutrality?

In developing countries, women often carry out the bulk of the farming practices. As such, knowledge should be evaluated for its applicability to both male and female participants. Programs which focus on women farmers often leave the men feeling de-valued and programs which focus on male farmers fail to recognise the significant role women play in agriculture.

8. Does it fit within the realm of cultural and/or customary acceptance?

Aspects of Western science may be considered as topics of taboo among some indigenous communities. All new knowledge should be developed with the inclusions of community elders and or community leaders to assess its cultural acceptance.

9. Is there a conflict between the two forms of knowledge?

At times, scientific knowledge may conflict with the indigenous knowledge, therefore knowledge must be evaluated collaboratively with the community. Epistemological conflict is inevitable and the knowledge evaluation process must acknowledge this inevitability. Strategies to resolve such conflicts must be established collaboratively with all key stakeholders.

Limitations of the SALF

As with any extension approach, the SALF is bound by limitations and constraints including issues of trust, alignment with national directives, cost and the need for training of extension officers to become facilitators. In some ways it is these limitations which actually enhance the approach. For example, the SALF is limited to working with small communities, yet it is through this small community approach which ensures agricultural extension projects are inclusive, based on the community needs and value community knowledge. Such a community based approach may enhance economic and environmental impact beyond those who attend.

Whether or not a component of knowledge is deemed to promote sustainability may not necessarily be known until after it has been woven with the other forms of knowledge or even after medium or long term follow up, thus limiting the efficiency of the SALF. Policies which promote the documentation and validation of indigenous knowledge may encourage a regional or national repository of knowledge relevant to sustainability. Such a repository may improve the efficiency of the SALF as it could provide validated knowledge which is adaptable to various contexts.

The SALF requires an understanding of indigenous knowledge and culture, yet if the extension officer is from the community, there may be hierarchical restrictions which limit access to indigenous knowledge and culture. It has been observed by this author that an extension officer from a different region has a more immediate respect and greater access to knowledge and cultural systems of the community. This aspect of the SALF will vary among different countries and cultures.

The SALF requires recognition by government agencies that national targets and directives can be achieved through sustainable agriculture. If timely production targets are viewed as the priority for the SALF, then it is unlikely that the approach will be successful.

The major limitation to the SALF is the required training for the extension officers and the attitude of the government department. Shifting the extension officer's approach from teacher to facilitator will require training and this requires the support of the government departments. To achieve a shift in institutional attitude, there must firstly be national recognition of the value of indigenous knowledge and culture.

Government failure to allocate funds to run agricultural extension projects in developing countries continues to impede agricultural extension projects. A lack of commitment by government agencies to funding the SALF will limit the success of the extension approach.

Conclusion

Climate change, population growth, urban expansion and political instability are placing concerns over food security in developing countries. Sustainable agriculture has the potential to not only reduce food poverty but also improve people's livelihoods. Indigenous farmer knowledge and indigenous culture may contribute to the global knowledge of sustainable agriculture.

Sustainable agriculture is knowledge intensive and although there is no 'one size fits all' approach to agricultural extension it is recognised that participatory approaches improve farmer knowledge. It is suggested that agricultural extension for indigenous farmers requires further enhancement, as such, this paper presents an alternative approach to agricultural extension, the sustainable agriculture learning framework (SALF). The SALF is heavily influenced by the philosophies of adult learning and entwines indigenous knowledge and culture with science to provide opportunities for knowledge creation and deeper learning as a mechanism for change.

The SALF is currently being trialled with farmers in Papua New Guinea and Vanuatu and initial feedback from farmers has been positive, however further research into agricultural extension approaches for indigenous farmers is required.

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